2017 summer outlook winter review 2016-2017

1 June 2017

entsoe

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1. Executive Summary

The 2017 Summer Outlook points to possible unbalances between generation and consumption – adequacy issues - in Italy and Poland. These risks only materialise in the case of severe weather conditions, such as a sustained heat wave.

In Italy, in the case of severe conditions with very high temperatures, adequacy might be at risk during most of the summer period. The most critical period is expected to be from mid-June till the end of July and the risks mainly concern Central and Northern Italy.

In Poland, the sensitivity analysis carried out for the European synchronous peak time of 19.00 Central European Summer Time (CEST) does not show any risk for Poland, but there could be risk to the security of the supply at other times during the day under severe conditions. In addition, a balance problem may occur during the day. Indeed, during the summer season (except in September), local peak load in Poland occurs between 13:00 and 14:00 CEST and the capacity of solar generation in Poland is still negligible. Even though there is a high amount of solar generation available during this period in neighbouring Germany, import possibility to Poland is significantly limited due to unscheduled flows through the Polish system (in the west to south direction).

Regarding downward regulation[1], each country would have sufficient transmission capacity to export a surplus of renewable generation during off-peak time. Only possible partial and limited-in-time photovoltaic (PV) or wind spillage might occur in Southern Italy, Sicily, and Sardinia during some sunny Sundays.

The Review of Winter 2016/2017 is complemented by a dedicated ENTSO-E report on the cold spell of January 2017. The report entitled "Managing critical grid situations" is looking in detail at the consequences of the cold spell on systems and markets in the most impacted countries.

The analysis of the net generating capacity confirms the decrease in nuclear and thermal, except gas, and an increase in wind and solar.

[1] Assessment of potential generation excess under minimum demand conditions, cf. chapter 3.3.2

2. Introduction

2.1. Purpose of the Seasonal Outlooks

ENTSO-E and its member transmission system operators (TSOs) analyse potential risks to system adequacy for the whole ENTSO-E area, which covers 36 countries including Turkey.[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 possibility for a power system to meet demand at all times and thus guarantee the security of the supply. The ENTSO-E system adequacy forecasts present the views of the TSOs on not only the risks to security of supply but also the countermeasures they plan, either individually or by cooperation.

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

The outlooks are performed based on the data collected from TSOs and using a common methodology. To add to this, ENTSO-E uses a common database in its assessment, the Pan-

[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.

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

In addition, in the Summer 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 an excess in generation, typically when the wind is blowing at night when demand is low or when the wind and sun generation are high but demand is not, for example a sunny Sunday.

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

Current summer outlook calculations were done for each week between 31 May 2017 and 1 October 2017. The winter review examines the system adequacy issues registered between 30 November 2016 and 2 April 2017.

The aim of publishing this forecast is two-fold:

1) 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 in difficulty. Moreover, all TSOs share with one another the remedial actions they intend to take within their control areas. This information sharing contributes to increasing the security of supply and encourages cross-border cooperation.
2) The publication also informs stakeholders of potential risks to system adequacy. The goal is to raise awareness and incentivise stakeholders to adapt their actions to reduce these risks by, for instance, reviewing the maintenance schedules of power plants, the postponement in decommissioning, and other risk preparedness actions.

If, after the final edition for publication of this 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 SMTA[5] experimentation, which is a

[4] Assessment of potential generation excess under minimum demand conditions, cf. Chapter 3.3.2.

[5] SMTA: Short- and medium-term adequacy.

setup between TSOs and regional security coordinators. This experimentation aims to check and update short- and medium-term active power adequacy analyses in line with agreed ENTSO-E methodologies for timeframes 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 analysis of net generating capacities in Europe confirms the decrease of nuclear and thermal, except gas, and the increase of wind and solar.

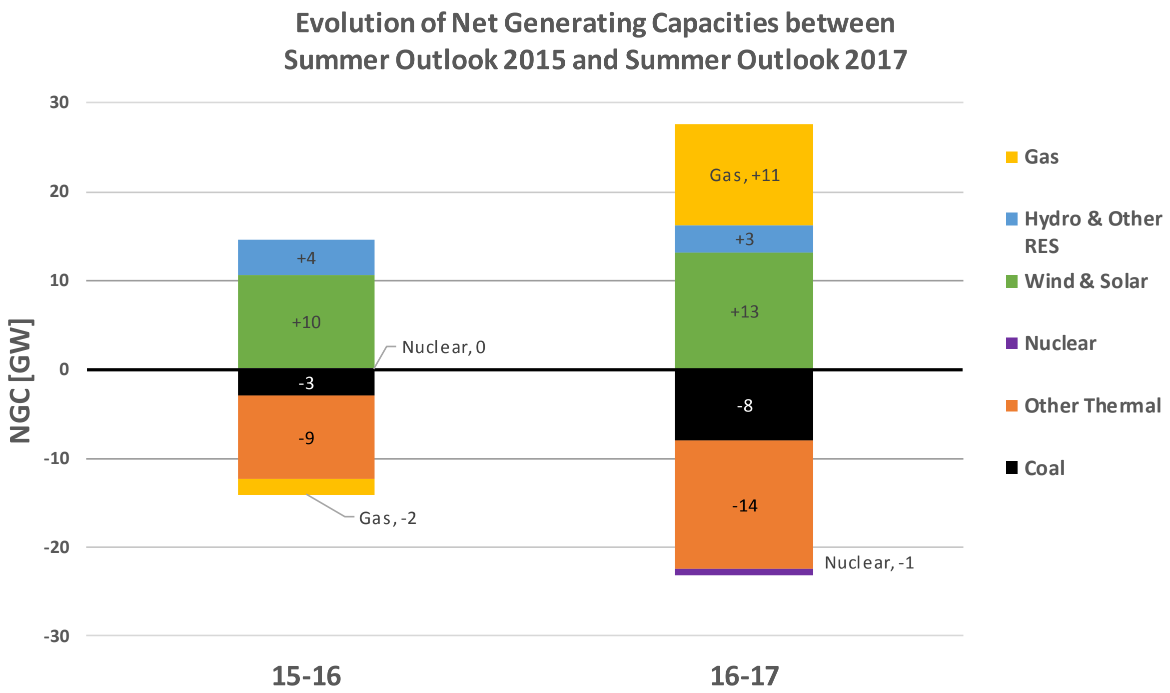


Figure 1: Evolution of net generating capacity per technology

Figure 2: Evolution of the net generating capacity from summer 2016 to summer 2017

In figure 3 one can see the net generating capacities including wind & solar for week 30 (the last week of July; a reference week for summer outlooks). The greener a country the more net generating capacities it has compared to its peak load (consumption peak).

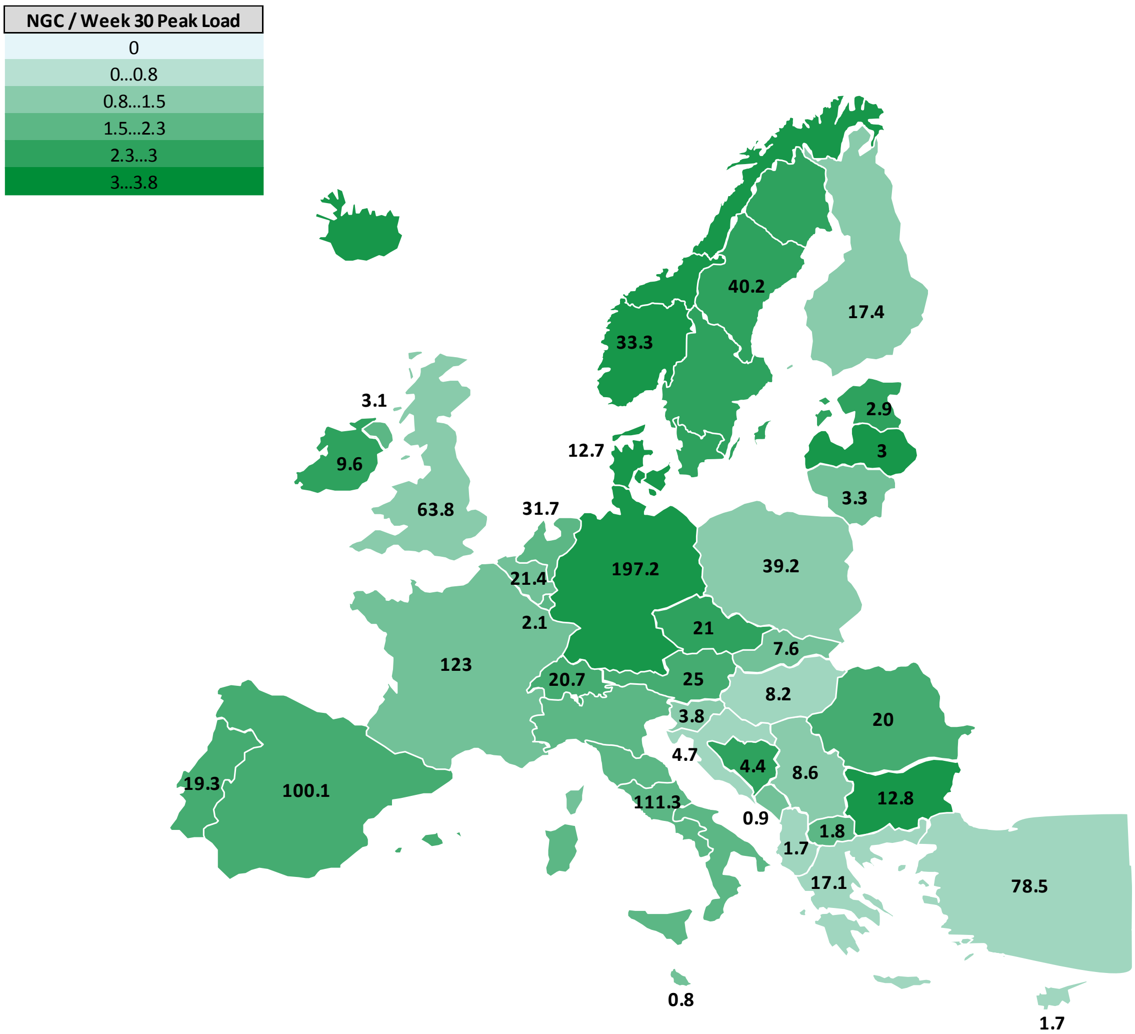


Figure 3: Map of net generating capacities versus peak load

3. 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, 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.*[6]

To improve data quality and pan-European consistency, ENTSO-E invested in a pan-European Climate Database (PECD 2.0) which covers 34 years of historical data (1982 to 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;
- The load sensitivity to temperature in each country is calculated based on the PECD.

3.1. 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' under either normal conditions or severe conditions.

- '**Normal conditions'** correspond to average weather conditions resulting in a normal peak demand, normal wind production and hydro output, and an average outage level of classical generation power plants;
- '**Severe conditions**' correspond to severe weather conditions resulting in a higher peak demand, low wind production and hydro output, and a high outage level of classical generation power plants. This scenario is not extreme but corresponds to the percentile P90, which means that the conditions could happen once in ten years.

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

The analysis is the same under normal or severe conditions and is schematically depicted in the figure below:[7]

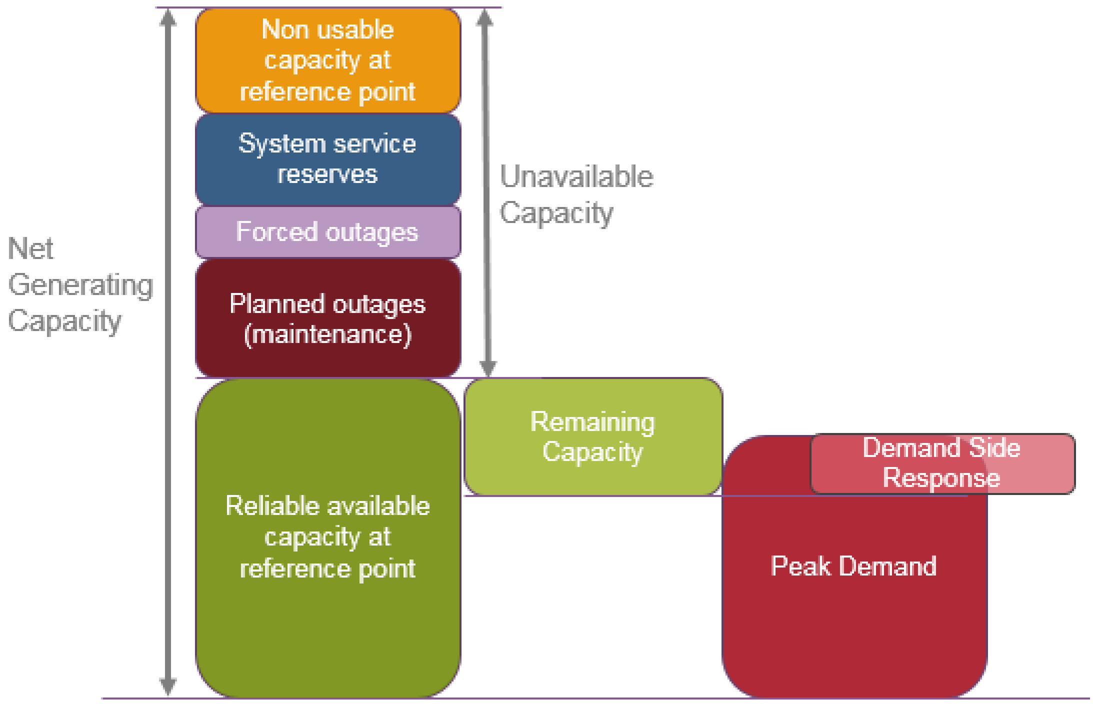


Figure 4: Upward adequacy methodology.

The upward adequacy analysis highlights periods when countries have remaining capacity or when countries are lacking remaining capacity 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 CEST. At this time, the highest European residual load[8] is identified in a database of 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,

[7] See Glossary for definitions in Appendix 4.

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

they may differ from the scenarios evaluated in each individual country-perspective analysis, which correspond to significant and realistic conditions for each country. For example, the severe conditions of the entire European system do not correspond to the ‘simple envelope’ of each individual severe condition.

For the upward simulations, the demand reduction measures and available strategic reserves are considered, as reported by the TSOs.

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 combined heat and power 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:

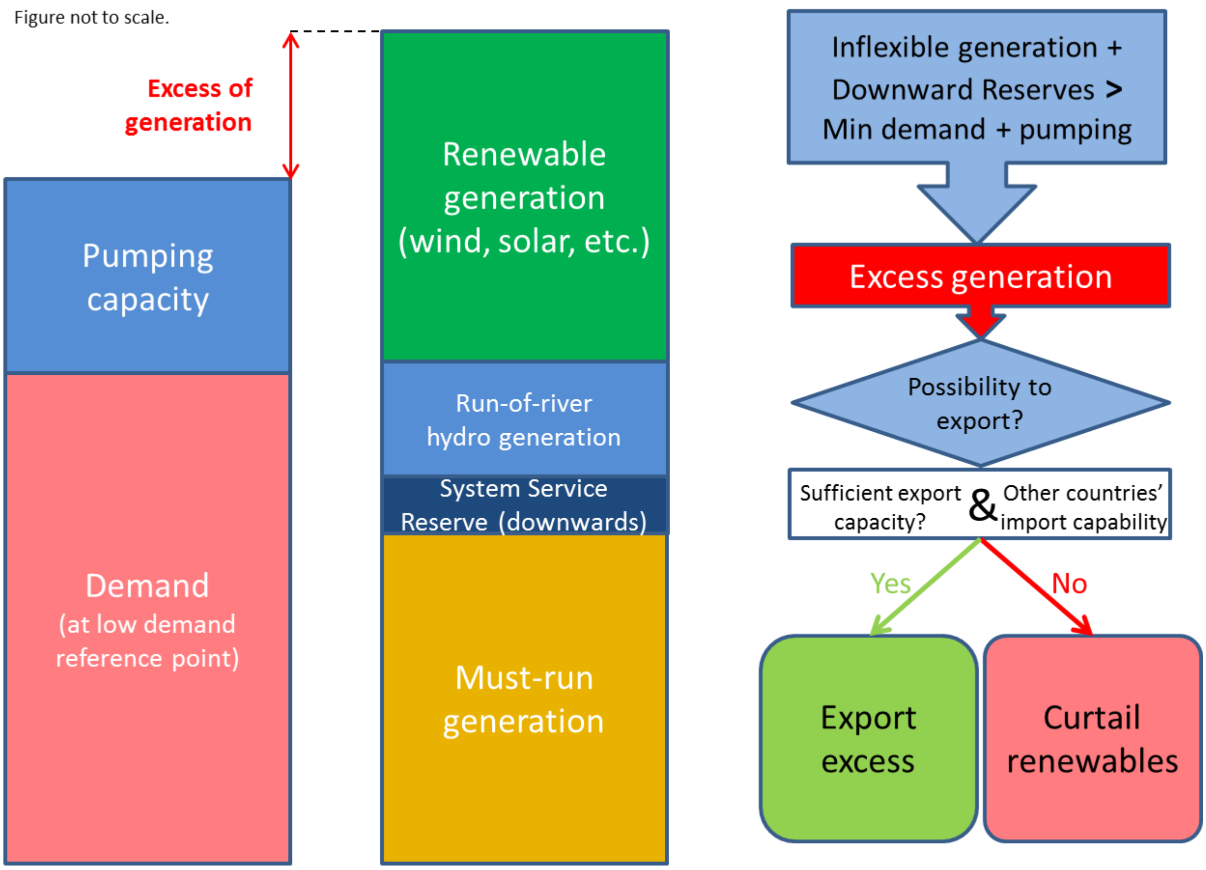


Figure 5: Downward adequacy methodology.

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 CEST and 11:00 CEST. At 05:00 CEST, 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 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.

3.2. Upward Adequacy and Downward Regulation Methodology

3.2.1. 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. In case a potential shortage is detected in one or more countries, the potential curtailment *will be equally shared*. In other words, the ratio of the curtailed energy to the initial remaining capacity will be equal among those countries. In real system operation, the sharing of curtailed energy follows much more complex rules, which can lead to significantly different curtailed energy sharing.

The pan-European analysis consists of several steps. The **first element** that is checked is whether, in a ‘copperplate’ scenario, there is enough power capacity to cover the demand. Here, all remaining capacity 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 net transfer capacity (NTC) values;
- 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 the Ukraine (except Burshtyn Island, which operates synchronously with continental Europe), the following values were assumed for the pan-European analysis:

- The balance (remaining capacity) of these systems was set at 0 MW.
- 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 (incl. run of river),
5. Nuclear,
6. Coal,
7. Gas,
8. Other non-renewable sources,
9. Hydro-pumped storage, and
10. Demand-side management and 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.).

3.2.2. 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[9] 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 Section 3.4.

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.

3.3. Data Processing

3.3.1. 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

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

PECD. This PECD contains, per country and per hour, load factors for solar, onshore wind, and offshore wind in a 34-year period (1982 to 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 one hour before the reference time and one hour after the reference time, on a date (day/month) from six days before the reference date and six days after the reference date. This yields a collection of 1326 records (34 years x 13 days x 3 hours) per reference time point;
- To achieve country representative load factors for the adequacy analysis, the 50th percentile (median) and 10th percentile (1 out of 10 situations) of the record collections are calculated for upward adequacy under normal and severe conditions for the renewable capacity factors per country (solar, onshore wind, and offshore wind).

Thus, consistent pan-European renewable infeed scenarios are created. For example, the 10th percentile scenario represents a consistent severe scenario for the different countries and for the different primary energy sources. It should be noted that this approach guarantees a 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 10th 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 90th percentile (value that is exceeded in 10% of situations).

3.3.2. 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 2. 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 2 for details).

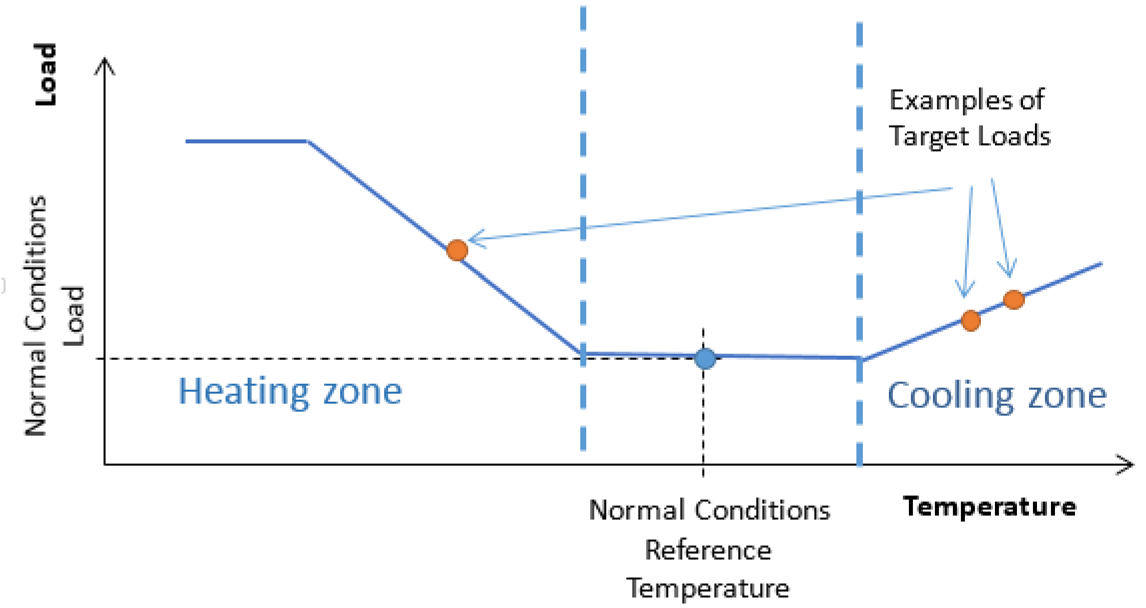


Figure 6: Load-temperature sensitivity.

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).

3.3.3. Import/export capacity

The import/export capacities (NTC values) 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 good estimate of the minimum 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 to limit the global imports or exports of a country.

3.4. Future Expected Improvements

In the constant improvement process and considering the lessons learnt of the past winter season, further improvements will be investigated for future Seasonal Outlooks:

- Investigate ‘stress tests’, not only regarding temperature but also regarding other known critical conditions, based on historical experience by TSOs (dry years, multiple outages, etc.).
- Investigate how to improve hydro modelling (e.g., using starting level and historical seasonal evolution of hydro reservoirs). This is identified as one of the most complex topics.
- Prepare implementation of the Clean Energy Package, especially Risk Preparedness Plan regulation, through coordinated methodology development with the week-ahead adequacy project.

The first proposal above related to more severe scenarios will to be addressed from next Winter Outlook 2017/18, considering the lessons learnt from the January 2017 cold spells. The other improvements are starting as well but will need more time for implementation.

4. Summer Outlook 2017 – Upward Adequacy Results

A pan-European assessment of the upward adequacy (cf. methodology explained in Chapter 3) was performed.

4.1. Upward Adequacy Under Normal Conditions

Based on normal conditions for generation and demand, most of the countries do not require imports at the synchronous reference time point, as shown in Table 1 and in Figure 7. Where a country is coloured green, it has excess capacity to meet demand and reserves. The countries that are fully coloured in purple can cover their deficit with imports, whereas the pan-European analysis revealed that, for the countries that show partial orange results, their deficit cannot be fully covered with imports due to insufficient reported cross-border exchange capacities or a lack of energy. The portion of the cell that is coloured in orange reflects the portion of the deficit that cannot be covered with imports. In addition, a **simplified merit-order approach**[10] was considered; the countries and weeks that do not require imports from an adequacy perspective but could from a market point of view are coloured in light blue.

[10] It is important to note that the merit-order approach is an assumption and that the presented table may not represent the real market situations.

Table 1: Upward adequacy at synchronous peak time under normal conditions.

- E (green): Country prone to export from a market perspective
- I (light blue): Country prone to import from a market perspective
- R (purple): Country required to import from an adequacy perspective

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

Figure 7: Generation adequacy map under normal conditions.

4.2. Upward Adequacy Under Severe Conditions

Under severe conditions (this is a constraining scenario to detect countries or regions potentially at risk), the picture is somewhat different; the demand of several individual countries increases, while generation availability might be lower due to, for instance, unfavourable meteorological conditions.

Simplified merit-order approach:[11] The countries and weeks that do not require imports from an adequacy perspective but may require from imports from a market point of view are coloured in light blue.

[11] It is important to note that the merit-order approach is an assumption and that the presented table may not represent the real market situations.

Table 2: Upward adequacy at synchronous peak time under severe conditions.

- Country prone to export from a market perspective
- Country prone to import from a market perspective
- Country required to import from an adequacy perspective
- 25% of deficit cannot be covered with imports
- 50% of deficit cannot be covered with imports

Week	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
AL	Export	Required	Export	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Export	Export
AT	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Required
BA	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
BE	Import	Import	Import	Import	Import	Import	Import	Import	Export	Import	Import	Import	Import	Export	Import	Import	Import	Required
BG	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
CH	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
CY	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
CZ	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
DE	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
DK	Import	Import	Import	Import	Import	Import	Import	Import	Import	Required	Required	Required	Required	Import	Import	Required	Import	Required
EE	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
ES	Import	Import	Import	Import	Import	Import	Import	Export	Export	Import	Import	Import	Import	Export	Import	Import	Import	Import
FI	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
FR	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
GB	Import	Import	Import	Import	Import	Import	Import	Export	Export	Import	Import	Import	Import	Export	Import	Import	Import	Import
GR	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
HR	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
HU	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required
IE	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
IT	Import	Import	Required	Required (deficit)	Required	Required	Required	Required (deficit)	Required (deficit)	Required	Required	Import	Required	Required (deficit)	Required (deficit)	Required	Required	Required
LT	Required	Required	Required	Required	Import	Import	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required
LU	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
LV	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required
ME	Export	Export	Export	Export	Export	Export	Export	Export	Export	Import	Import	Import	Import	Import	Export	Export	Export	Export
MK	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required	Required
MT	Import	Import	Import	Export	Import	Import	Export	Export	Export	Import	Import	Import	Import	Export	Export	Import	Import	Import
NI	Import	Import	Import	Import	Import	Import	Export	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import
NL	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Import	Export	Import	Import	Import
NO	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
PL *	Export	Export	Export	Export	Export	Export	Export	Required	Export	Export	Export	Export	Export	Export	Export	Import	Export	Export
PT	Export	Export	Export	Export	Export	Export	Export	Import	Export	Import	Export	Export	Export	Import	Import	Export	Export	Export
RO	Export	Export	Export	Export	Export	Export	Export	Export	Import	Import	Import	Export	Export	Export	Export	Import	Import	Import
RS	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
SE	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
SI	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export
SK	Import	Required	Required	Required	Required	Import	Import	Import	Import	Import	Required	Required	Required	Required	Required	Required	Required	Required
TR	Export	Export	Export	Export	Import	Export	Import	Export	Import	Import	Import	Import	Import	Import	Import	Export	Import	Import
UA_W	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export	Export

* In Poland, even if no adequacy issue was identified for European synchronous time at 19.00 CEST, a balance problem may occur during local peak time in the early afternoon (see Chapter 4.5).

The European map below provides another view of the data from the above table. It indicates the countries expecting a need for imported energy for at least one week of the considered period or for all weeks of the considered period, respectively.

Figure 8: Generation adequacy map at peak time under severe conditions.

4.3. Sensitivity Analysis with Six Bidding Zones in Italy

The deterministic country approach in the previous chapter showed that Italy may have an adequacy issue during some weeks of the coming summer. To estimate which part of Italy would be more concerned by adequacy risks, a detailed modelling of Italy was implemented, moving from a country to a bidding zone perspective; the six Italian 'geographical' bidding zones have been implemented in the model, as already modelled in other studies.[12] Table 3 and Figure 9 show upward adequacy under severe conditions with Italy partitioned into six zones (North, Central-North, Central-South, South, Sardinia, and Sicily).

[12] As in ENTSO-E Mid-Term Adequacy Forecast.

Table 3: Upward adequacy at synchronous peak time under severe conditions with six nodes in Italy.

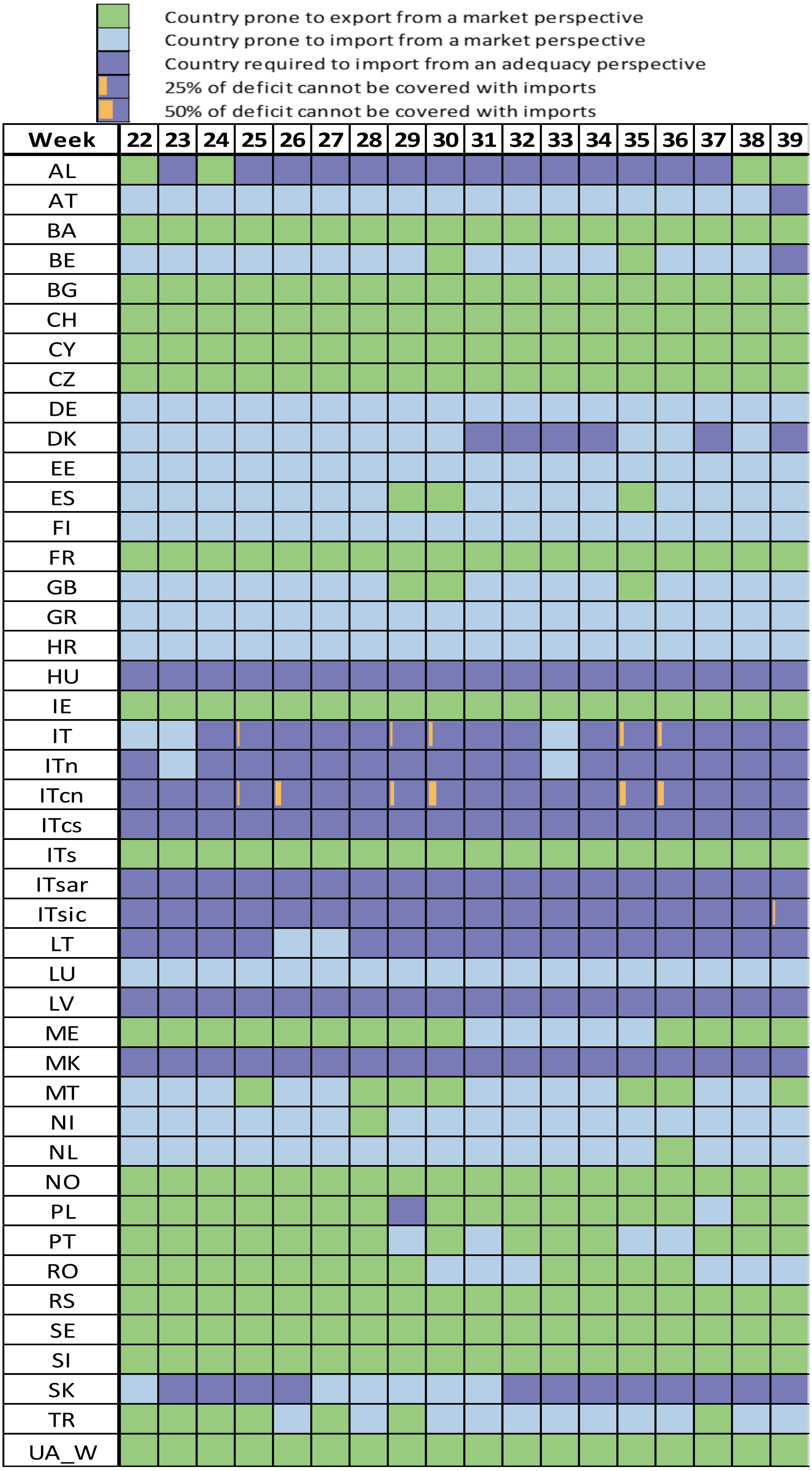


Figure 9: Generation adequacy map at peak time under severe conditions with six nodes in Italy.

4.4. Probabilistic Sensitivity Analysis in Italy

The results of the conducted deterministic simulations in the case of severe conditions have demonstrated that Italy could be subjected to the elevated risk of the lack of demand coverage during the summer period (i.e., June – September), with the exception of the central weeks of August, while the worst period in the terms of adequacy is expected from week 25 to week 30.

This situation has increased the necessity of conducting the probabilistic evaluation aimed at estimating the expectation of the lack of adequacy. Determining the most representative week for conducting this evaluation was led by the fact that this week is effectively the most critical in the deterministic analysis but the operational experience from the previous years was also considered. In line with previous assumptions, week 30 has been selected for the probabilistic simulations.

The results of the probabilistic analysis have confirmed the elevated risk of the lack of adequacy in the case of particularly high temperatures and medium/low PV/wind production in Italy.

Examining the results of the evaluation more closely, the possible adequacy absence would occur in the Central-North zone of Italy due to the low availability of the production in the corresponding area. It should also be pointed out that the cross-border capacities of some borders are not expected to be fully used in some of the simulated system conditions. Such behaviour appears on the borders between Italian bidding zones but, in some cases, could also involve borders with neighbouring countries, where the excessive capacity is not sufficient to saturate the exchange limits (price convergence could be expected).

The figure below highlights an example where all northern Italy interconnections are saturated (red), whereas the Italy North to Central-North link is not saturated. In this case, even considering the full import from neighbouring countries, the excess of capacity in the North bidding zone is not sufficient to fully use the cross-border capacity from North to Central-North: the same (high) price can be expected in both zones.

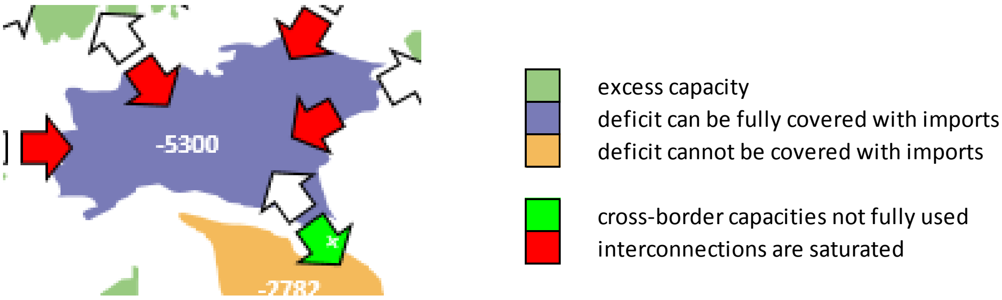


Figure 10: Example of possible grid situation in Italy.

However, in most the simulated cases, the generation availability in the other Italian bidding zones would cover this deficit in a sufficient manner.

The figures below summarise the results of the probabilistic evaluation. The x-axis represents the cumulated wind and PV production in Italy as a whole and the Central-North zone, respectively, while the y-axis represents the daily average temperature scale. Orange dots represent the cases with negative margins. The simulations refer to hour 19 of the day with a corresponding PV production that is quite low (around 1000 MW) and very variable wind production. It is important to point out that the installed capacity of wind is not high in the Central-North zone. This can be observed from the two figures observing the shapes of the clusters. On the national level, the effect of wind is not a predominant, as the swarm is spread out (Figure 11), while the situation is quite different in case of the Central-North zone, where the cluster is more concentrated (Figure 12).

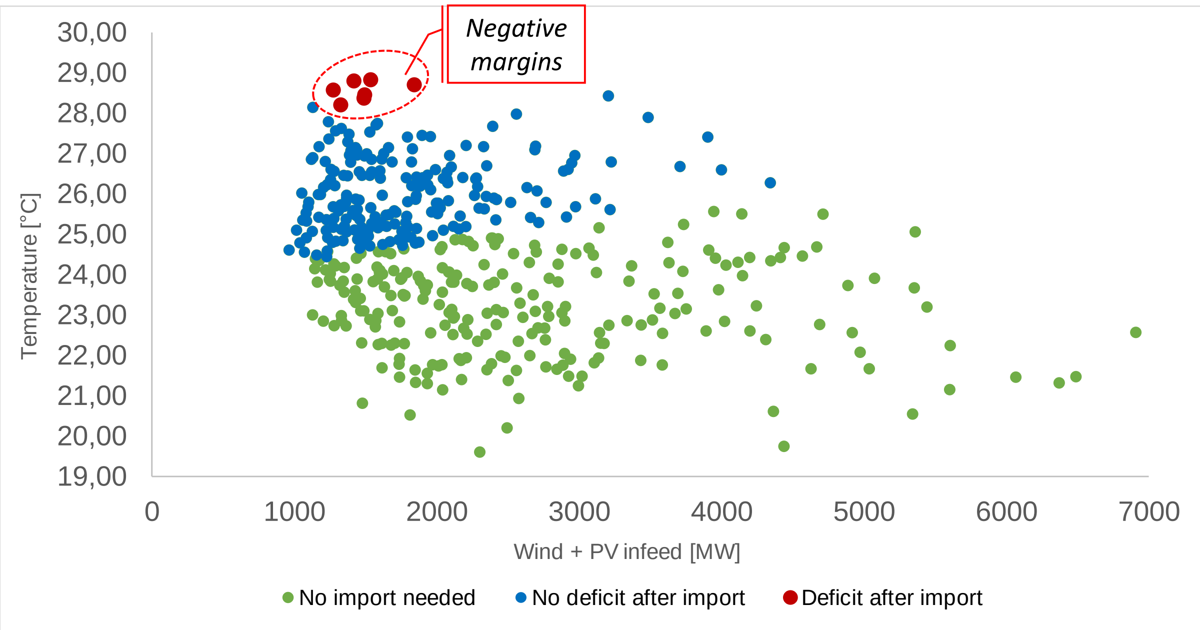


Figure 11: Outcomes of the probabilistic assessment – national level.

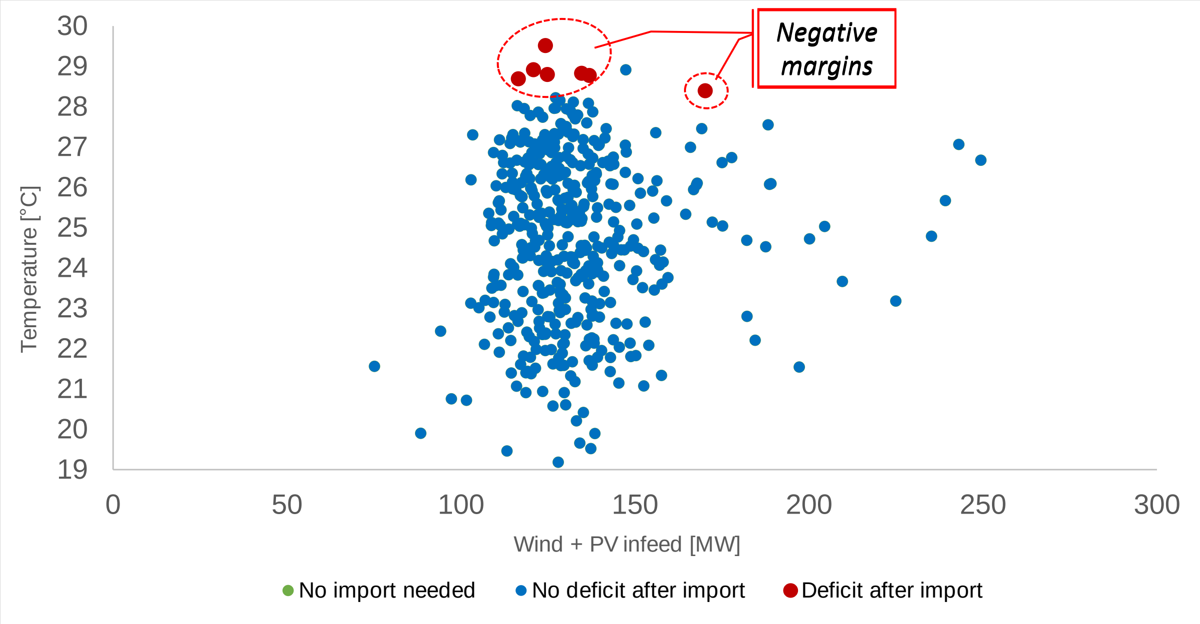


Figure 12: Outcomes of the probabilistic assessment – bidding zone CN.

In conclusion, from these probabilistic simulations, in case of very high temperatures (>28°C), it could be highly challenging to cover the demand (probability of risk occurrence ~20%). This temperature threshold has been exceeded in 16 out of the last 35 years (on one or more days).

4.5. Adequacy Sensitivity for Local Peak Time in Poland

In Poland, under severe conditions, even if no adequacy issue was identified for European synchronous peak time at 19:00 CEST, a balance problem may occur during the day, like the problem that occurred in August 2015. During the summer season (except for September), the peak load in Poland occurs between 13:00 and 14:00 CEST and the capacity of solar generation in Poland is still negligible. Indeed, there is a lot of solar generation available at the same time in Germany, a neighbouring country, but the import possibility to Poland is significantly limited due to unscheduled flows through the Polish system (in the west to south direction).

For almost all reference points, Poland has a negative balance, and in two of them (in weeks 29 and 30), the negative balance even exceeds the forecasted import capacity.

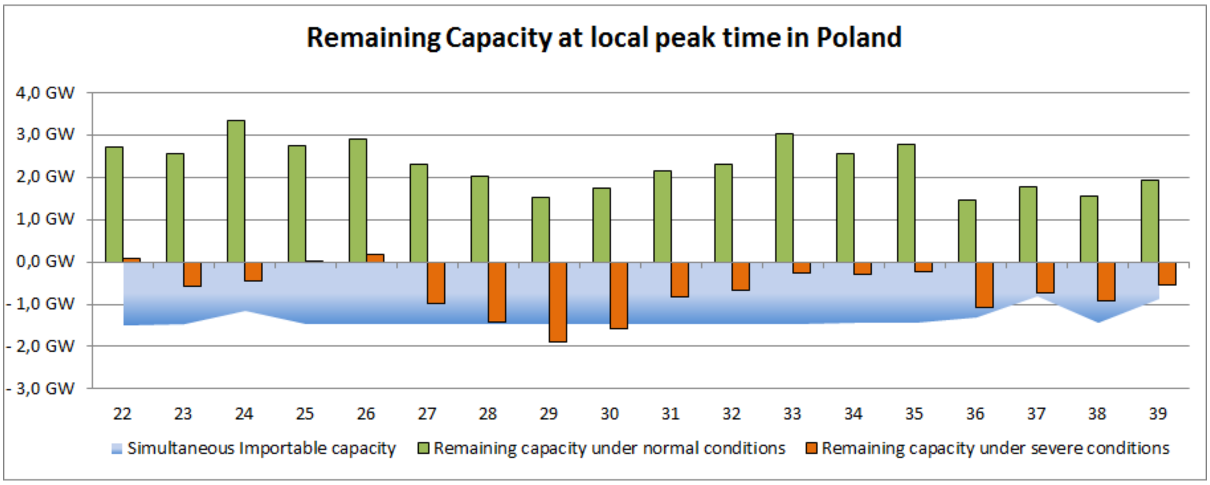


Figure 13: Upward adequacy in Poland at local peak time

Available import capacity comes from Sweden, Lithuania, Ukraine (radial operation), and the synchronous profile[13] with DE+CZ+SK[14]. Except during planned maintenance, import capacity from Sweden, Lithuania, and Ukraine are not limited by any network constraints and refer to technical capabilities of the interconnections with Sweden and Lithuania, and the dedicated units on Ukraine side. Due to above mentioned unscheduled flows that the Polish TSO evaluates, only around 200 MW might be available on the synchronous profile with DE+CZ+SK. The Polish TSO may use a few remedial actions like demand side response or an increase of import possibility (described in detail in Appendix 1 of this report), but the situation in August 2015 proved that such countermeasures may not be enough to keep the system in balance, and load reduction might be necessary. Therefore, the Polish TSO is of the opinion that the missing capacity problem will be solved by the implementation of a capacity market in Poland.

More information about the situation for the coming summer is accessible in the chapter with national comments, and a detailed description of unscheduled flow problems can be found in the previous Outlook reports (e.g., Summer Outlook 2016[15]).

[13] A profile means a geographical boundary between one bidding zone (area where electricity is traded without capacity allocation) and more than one neighbouring bidding zone. Synchronous indicates that it is managed at the same time.

[14] Germany, Czech Republic, Slovakia

[15] https://www.entsoe.eu/Documents/SDC%20documents/SOAF/2016_Summer_Outlook_REPORT.pdf

5. Summer Outlook 2017 – Downward Regulation Results

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

The downward regulation margins were calculated for, respectively, windy Sunday nights (very low load and high wind) and Sunday daytime with high PV generation. These margins were calculated while making certain assumptions (the once-in-ten-years highest solar and wind infeed scenario was considered) for renewable infeed and are therefore not a prediction for the reference points.

5.1. Daytime Downward Regulation

The results of the analysis of available downward regulation margins at the daytime reference time point (19:00 CEST) are shown below in Table 4. Where a country is coloured green, it has sufficient downward regulation margin. The countries that are fully coloured in purple can export their excess energy, whereas for the countries that show partial orange results, the pan-European analysis revealed that their excess cannot be fully covered with exports, considering the reported NTC values.[16] The portion of the cell that is coloured in orange reflects the percentage of export capacity increase that would be needed to evacuate the excess of generation in the concerned country.

[16] More details on NTC data collection in chapter 3.4.4.

Table 4: Export needs at the daytime minimum (reference points on Sunday 11:00 CEST).

- ○ no generation excess (no need to export)
- ● excess can be covered by export
- 25% of excess cannot be covered by export
- 50% of excess cannot be covered by export

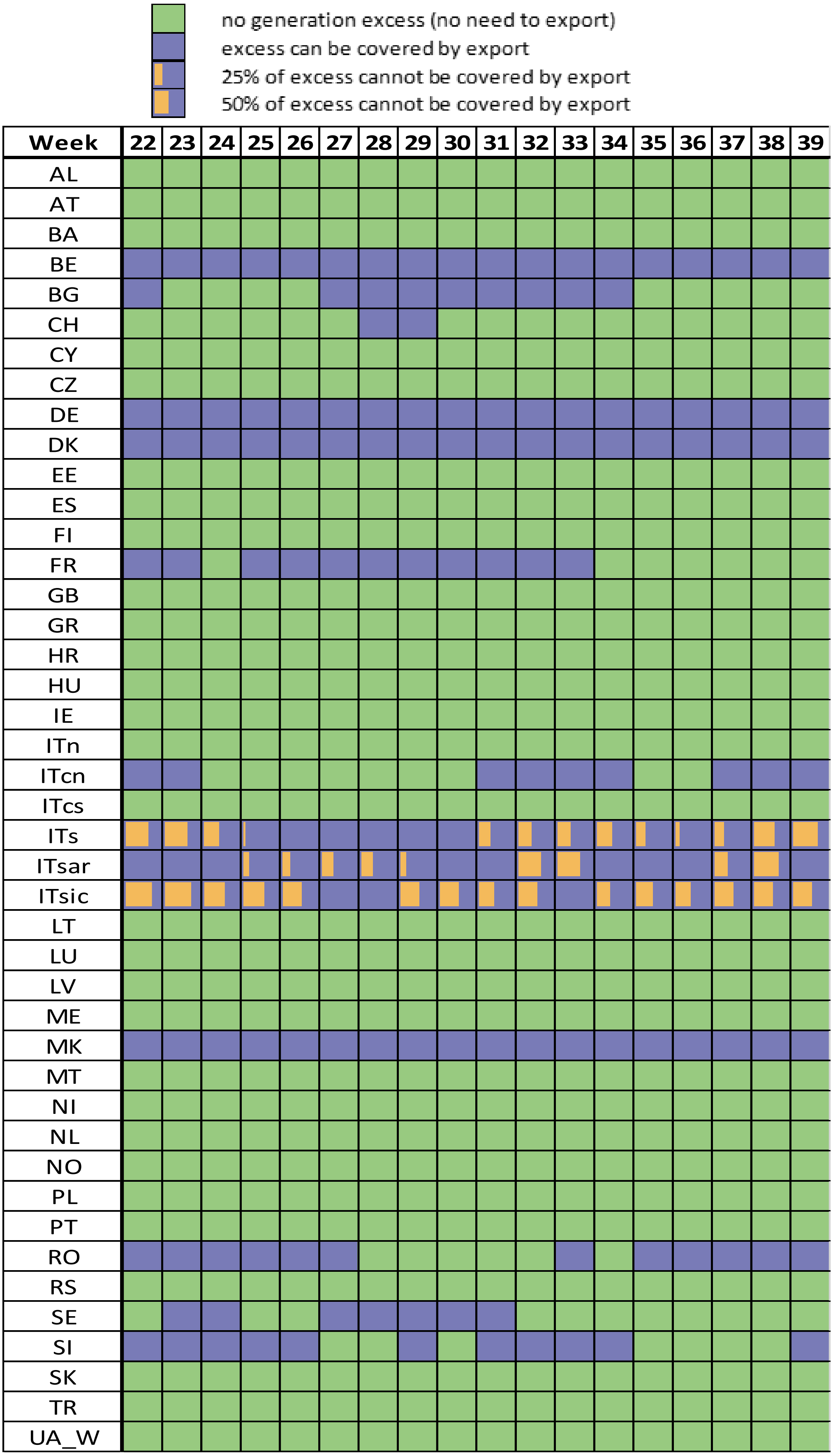
Week	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
AL	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
AT	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
BA	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
BE	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
BG	●	○	○	○	○	●	●	●	●	●	●	●	●	○	○	○	○	○
CH	○	○	○	○	○	○	●	●	○	○	○	○	○	○	○	○	○	○
CY	○	○	○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

At the country level, no risk of wind or solar curtailment was identified in the case of a typical sunny Sunday. Taken as a whole, each country is considered with infinite internal transmission capacity (‘copper plate’).

However, inside Italy, important flows from south to north can be expected due to the high amount of PV and wind capacity installed in the southern part and on the islands, while major consumptions are in the north. Moreover, considering the transmission constraints within Italy, the same simulation of a sunny Sunday noon with Italy partitioned into six zones shows the risk of possible renewable spillage in Southern Italy, Sicily, and Sardinia. Nevertheless, the presented results are based on a conservative assumption: simultaneous very high renewable infeed in all six Italian bidding zones is considered.

Downward regulation margins results at the daytime reference time point with Italy partitioned into six zones (North, Central-North, Central-South, South, Sardinia, and Sicily) are shown below in Table 5 and Figure 14.

Table 5: Export needs at the daytime minimum with six nodes in Italy (reference points on Sunday 11:00 CEST).



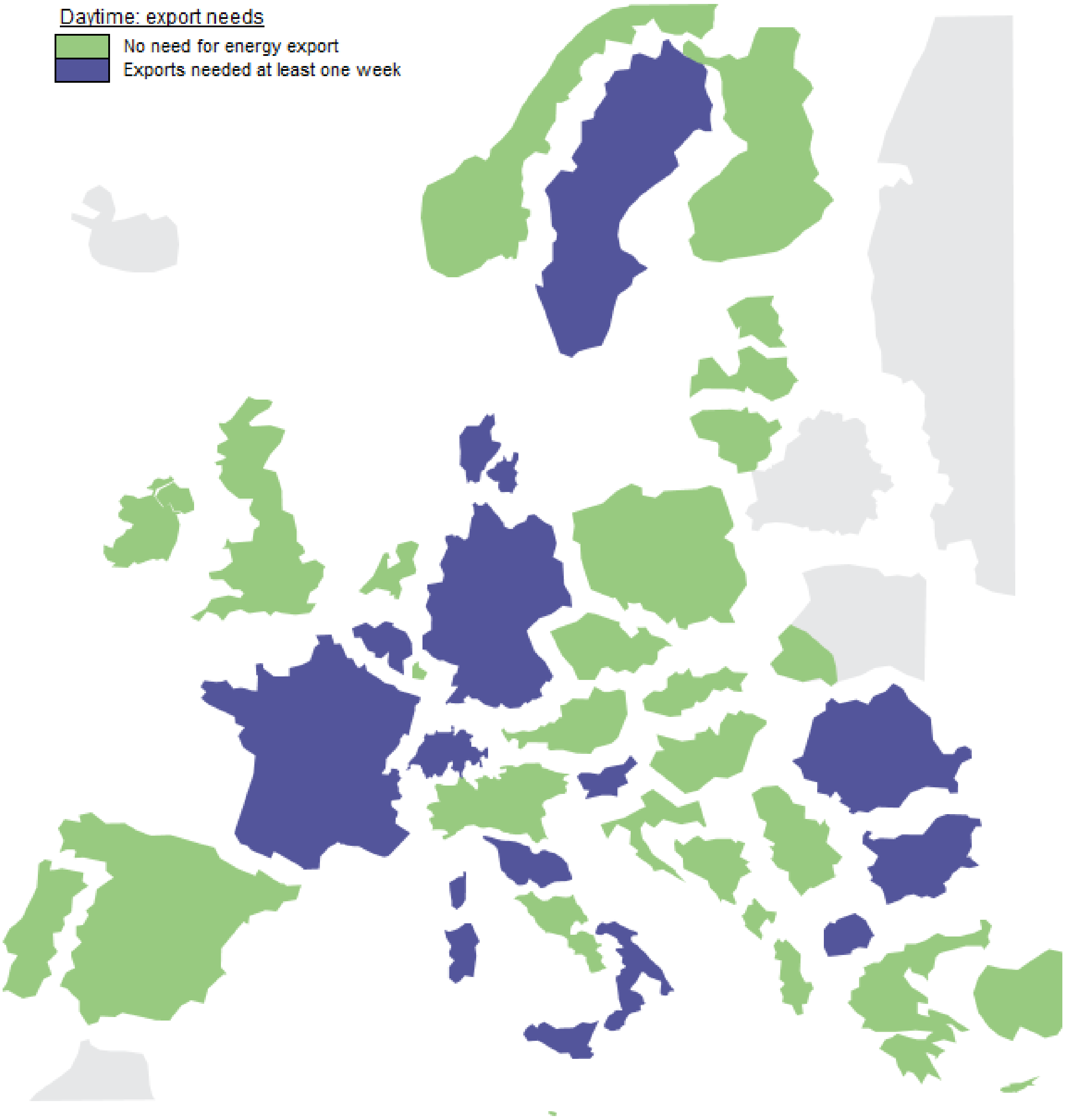


Figure 14: Overview of the export needs for the daytime scenario with six nodes in Italy.

5.2. Night-time Downward Regulation

The night-time downward adequacy corresponds to Sunday early morning (5:00 CEST). At that time, renewable generation is mostly wind (almost no sun yet), but the consumption is lower than in the daytime. In case of high winds during the weekend nights, several countries would need to export electricity, but no risk of wind or PV spillage is expected.

The results of the analysis of available downward regulation margins at the night-time reference time point with Italy partitioned into six zones (North, Central-North, Central-South, South, Sardinia, and Sicily) are shown below in Table 6 and Figure 15.

Table 6: Export needs at the night-time minimum with six nodes in Italy (reference points on Sunday 5:00 CEST).

- (green) no generation excess (no need to export)
- (blue) excess can be covered by export
- 25% of excess cannot be covered by export
- 50% of excess cannot be covered by export

Week	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
AL	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
AT	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
BA	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
BE	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
BG	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	green	green	green	green	green
CH	blue	green	green	green	green	green	blue	blue	green	green	green	green	green	green	green	green	green	green
CY	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
CZ	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
DE	green	green	green	green	green	green	green	green	green	green	green	green	green	blue	blue	blue	green	green
DK	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
EE	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ES	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
FI	green	green	blue	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
FR	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
GB	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
GR	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
HR	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
HU	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
IE	green	green	green	green	green	green	green	green	green	green	green	green	green	green	blue	blue	blue	blue
IT	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ITn	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ITcn	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ITcs	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ITs	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
ITsar	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
ITsic	blue	blue	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
LT	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
LU	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
LV	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
ME	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
MK	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue	blue
MT	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
NI	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
NL	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
NO	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
PL	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
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SI	blue	green	blue	blue	green	green	green	green	green	green	green	green	green	green	green	green	green	blue
SK	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
TR	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green	green
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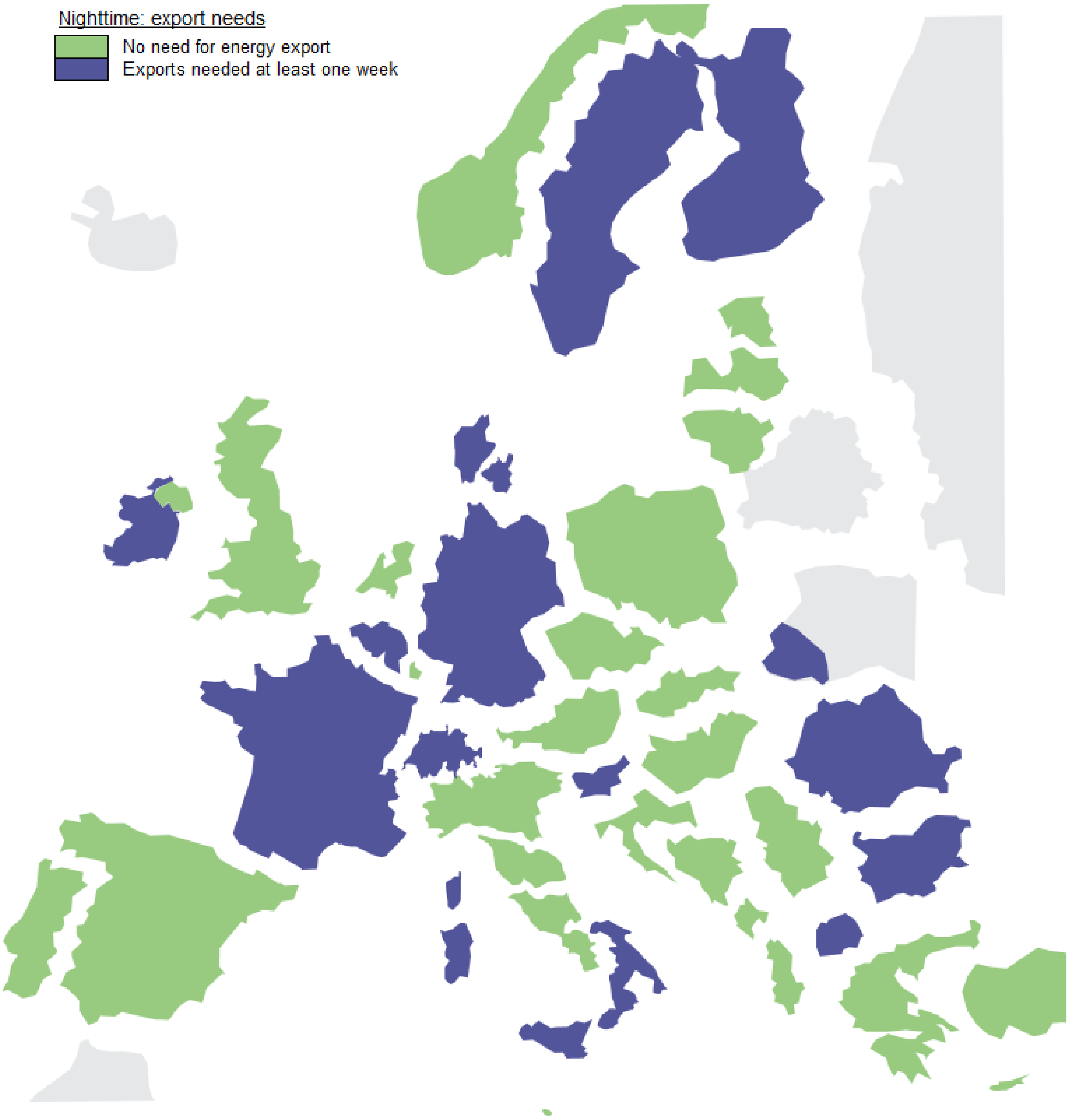


Figure 15: Overview of the export needs for the night-time scenario with six nodes in Italy.

6. Winter Review 2016/17

The ENTSO-E Winter Outlook 2016/2017 indicated that cold weather combined with reduced generation capacity in some areas could lead to adequacy problems in France and in some neighbouring countries. This tight situation was indeed experienced in western continental Europe in January 2017. In south-eastern European countries, a very severe cold wave occurred with temperatures much lower than the once-in-ten-year situations assessed in the Seasonal Outlook. There were also registered local severe weather phenomena (i.e., snowstorms, avalanches, and river droughts) that had an effect on the generation units or transmission lines.

From mid-January 2017, the stressed situation spread quickly through several countries, and the challenge of meeting electricity demand increased. Weather conditions led to a reduction of reserve capacities, demanding extraordinary efforts and measures from our members to ensure security of operation and supply. The peak of high load due to low temperatures was reached on weeks 3 and 4, depending on the region. Nevertheless, the TSOs could manage the situation by utilising well-prepared and proven mutual support mechanisms. The close cooperation and daily updates between TSOs helped maintain an uninterrupted electricity supply in all countries.

Italy, France, Switzerland, Belgium, Bulgaria, Romania, and Greece were particularly affected by the cold spell, and in some cases, the TSOs had to reduce the NTC export values. This situation was monitored by the European Commission with concerns raised by energy traders, especially where countries experienced an export ban. Questions were asked by the Commission to Member States' representatives during the Electricity Coordination Group (ECG)[17] meeting on Tuesday 14 February 2017. ENTSO-E presented a preliminary analysis and was tasked by the Commission to provide a technical assessment of the cold spell by June 2017. The Commission will use it for its case study review of the cold spell and the situations that occurred in each country.

More details on the Winter Review can be found in the country comments in Appendix 1.

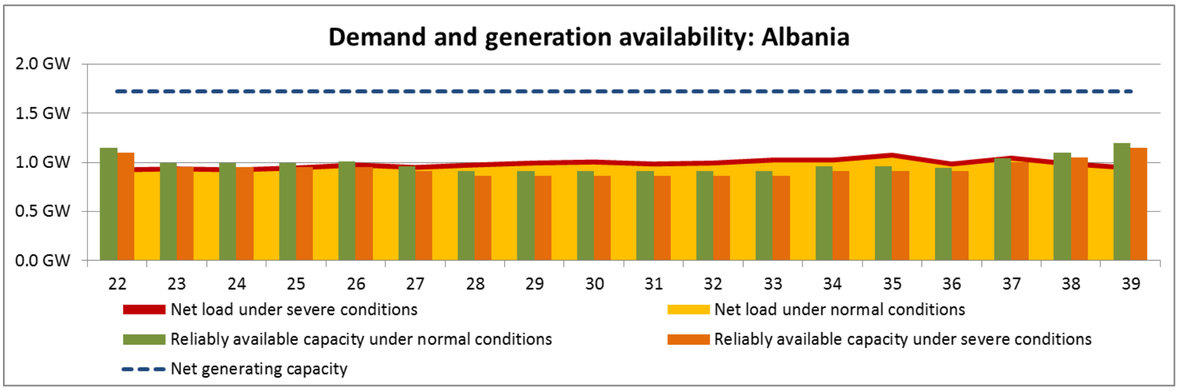
[17] ECG is a platform for strategic exchanges between Member States, national regulators, ACER, ENTSOE, and the commission on electricity policy.

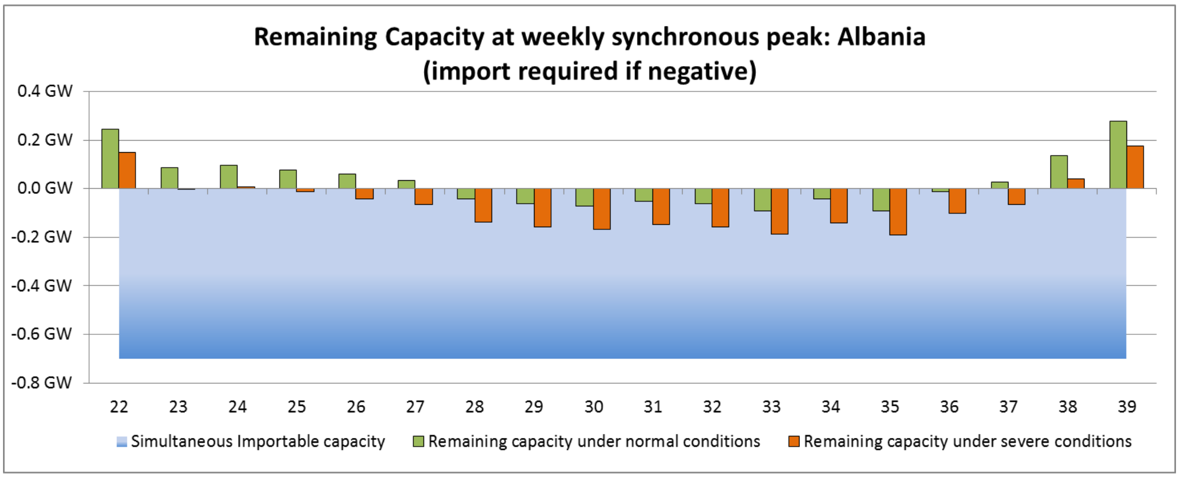
7. Appendices

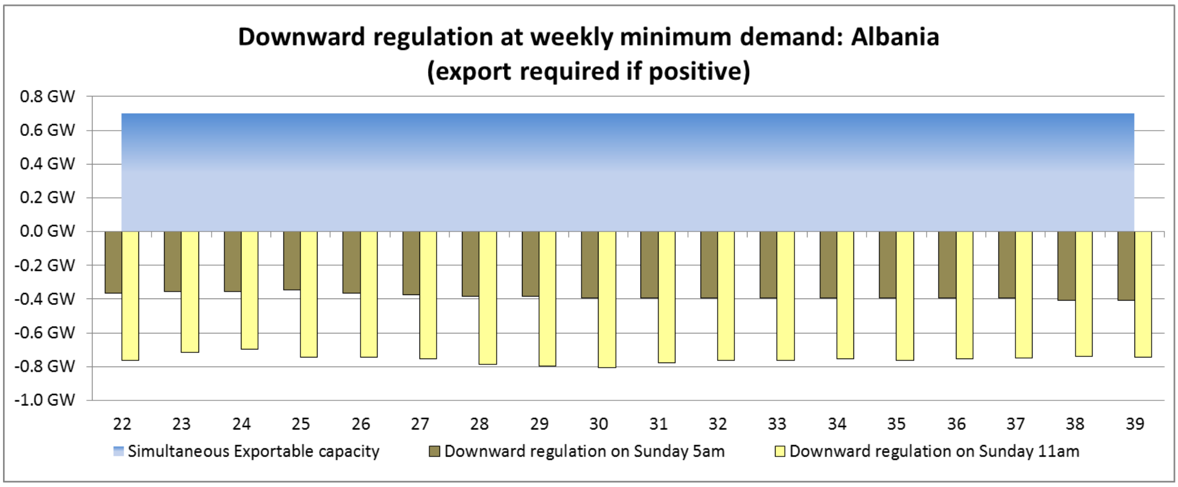
Appendix 1: Individual country comments on the Summer Outlook and Winter Review

Albania: Summer Outlook 2017

For the upcoming summer 2017 there are no unexpected conditions foreseen. Most of the maintenance works in generation – transmission system will be performed according to the scheduled period from April until October.







Most critical periods for maintaining adequacy margins and countermeasures

The most critical period remains during months of July and August, depending on the temperatures, and hydro levels, although the maintenance schedule of units and transmission elements in that period is set to minimum. The adequacy will be maintained with firm contracts of imports from OSHEE (DSO) around 250-300 MW. In general, the interconnections are sufficient for fulfilling the need of electricity imports. Nevertheless, it is of high importance to put in operation the OHL 400kV Tirana2-KosovaB. The maintenance of the interconnectors is arranged to be in the period of April – May and September – October when the demand is relatively lower, as also in the neighbouring TSOs. Thus the adequacy will be maintained.

Most critical periods for downward regulation and countermeasures

Albania does not yet have inflexible generation, thus it is not expected to have any problem with minimum demand periods.

Albania: Winter Review 2016/2017

General comments on past winter conditions

During the month of January 2017, Albania was hit by very low temperatures in comparison to seasonal average values. This caused an increase in the consumption, although it was expected being a country relying on electricity for heating. The generation capacity was available, but the run of river HPP[18] had low inflows due to cold weather. Only Unit 3 in Koman HPP which is under rehabilitation and TPP[19] Vlora was unavailable. So basically the adequacy was met in tight conditions but there was no margin and all reserves were used. Generally, adequacy was maintained at a stable state by firm contracts of imports from DSO Company.

Specific events and unexpected situations that occurred during the past winter

In the perspective of electricity market, the only restriction experienced was during the second week of 2017. Here due to extreme low temperatures and high load consumption in Greece Control Area, as well as the lack of gas supply, there were curtailments of the exports schedules for the direction GR->AL (11-12 January 2017).

[18] HPP: Hydropower plant

[19] TPP: Thermal power plant

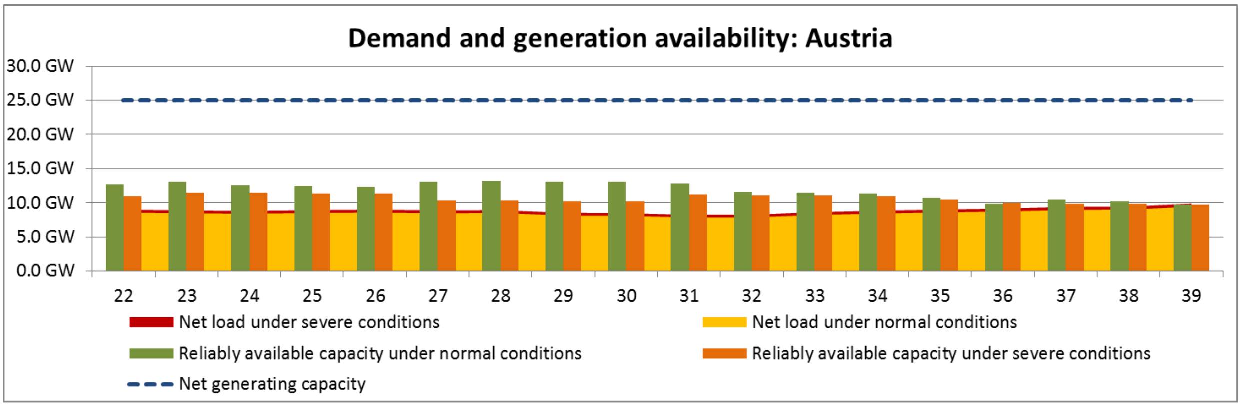
Austria: Summer Outlook 2017

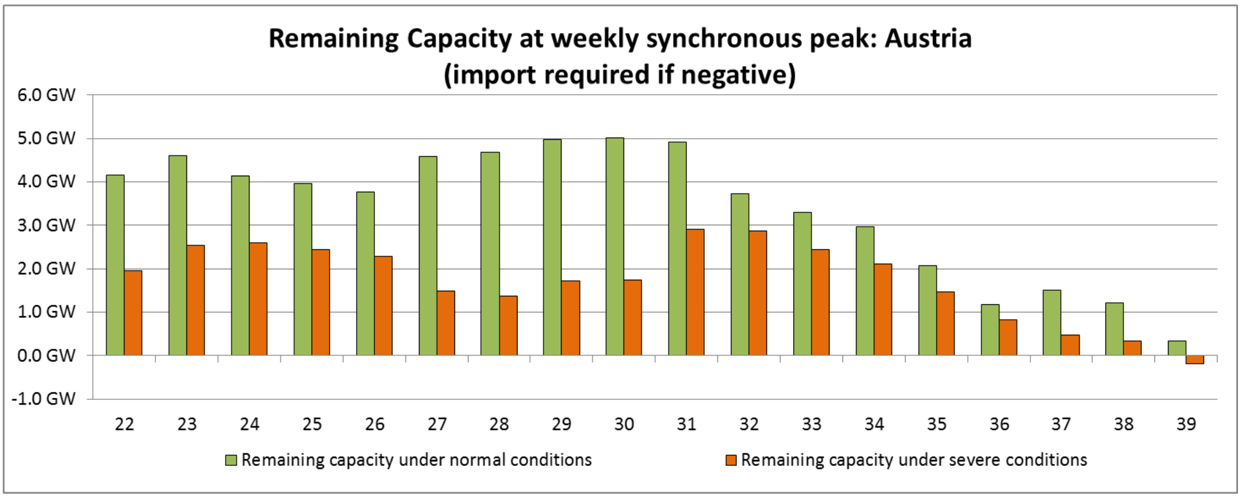
Concerning the PPSPs[20], a new approach of calculating their availability has been applied. One of the main reasons for this is the energy constraints of the PPSPs. The new approach assumes that the plants only generate during day time (Mo.-Fr. 8:00-20:00 CEST) and pump during night-time, which leads to a timeframe of 60h/week of generation. Referring to historical generated energy of the Austrian PPSP in a normal respectively in a dry year (normal conditions / severe conditions) in the affected period of time (weeks 23-39) the available power was calculated by applying the method above. This approach considers the seasonal inflow and the sustainable exploitation of a PPSP.

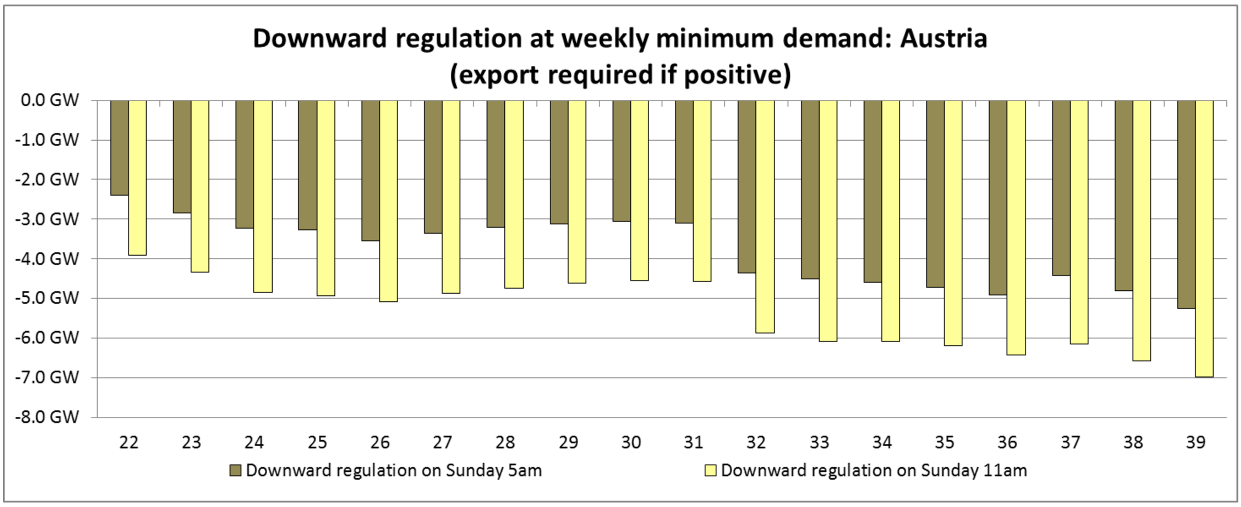
For the upcoming summer, the Austrian Power Grid AG (APG) assumed an increase of load of +0.56% compared to summer 2016. Furthermore APG supposed a rise of load "under severe conditions" of 5%.

The net generating capacity of the "Kraftwerksgruppe Obere Ill-Lünersee" (1.7 GW) is considered as firm export to Germany as it is directly connected to the German TSO TransnetBW. Since it is located in the control area of APG, the net generating capacity has been considered in the APG data sheet as part of the installed Hydro Power capacity.

[20] PPSPs: (Pumped-) power storage plants







Most critical periods for maintaining adequacy margins and countermeasures

In September this year it is assumed to have the lowest availability of hydro. Under normal conditions the remaining capacity should be slightly above zero and “under severe conditions” a little below zero. Considering from the import capacities there is no adequacy issue foreseen.

Austria: Winter Review 2016/2017

General comments on past winter conditions

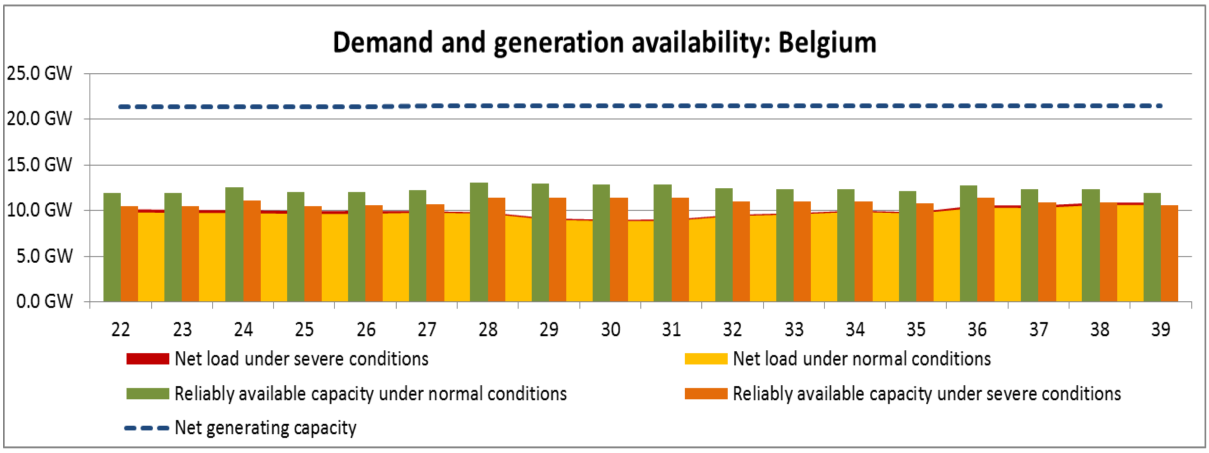
December 2016 was mild, sunny and very dry. In January 2017 the temperature in Austria was 3°C below long-term average. Furthermore it was sunny and in several regions very dry. December and January were similar to the year before. On the contrary February was one of the warmest in history (almost 3°C above long-term average) and pretty dry (-20% below average).

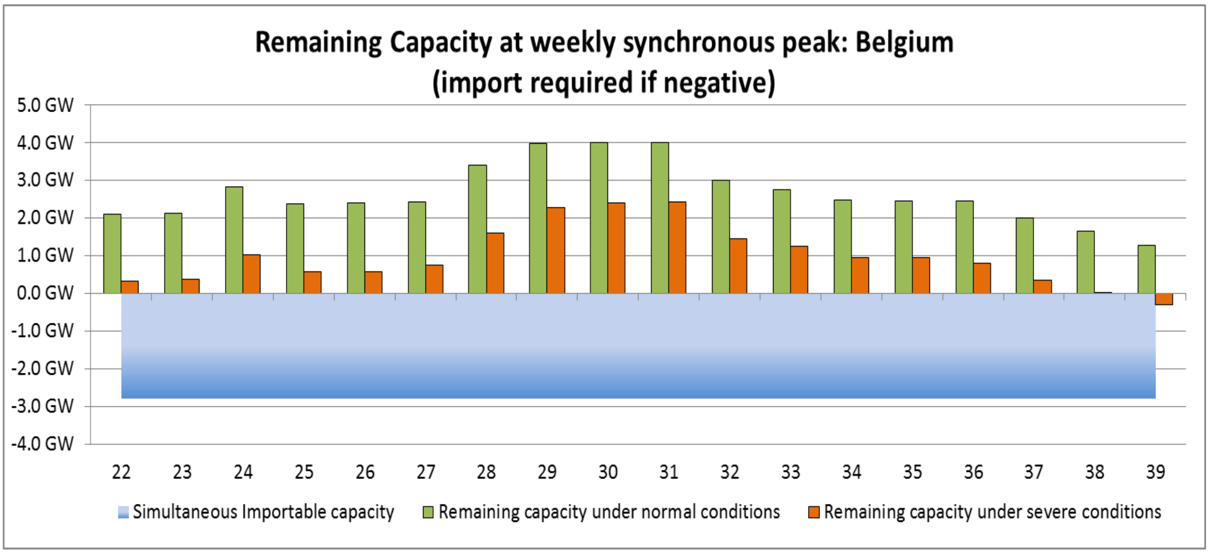
Specific events and unexpected situations that occurred during the past winter

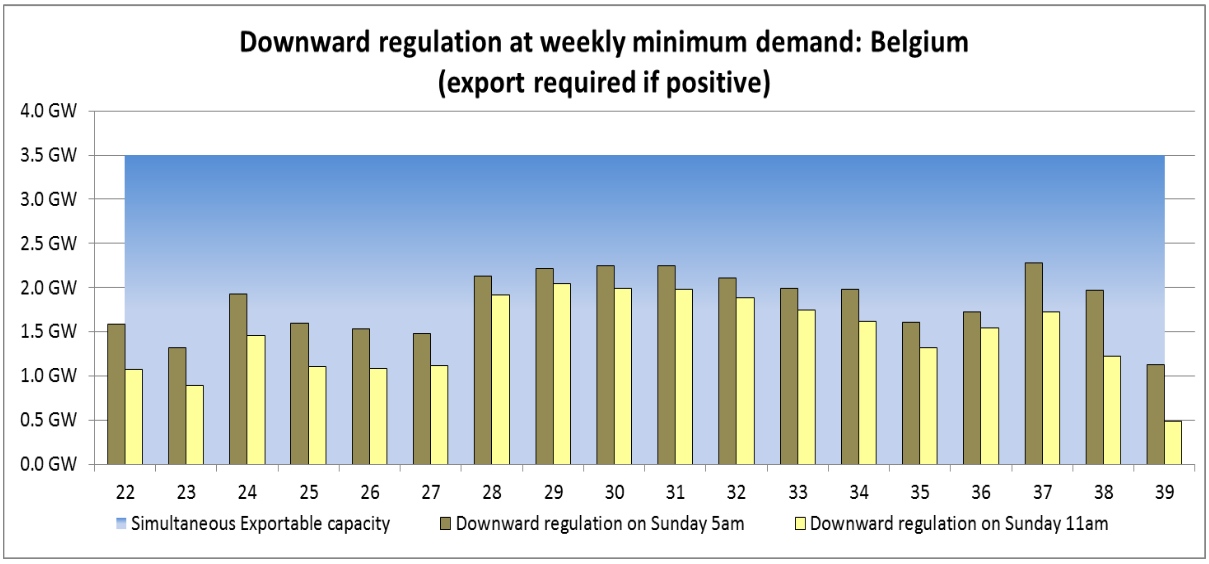
During the cold spell in France in January this year Austria faced very low generation of hydro and historically low reservoir levels of the PPSPs. Thus the remaining capacity calculated by the new method mentioned above would have been much lower than calculated for the winter outlook 2016/2017.

Belgium: Summer Outlook 2017

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.







Most critical periods for maintaining adequacy margins and countermeasures

During summer no critical periods are expected.

Most critical periods for downward regulation and countermeasures

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

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

In case of high wind and solar conditions (P90) 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 2016/2017

General comments on past winter conditions

Respect the fact that the status of the nuclear generation park has normalized (except unplanned outage of Tihange 1 (~1 GW)) the Belgian power system is still strongly dependent on imports to cover the demand in severe weather conditions.

For the winter 2016/2017 a strategic reserve capacity of 750 MW was contracted. This additional capacity can be used in order to avoid scarcity situations.

Specific events and unexpected situations that occurred during the past winter

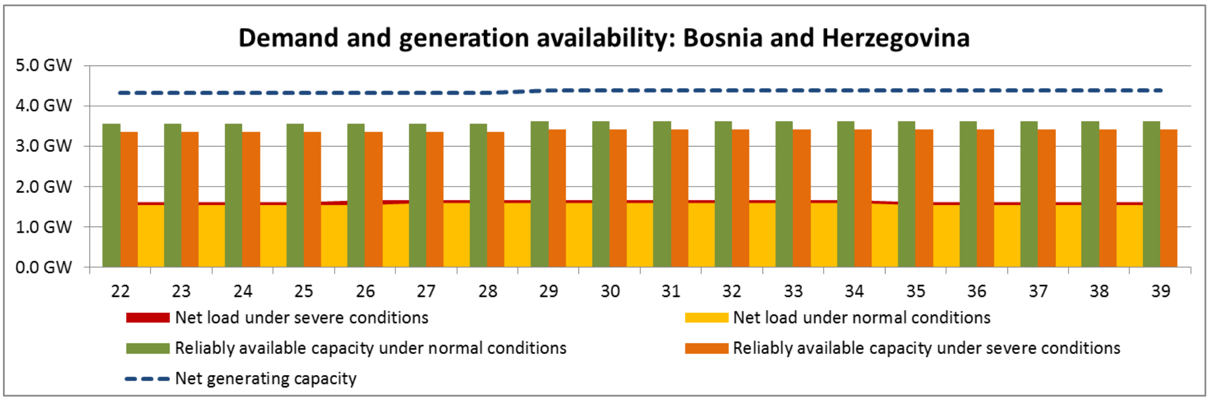
The adequacy forecast for the week of the cold spell (3rd week of January) showed a very tight situation, with large import needs for Belgium and France. However, it was expected that the available volume of strategic reserve would be sufficient in order to avoid further extraordinary measures. Some actions were taken such as the cancellation of maintenance works reducing the cross-border capacity or encompassing additional operational risks, informing the balance responsible parties to stress the importance of a reliable and fully available generation fleet, using dynamic line rating and cold weather limits. The Belgian ministry was informed about the tense situation.

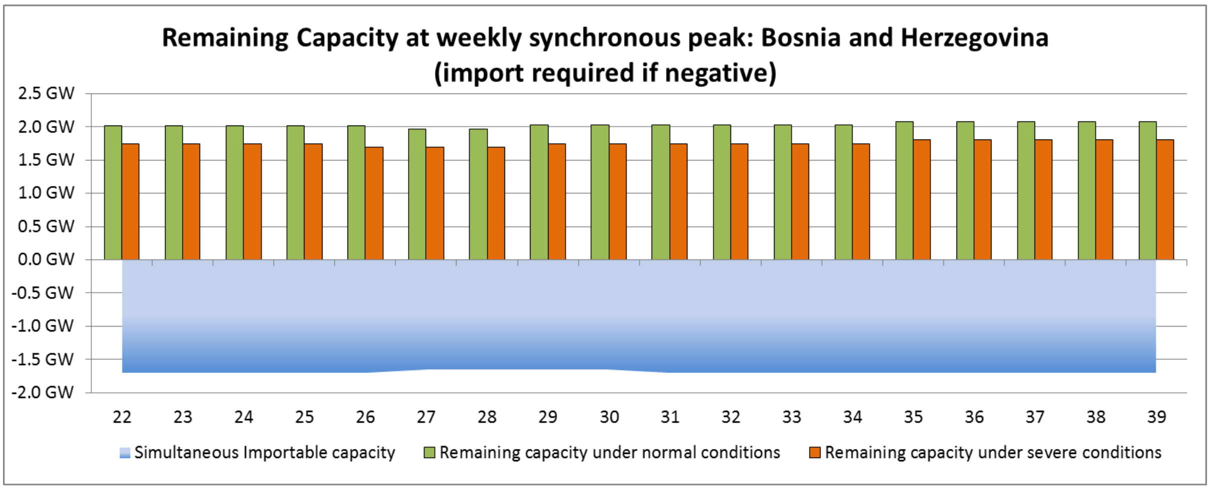
During the cold spell Belgian market parties could source sufficient volumes abroad leading to an overall situation where adequacy in Belgium could be maintained, even without the use of the strategic reserve capacity.

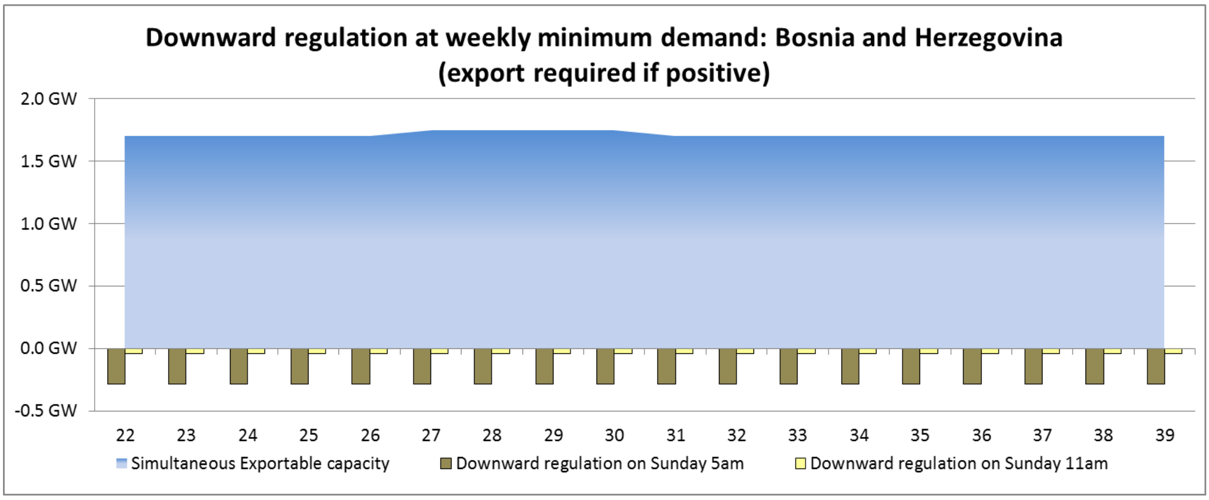
Bosnia and Herzegovina: Summer Outlook 2017

For the summer 2017 no increase of load is expected.

Regarding power system adequacy in Bosnia and Herzegovina for the upcoming summer, we do not expect any particular problems.







Bosnia and Herzegovina: Winter Review 2016/2017

General comments on past winter conditions

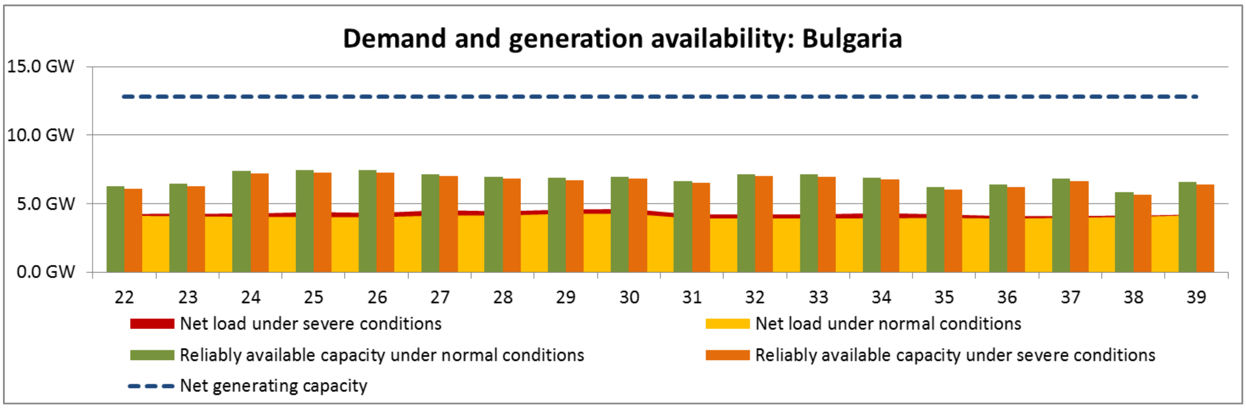
During the winter period 2016/2017 there were not significant unusual events in the electric power system of Bosnia and Herzegovina. Because of extremely low temperatures in January, the maximum load occurred on 11 January at 18:00 CET, and it was 2,189 MW. Maximum load in December was registered on 31 December, at 18:00 CET, and it was 2,098 MW.

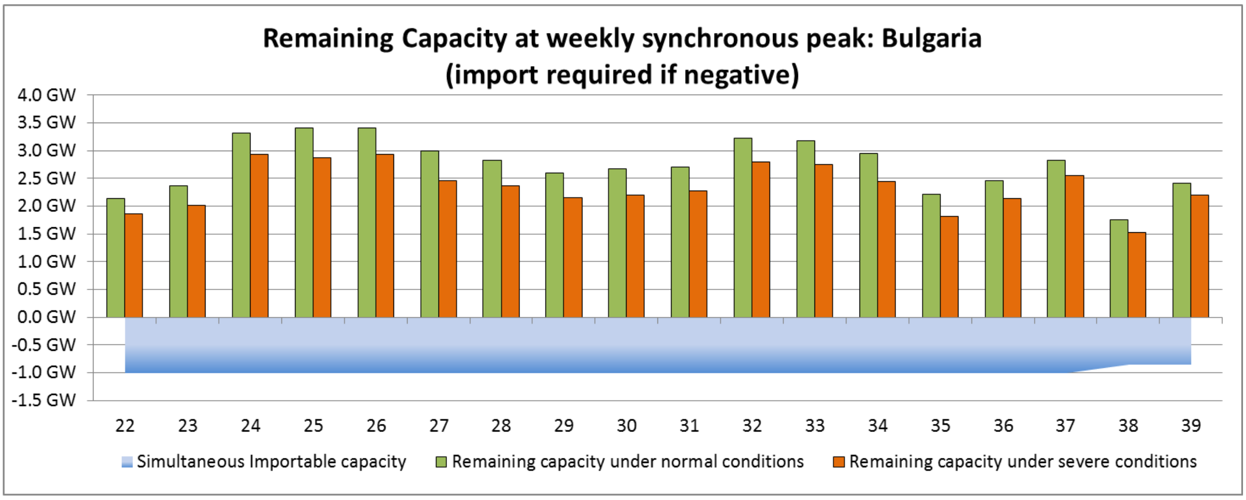
Specific events and unexpected situations that occurred during the past winter

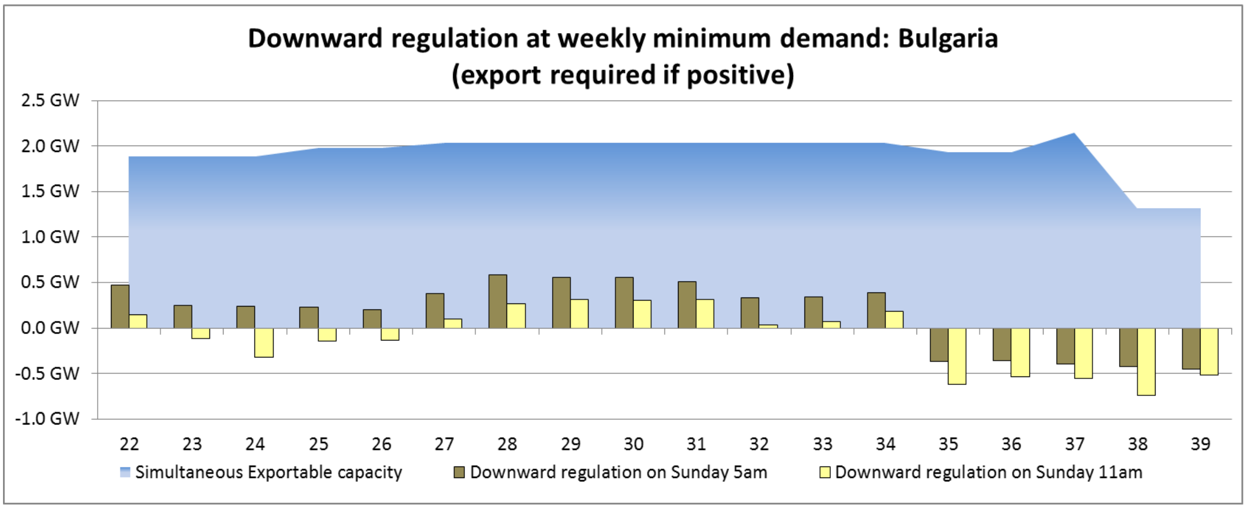
There was not any unexpected situation with an effect on Bosnia and Herzegovina power system.

Bulgaria: Summer Outlook 2017

No adequacy issues are expected during the upcoming summer period in Bulgaria.







Bulgaria: Winter Review 2016/2017

General comments on past winter conditions

Bulgaria was hit by an extreme cold wave in January 2017 that had major impact on security of supply.

At the start of January 2017, circulating atmospheric conditions formed over the northern territory of the European part of Russia had facilitated the transfer of extremely cold air masses from the arctic zones and Siberia towards Southeast Europe. Additional circumstances predetermined the long duration of this cold spell, mostly for the countries of the Balkan Peninsula. Severe cold spells are not unprecedented for the region. They are observed on average basis once in 35 years. The difference for the cold spell in January 2017 is that it was with extreme duration and extreme negative deviations from the normal temperatures. The last cold wave with similar parameters is reported to be observed before 69 years – in 1948. The monitoring of all cold spells since 1948 shows a slight increase in the extremely low temperatures, as the climatologists attribute this trend to the ongoing processes of global warming. The sudden drop of temperatures in Bulgaria started at 07:00 EET on 6 January and was combined with heavy snowfall and strong wind gusts coming from east – northeast. That led to serious transportation issues and faults in the distribution grid, mostly in the eastern part of the country.

On 6 January 2017 all facilities in cold reserve were activated – 550 MW. The cold reserve suppliers were not able to reach the agreed power due to force majeure (freezing of coal and/or water for technological needs) and supplied only 350-400 MW. The frequency restoration reserve (secondary control reserve) was reduced for most of the cold spell, which provided additional 95 MW of free capacity to be used by the public supplier to cover its obligations on the regulated market, thus decreasing the security of supply.

Before the imposed limitation of exports originating from Bulgaria, emergency assistance requests were sent to all the neighbouring operators but the circumstances were as follows:

- The Greek system operator limited commercial exports to Bulgaria starting from 11 January 2017;
- the Romanian system operator had not the legal and commercial possibilities to deliver emergency assistance with a preliminary notice on 23 December 2016;
- there was no opportunity for emergency assistance from FYROM, Turkey and Serbia, as extreme winter temperatures realized on their territory as well.

At the same time, the situation in the region continued to be delicate in regards with supplying of electricity demand.

In practice, Bulgaria was not only forced to cut its export of electricity but was struggling to balance its power systems.

In addition to the above measures, the Bulgarian TSO implemented extra ones:

- The number of autotransformers and transformers in operation was optimized resulting in load reduction of around 20 MW;
- The medium voltage of the buses in the substations was decreased by 3% to 5% in accordance with IEC60038 without affecting the quality of supplied energy to end users, including the distribution companies. As a result, the electrical load was reduced by more than 250 MW;
- At the suggestion of Maritsa Iztok mining complex the rotary excavators were put in idle mode in the time span from 17:00 to 23:00 EET without interruption of coal supply. As a result, the electrical load was reduced by up to 60 MW.

Owing to the extreme winter conditions, the failure rates in the production facilities increased and the extra loading led to depletion of coal stocks in the thermal power plants, which were sufficient only for 2 days of full load operation.

There were commercial transit flows through the national power grid ranging from 200 MW to 400 MW per hour and, for some hours commercial imports for load coverage in Bulgaria were realized reaching 225 MW per hour, which was indicative of power deficit in the country despite the activation of all reserve generating capacities.

As of 8 January 2017, market participants were unable to meet their consumption schedules even by buying cross border electricity since there was a shortage in the whole region. Therefore, the commercial schedules of the market participants kept deviating from the real load by about 350 MW and in some hours even by 500-600 MW in deficit.

All market mechanisms for coping with power deficit were practically exhausted. This would have compromised the power system reliability in case of a potential failure of a 1,000 MW unit in the NPP[21] of Kozloduy, whose compensation would have been impossible as all other available generation capacities were operating at full load. Such an accident would have led not only to an imbalance between production and consumption in the country, but also to a

[21] NPP: Nuclear power plant

serious deviation in the physical exchange power flows with prerequisites for cascading faults in the power system not only in Bulgaria but on a regional level as well.

Considering the above circumstances and a subsequent letter from NEK Public Supplier informing of its inability to meet its obligations for power supply to protected consumers in Bulgaria, as a measure of last resort, on 13 January 2017 the Minister of Energy issued an order for limitation of power exports with Bulgarian origin but without interfering with the commercial power transits (import and export) through Bulgaria. The suspension lasted till 01:00 EET on 9 February 2017 when all operational reserves were restored to their required level ensuring the safe and reliable operation of the power system.

Cold spell in Bulgaria in January 2017 – Statistical facts and indicators

Figure 16 shows the daily average temperatures for the entire country during the examined term compared to normal values, defined on the basis of a 35-year period. The daily average temperature for the country is weighted using the participation of each of the 16 regions in the total electricity demand with the last update of the weighting coefficients done in 2015. Since 6 January the temperature had been going down for three days and on 8 January reached its extreme minimum value of -10.6°C. This temperature is lower than the one registered on 5 January (1.8°C) by 12.4°C, making that a 4.1°C fall per 24-hour period.

The most important statistical indices of the daily average temperature are included in Table 2. Figure 17 depicts a chromatic map of Europe with deviations from the corresponding normal temperatures for the coldest days – the interval between 7 and 11 January (***source: KNMI/E-OBS – WMO/Europe regional***). Part of western Bulgaria is situated in the zone with the largest negative deviations, ranging from -12°C to -15°C. This zone comprises of almost the whole of Serbia, Montenegro and FYROM.

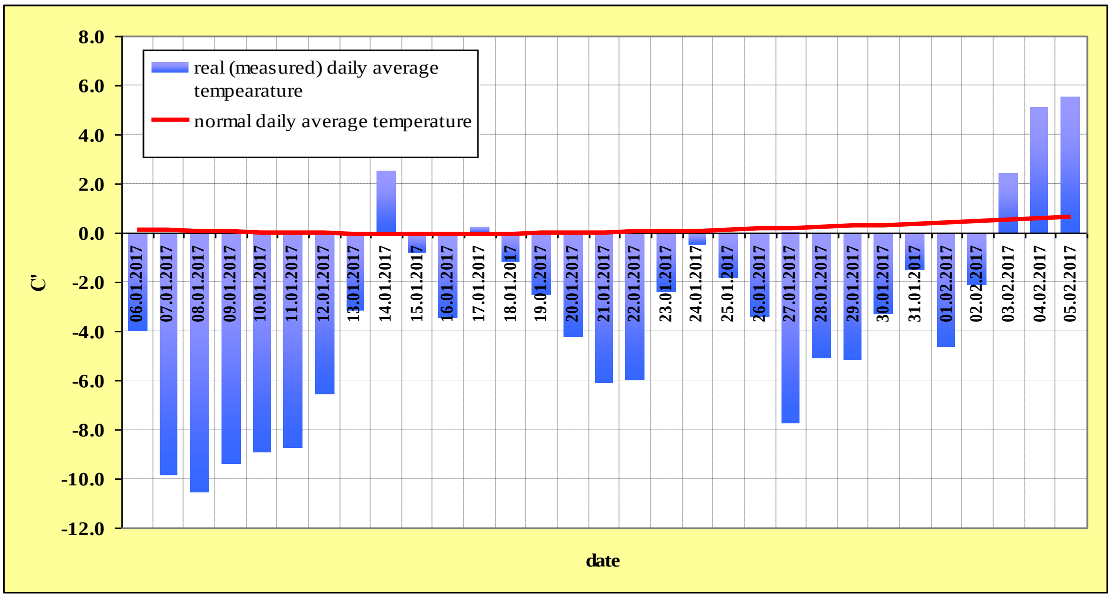


Figure 16: Measured and normal daily average temperatures in Bulgaria from 6 January to 5 February 2017.

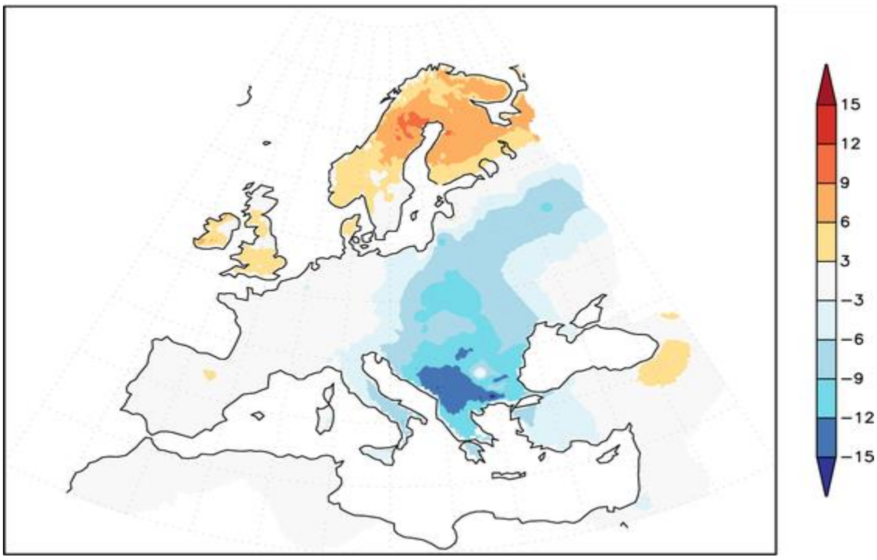


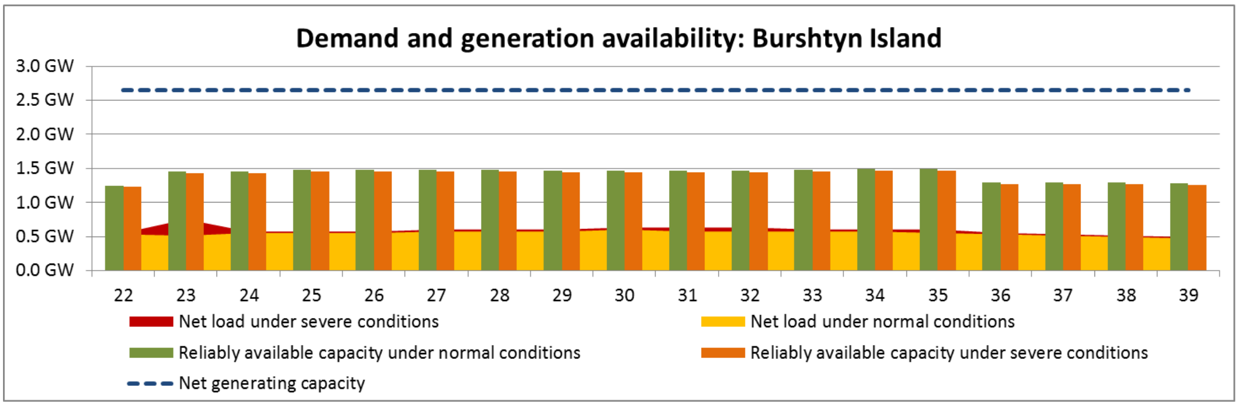
Figure 17: Deviation of the registered daily average temperatures in Europe based on their normal values during the period 7 January to 11 January 2017.

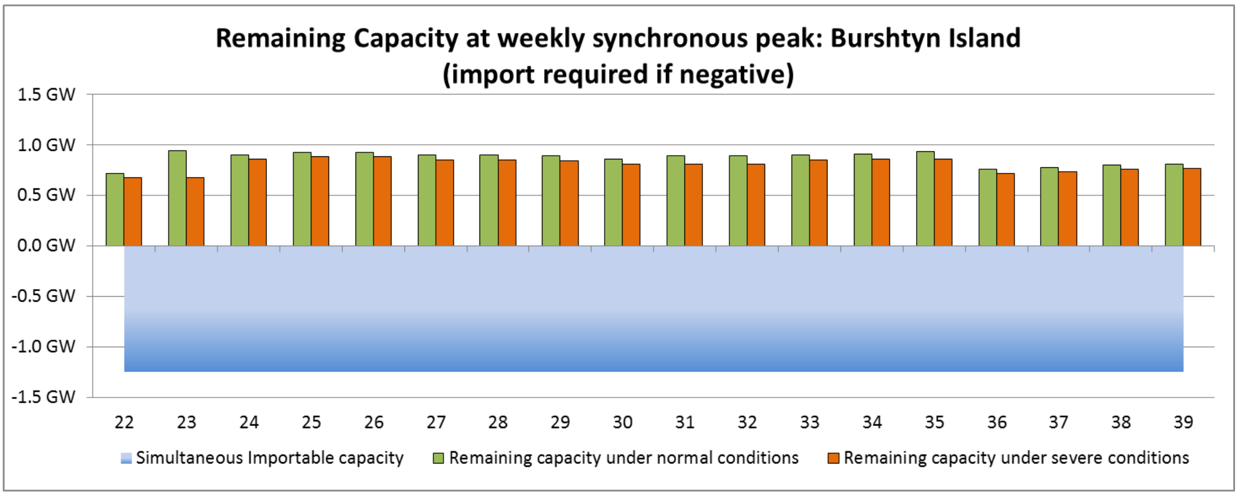
Table 7 – Main records on past winter temperatures in Bulgaria

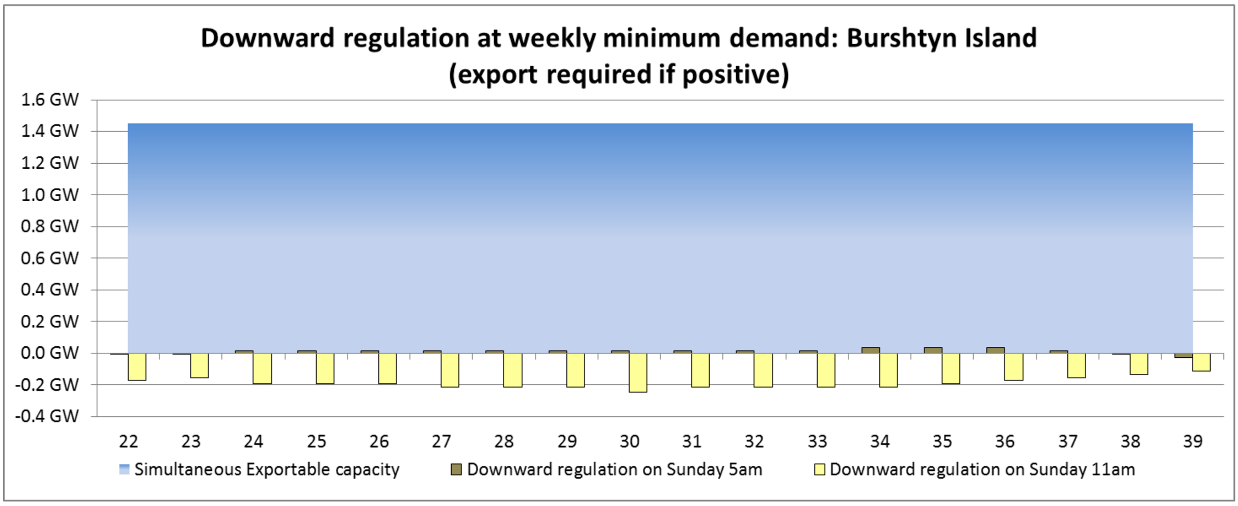
Day with:	value	date
highest daily average temperature, °C	4.6	5 Feb
lowest daily average temperature, °C	-13.6	11 Jan
highest maximum temperature, °C	8.5	5 Feb
lowest maximum temperature, °C	-10.9	7 Jan
highest minimum temperature, °C	1.5	5 Feb
lowest minimum temperature, °C	-21.0	12 Jan
largest difference between max and min temp., °C	19.5	12 Jan
smallest difference between max and min temp., °C	2.1	19 Jan
Largest hourly gradient of temperature increment, °C/h	5.2	30 Jan between 01:00 and 02:00 EET
largest hourly gradient of temperature decrement, °C/h	-4.2	22 Jan between 11:00 and 12:00 EET

Burshtyn Island: Summer Outlook 2017

Even in severe condition, no adequacy issue is expected in Burshtyn Island for coming summer.







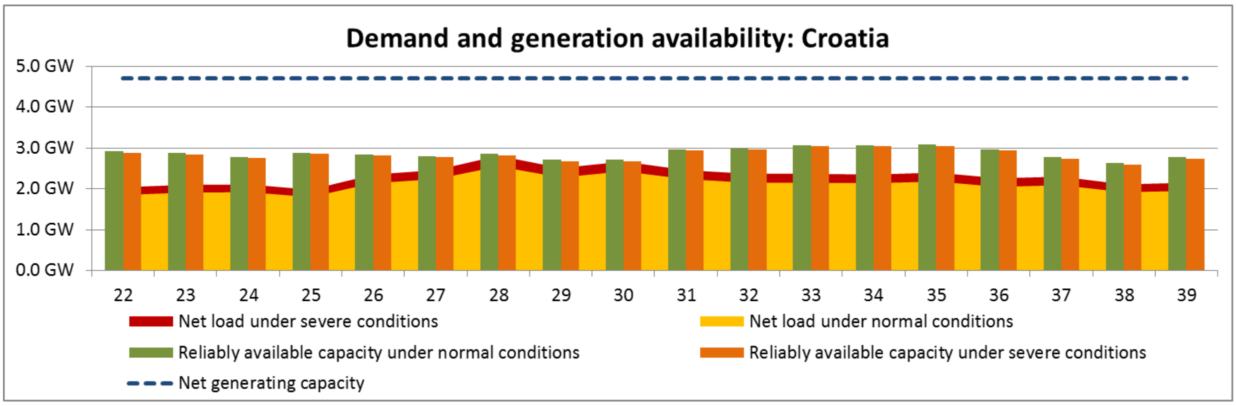
Burshtyn Island: Winter Review 2016/2017

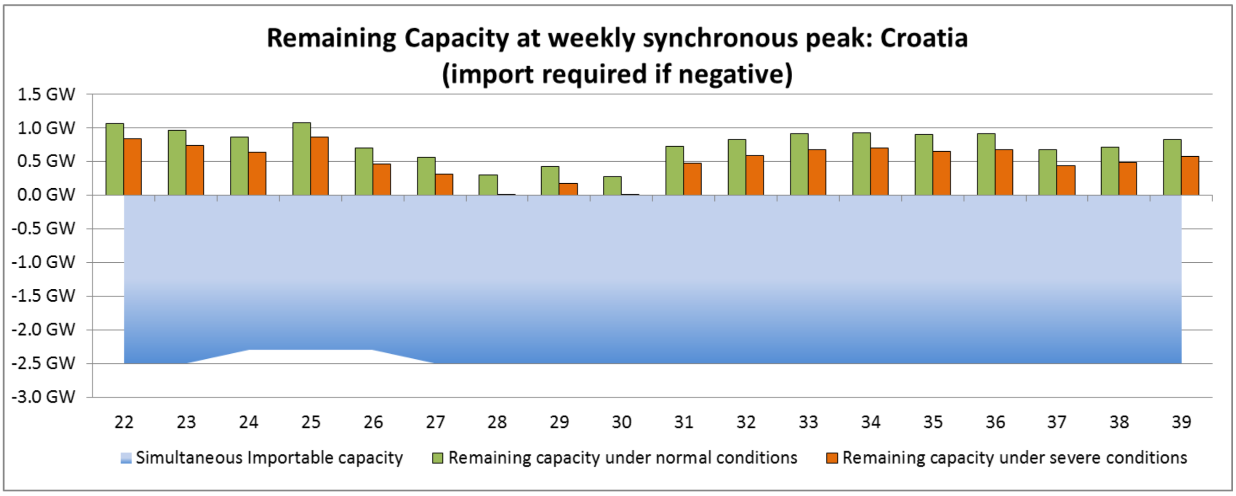
No adequacy issue was identified in Burshtyn Island last winter

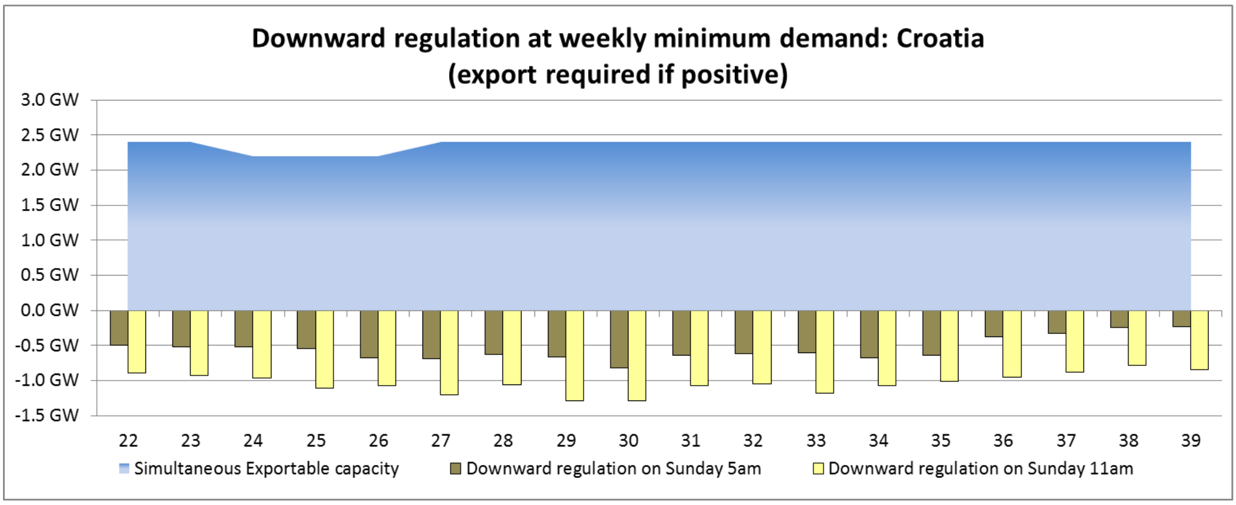
Croatia: Summer Outlook 2017

Generally, Croatian transmission system operator does not expect any serious problem in supply.

Installed capacity of the available power units is satisfactory to meet even the highest electricity demand. However, many units will be not engaged because of the economic reasons. Instead of it, needed amounts of electricity will be imported. The capacity of tie-lines makes possible both the import for Croatian consumers and transit.







Croatia: Winter Review 2016/2017

General comments on past winter conditions

During the winter 2016/2017 the most critical period was in January 2017. Due to extremely low temperatures the consumption reached the values much greater than yearly average. At the same period the significant production in wind power plants was made possible.

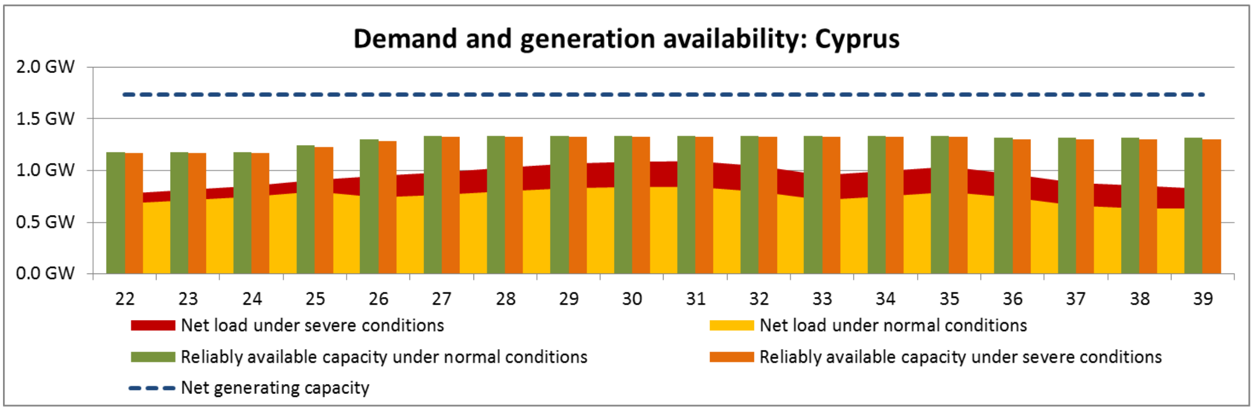
Greater interruptions of supply were not recorded.

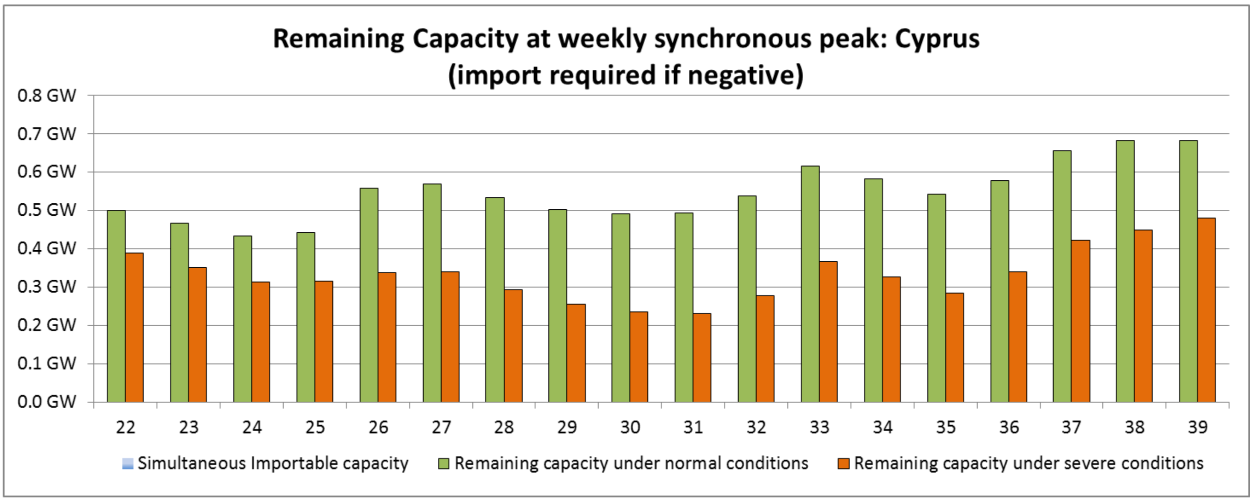
Specific events and unexpected situations that occurred during the past winter

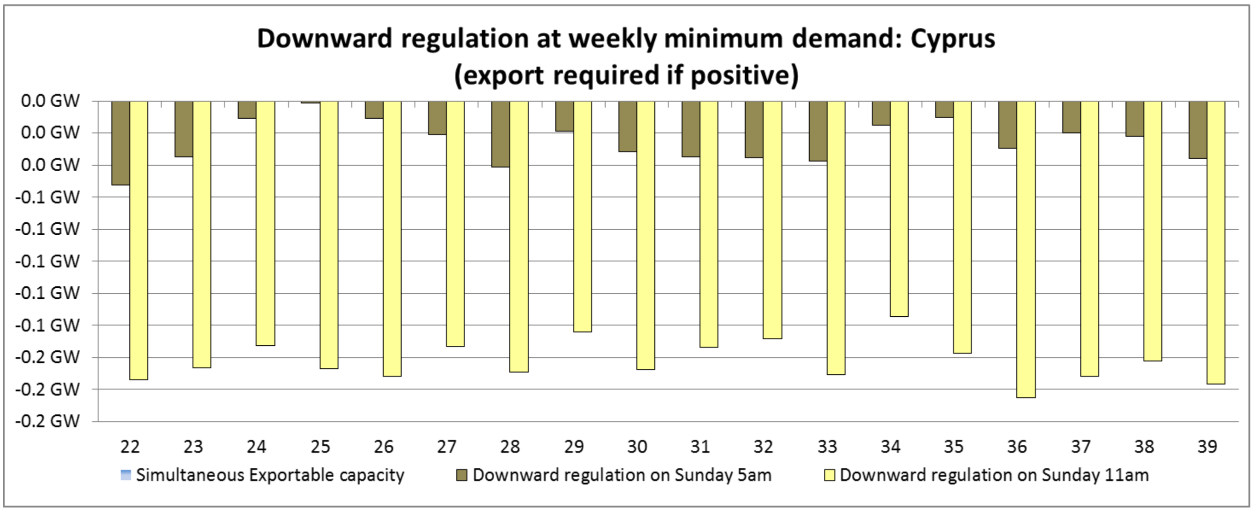
There was not any specific event in Croatian power system.

Cyprus: Summer Outlook 2017

During summer no specific period is considered critical.





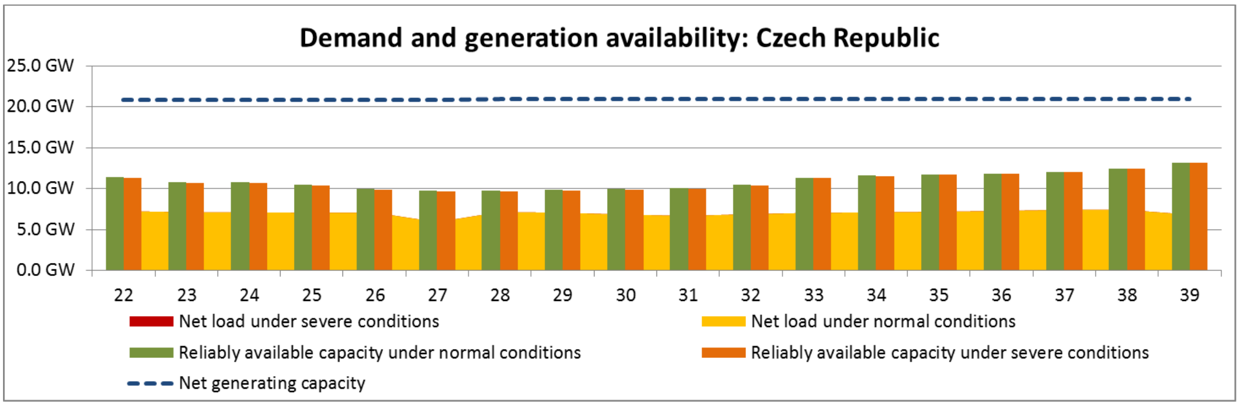


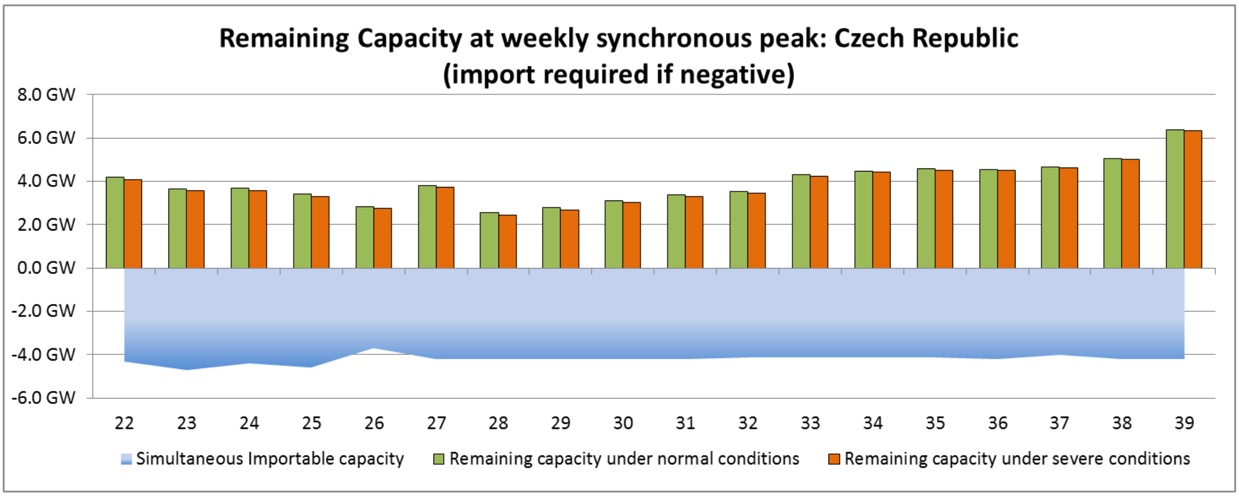
Cyprus: Winter Review 2016/2017

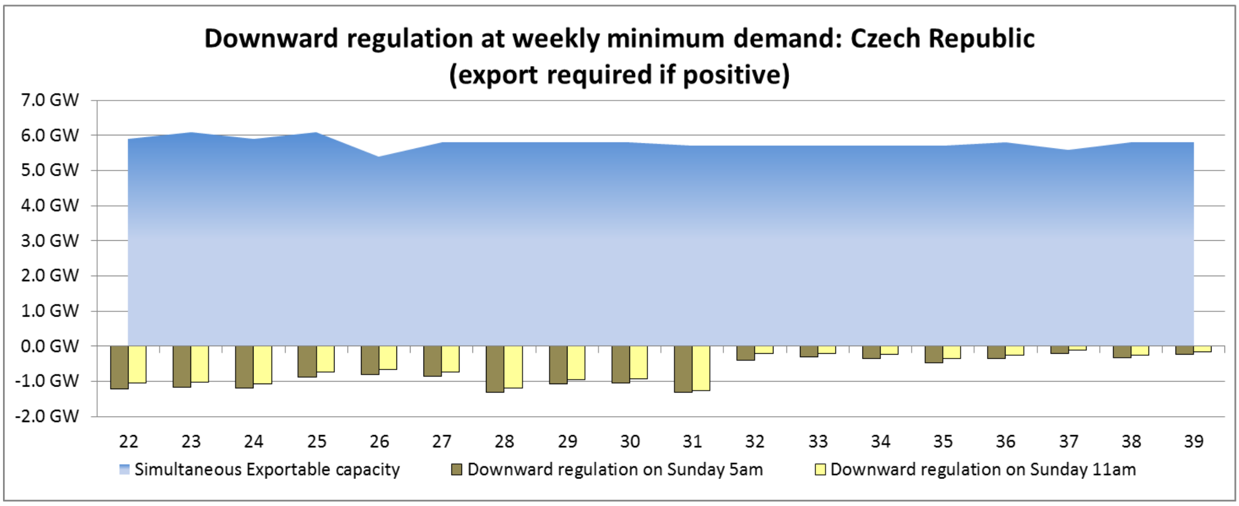
No specific event or unexpected situations occurred.

Czech Republic: Summer Outlook 2017

The Czech TSO is not expecting any adequacy problems during the summer period. Due to effective coordination between generation and transmission, there are no expected issues associated with utilising interconnection capacity. The forecasted NTC (Net Transfer Capacity) values represent the best estimates based on currently available information (e.g. maintenance plan). These values may therefore be updated at a later date.







Potential risks were considered within our Generation adequacy report available at https://www.ceps.cz/ENG/Cinnosti/Dispecerske_rizeni/generation_adequacy/Pages/default.aspx

Most critical periods for maintaining adequacy margins and countermeasures

We do not expect any problems with upward adequacy in the summer period.

Most critical periods for downward regulation and countermeasures

We do not expect any problems with downward adequacy in the summer period.

Czech Republic: Winter Review 2016/2017

General comments on past winter conditions

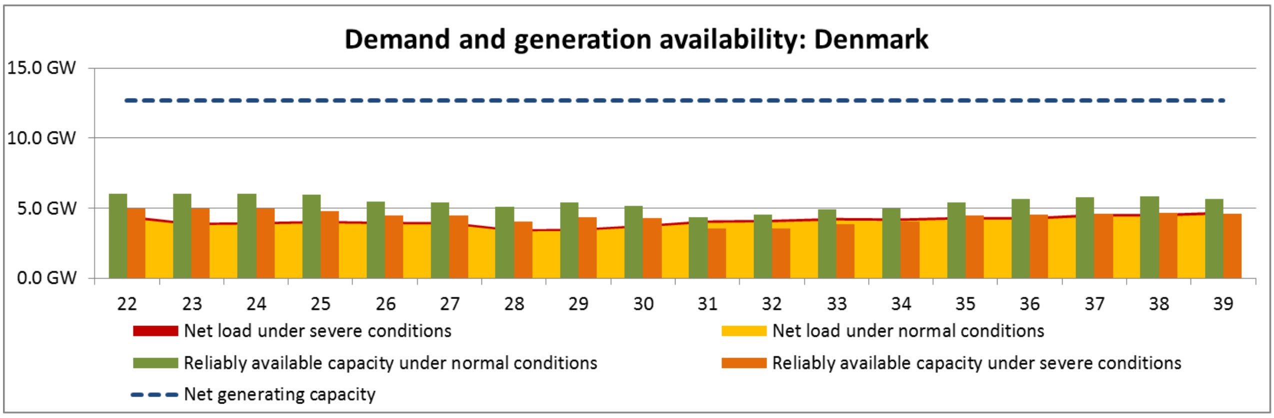
During the winter period, there was generally less available power mainly due to power plant outages (planned and unplanned). The demand was met by increased output of other power plants.

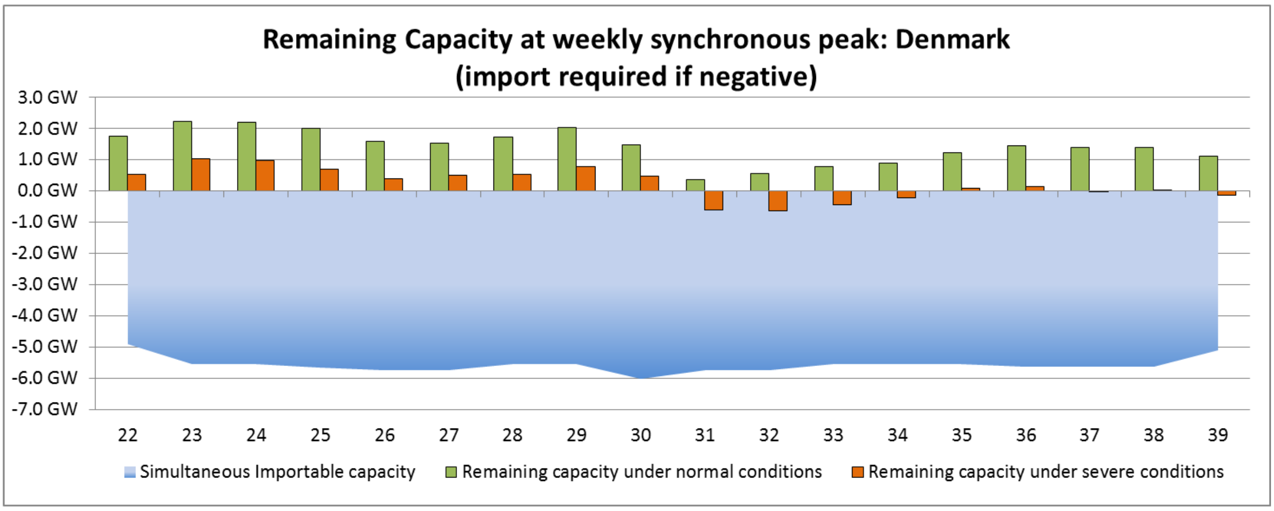
Specific events and unexpected situations that occurred during the past winter

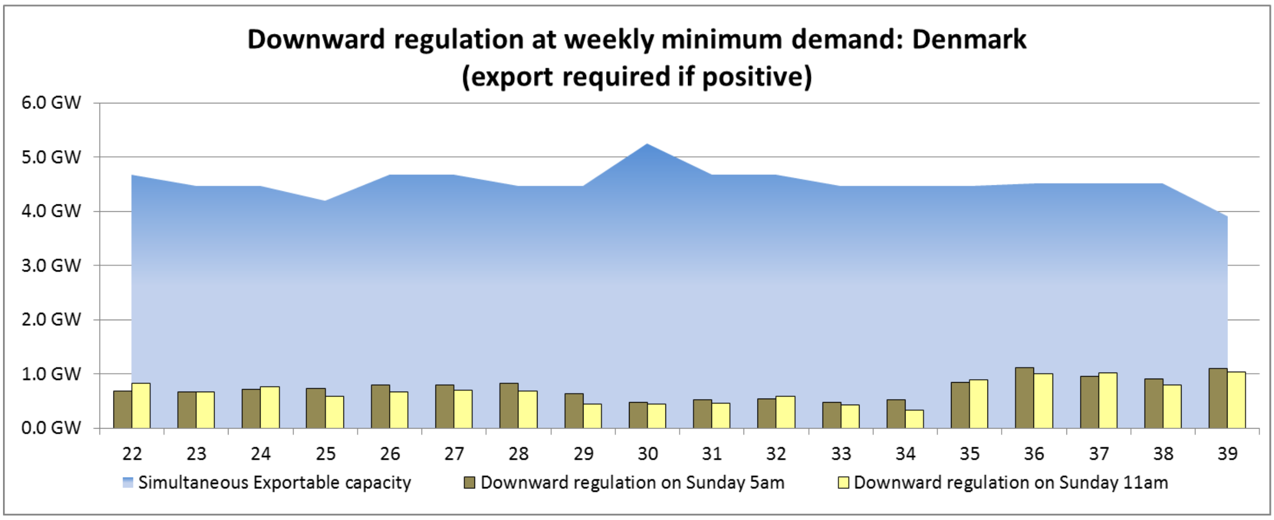
A significant cold spell during the winter resulted in an increase in real consumption (compared to the forecast), reaching the historical hourly maximum load during the month of January 2017. The first two of four Power Shift Tranformers (CZ - DE) were commissioned in January 2017.

Denmark: Summer Outlook 2017

Energinet.dk expect a stable summer period. There are planned maintenance on power plants and some grid outages that affect the capacity but generally it looks fine.







Most critical periods for maintaining adequacy margins and countermeasures

The border connection between Energinet.dk and Statnett (Skagerrak) will in periods be reduced on weekdays and workdays. That will affect the power balance in DK1[22]. The reason for that is change of pylons and wires.

There will be short periods with restriction on the border connection between Sweden and Energinet.dk (Øresund). The reason for that is planned work on the 400 kV lines between Hovegaard and Söderåsen and also planned work in 400 kV station Söderåsen. This work will affect the power balance in DK2[23].

Most critical periods for downward regulation and countermeasures

Energinet.dk doesn't expect any problems with downward regulation.

Energinet.dk expects still, in periods with high wind in feed, countertrades against TenneT TSO GmbH on the Danish-German border. Reason for that is a high amount of wind production in the Northern Part of Germany. Eneginet.dk will manage that with down regulation in DK1 and DK2.

Denmark: Winter Review 2016/2017

General comments on past winter conditions

In general it has been a very still winter, with no major disturbances in the power system.

The average electricity prices continued to increase due to the developments in Germany and the rest of continental Europe, and historic low reservoir filling in Norway and Sweden. Despite the high prices, the high wind infeed in both Germany and Denmark caused negative prices in price areas in DK1, DK2 and DE in some hours during winter.

The capacity at the border between Energinet.dk and TenneT border in southbound direction (DK1->DE) was, as expected, restricted for much hours due to the load flow and wind infeed in the North of Germany and planned outages of the interconnectors due to grid expansions.

In November 2016 Energinet.dk and 50Hertz successfully installed an upgrade of the control system. The upgrade caused some limitation on the border, and the capacity ranged between 0 and 85/600 MW during the month.

Specific events and unexpected situations that occurred during the past winter

[22] DK1: Western Denmark

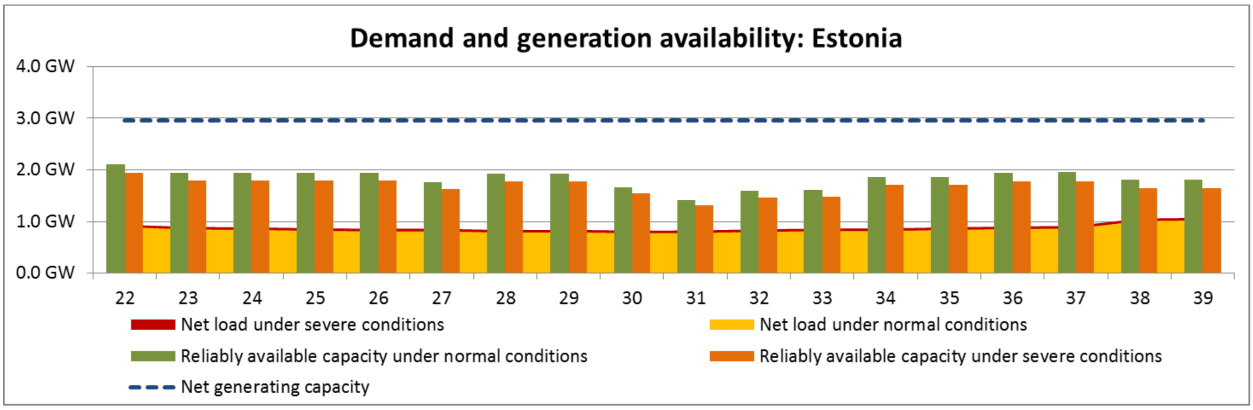
[23] DK2: Eastern Denmark

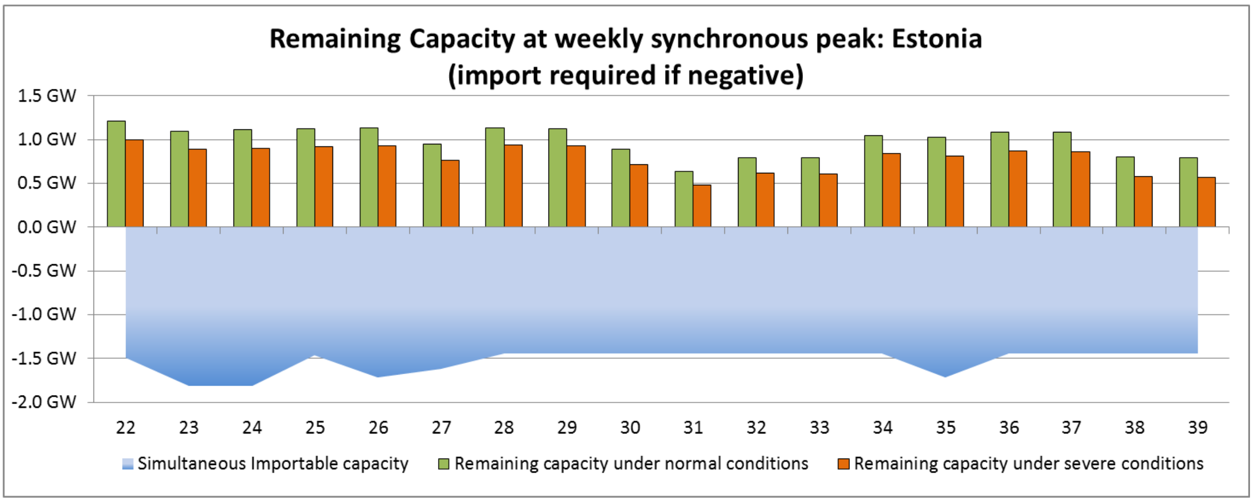
DK2 experienced a few weeks with a more restricted power for manual reserves due to planned revision of power plants. It caused some weeks with high prices for manual reserves.

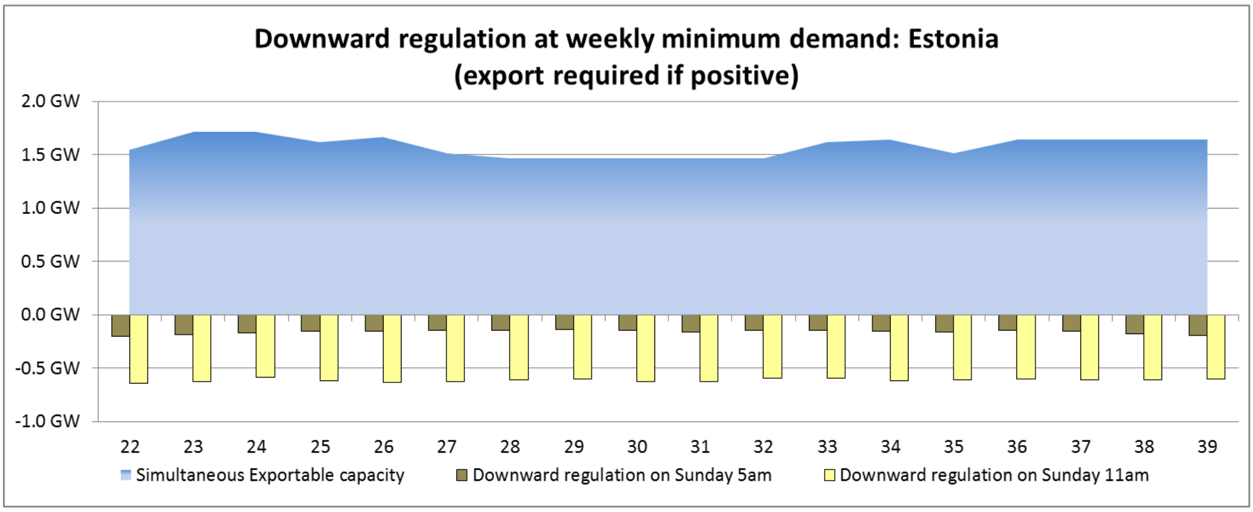
Due to changed capacity calculation in Svenska Kraftnät control area, there has been hours with limited export capacity from Denmark to Sweden, especially during periods with high wind infeed. Svenska Kraftnät is compelled to limit the import due to the power situation at the West Coast Corridor.

Estonia: Summer Outlook 2017

It is expected that the adequacy is guaranteed for upcoming summer. The system is expected to be net export for whole summer. At the end of July and the beginning of August (from week 30-33) there will be less production capacity than during the rest of the summer due to maintenances in oil shale power stations but the remaining generating capacity even during the most severe maintenance period still exceeds expected peak load.







Most critical periods for maintaining adequacy margins and countermeasures

The lowest import/export capacity in Estonia-Latvia interconnection is from the mid July to the beginning of August when the transfer capacity to Latvia is limited to 450 MW. The usual case is that the energy flows in direction to Lithuanian and Latvian power system thus, there might occur some stressed period for interconnection between Estonia and Latvia. However, new DC connections to Lithuania (Nordbalt and Litpol link) have decreased the power flows to Lithuania via Latvia and Estonia. Generally, in summer maintenances, which decrease significantly capacities in Estonia/Russia-Latvia interconnection, are limited to avoid congestion.

Most critical periods for downward regulation and countermeasures

The part of inflexible generation in Estonian system is not large enough to cause any serious problems, even for times of minimum demand.

Estonia: Winter Review 2016/2017

General comments on past winter conditions

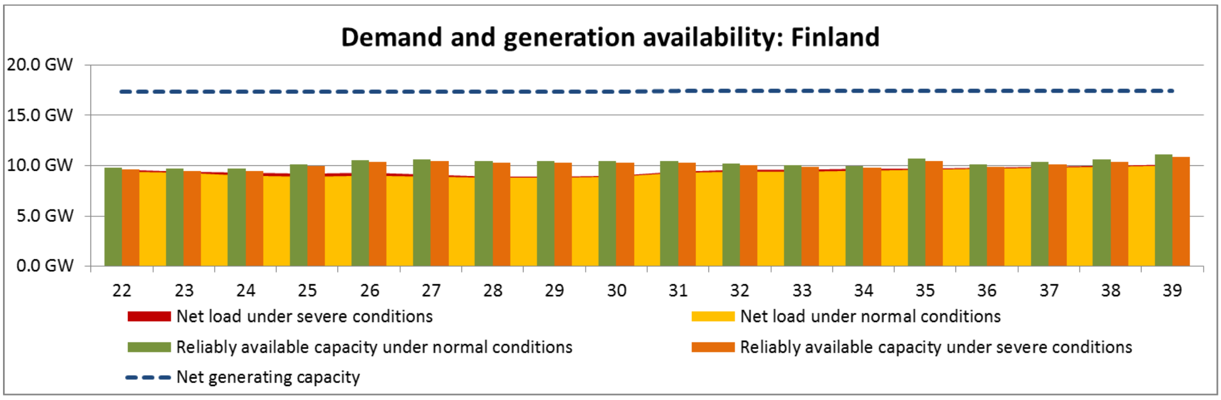
The winter 2016/2017 was similar to previous year winter. Most of the time winter was mild. Peak load 1483 MW occurred on 5 January at 15:25 EET when the temperature was -15°C, compared with last period winter peak this year's peak was 4% lower. The average temperature of winter (December until the end of March) was -1.2°C.

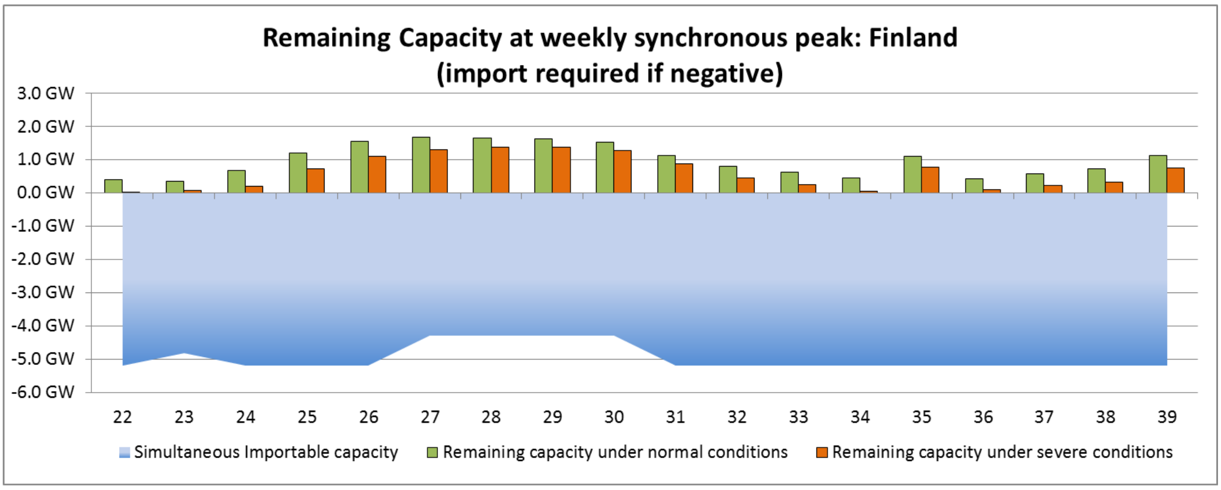
Specific events and unexpected situations that occurred during the past winter

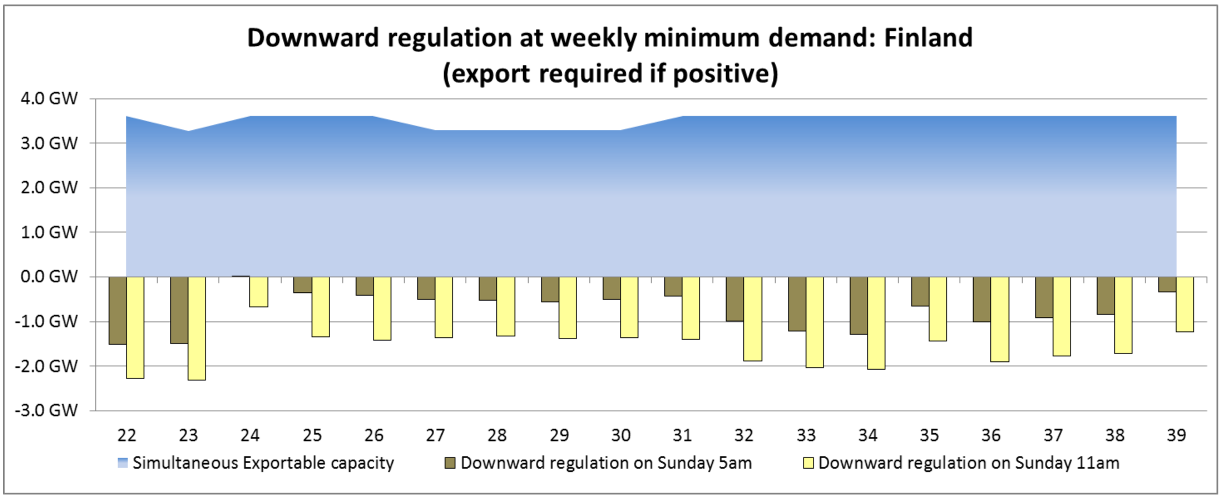
The generation was sufficient to cover the load, even during peak load and the system was in net export. The power flow towards Latvia and Lithuania was lower than previous years due to new DC links in Lithuania (LitPol and NordBalt).

Finland: Summer Outlook 2017

Typically, summer peak load in Finland is 60% to 70% of the winter peak load and therefore summer is not as critical from adequacy perspective as winter. However, summer is high season for power plant maintenances and overhauls hence there is less generation capacity available in summer than in winter. In addition, there are some maintenances on interconnectors during summer.







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

There are no specific export needs due to inflexible generation at minimum demand period.

Finland: Winter Review 2016/2017

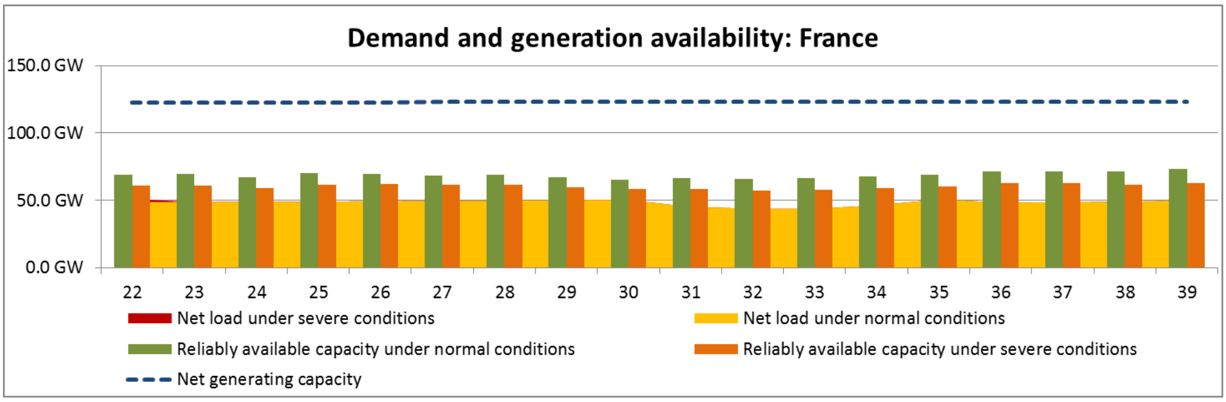
General comments on past winter conditions

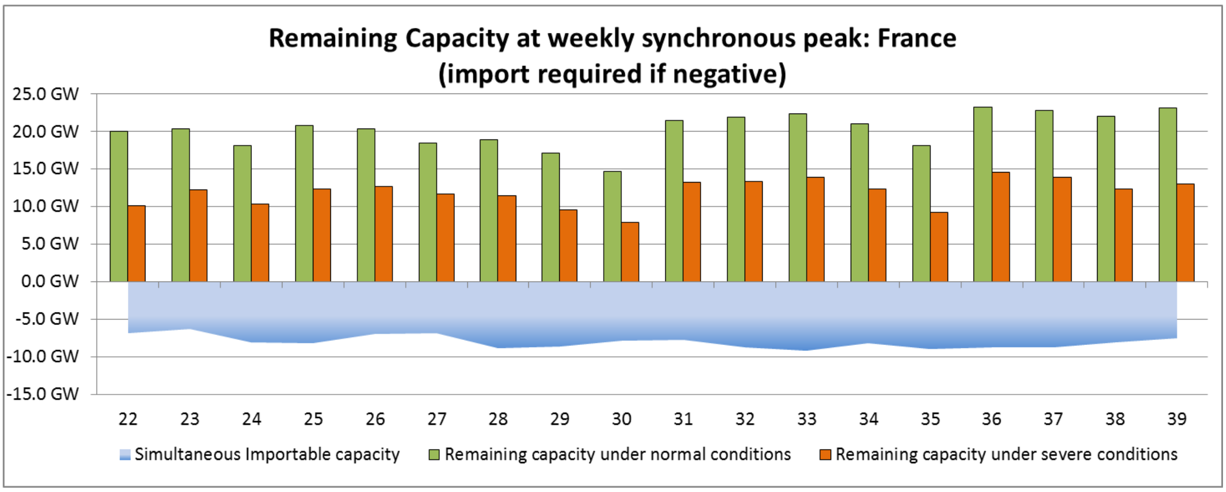
Winter 2016/2017 was generally mild in Finland except a short cold period that happened in early January. Winter peak load, 14.3 GW, was recorded during that short cold period. Due to warmer temperature, the peak load in winter 2016/2017 was less than in previous winter when the all-time highest peak load, 15.1 GW, was recorded in Finland.

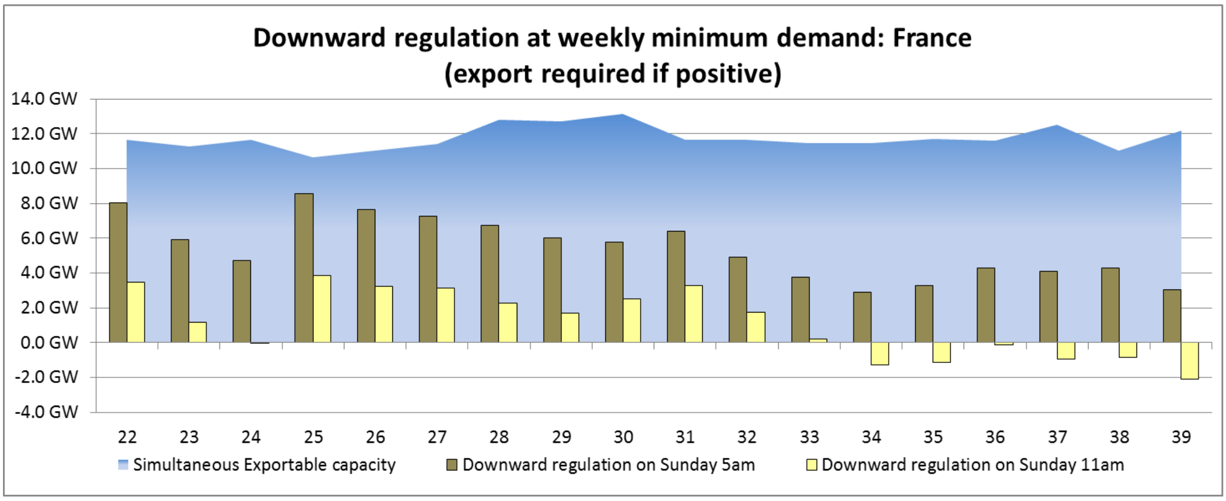
Specific events and unexpected situations that occurred during the past winter

No adequacy problem occurred in winter 2016/2017. New import record, 4.8 GW, was reached in the morning of the peak load day in January.

France: Summer Outlook 2017







Most critical periods for maintaining adequacy margins and countermeasures

The most critical period for severe conditions is week 30, with a high level of nuclear maintenance, combined with the availability of nuclear plants which are non-usable during a hot wave. Upward margins should remain positive all over summer, with no need to import power for adequacy reasons.

Most critical periods for downward regulation and countermeasures

The most critical period for downward regulation should happen in the early summer (week 25), due to numerous nuclear power plants that must run close to their maximum power, with around 6 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 week-ends in particular - as every summer.

France: Winter Review 2016/2017

General comments on past winter conditions

In comparison with winter 2015/2016, temperatures were much lower – especially in December 2016 and January 2017 – and led to a significant increase in national consumption (+13% in December and +14.3% in January, compared with previous winter). These two months, France was in import balance. We noticed that it was the first time since February 2012. In February 2017, temperatures were milder than the previous months.

Specific events and unexpected situations that occurred during the past winter

This winter, the low nuclear power supply is due to numerous long-lasting planned outages (up to 11 additional planned outages) by EDF[24] in response to the request from France nuclear security regulator (ASN) to perform safety checks through a review of the strength of crucial steel components. This lack of nuclear production led to a tense situation regarding the balance between demand and supply of electricity particularly during the cold spell and to consider the need for load shedding. RTE was fully prepared for such a crisis situation and prepared with other TSOs and Coreso a set of specific means to face it at best.

For week 3, due to low temperatures, it was expected in week-ahead necessary to perform load shedding at the end of the week to preserve the balance between demand and supply and to ensure electricity power grid reliability: a report was sent through the Crisis Communication Tool on 13 January to inform ENTSO-E TSOs about this expected tight adequacy in France. In real time operation, milder temperatures reduced electricity demand compared to weekly forecasts and avoided RTE to activate any load shedding.

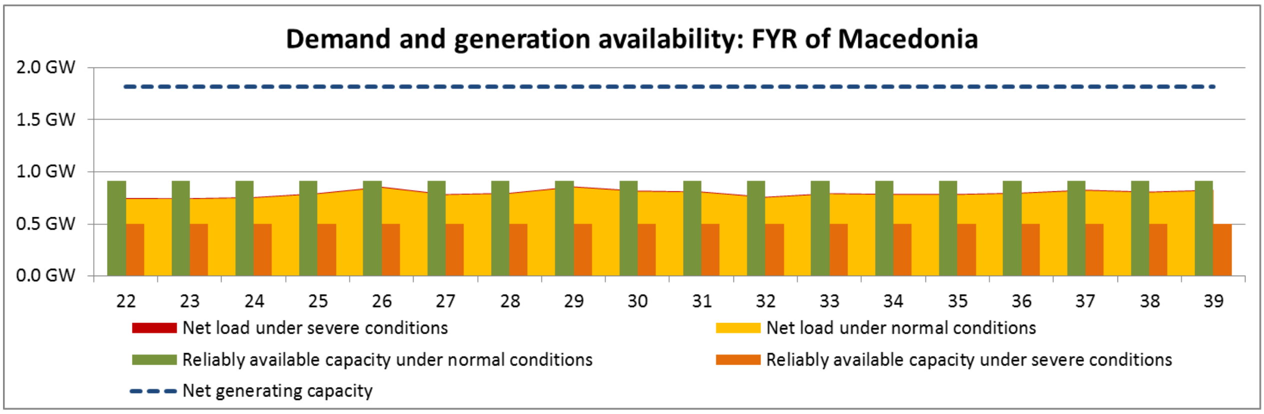
On 25 January, French TSO RTE changed its System State on European Awareness System (EAS) to Alert State from 13:00 to 19:29 CET for a lack of reserve and to Emergency State from 15:56 to 17:49 CET due to the absence of available margin. This event was mainly

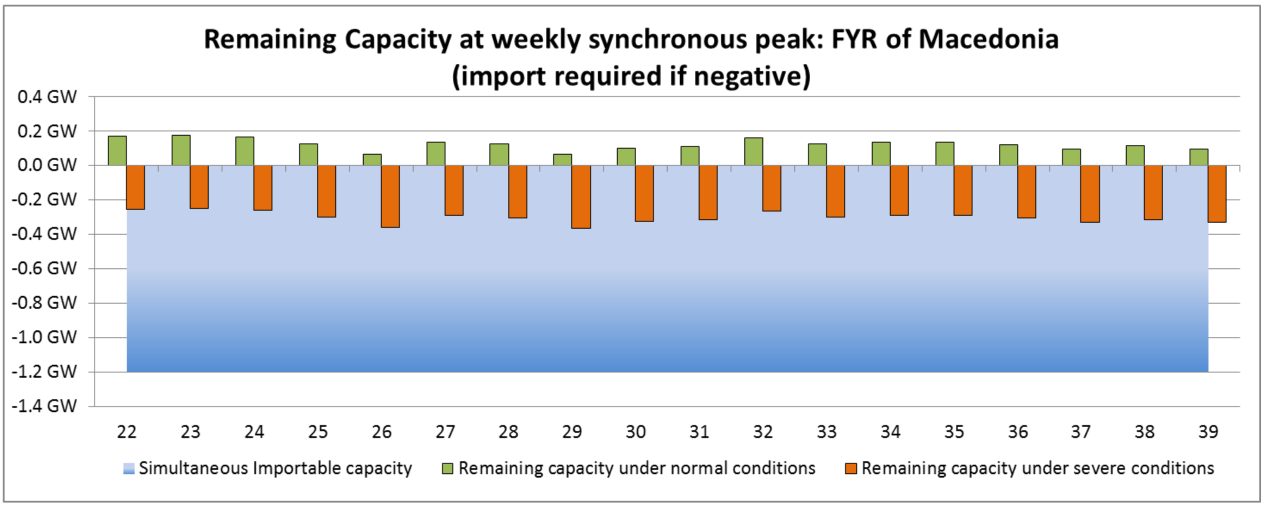
[24] EDF: Électricité de France S.A., French electric utility company

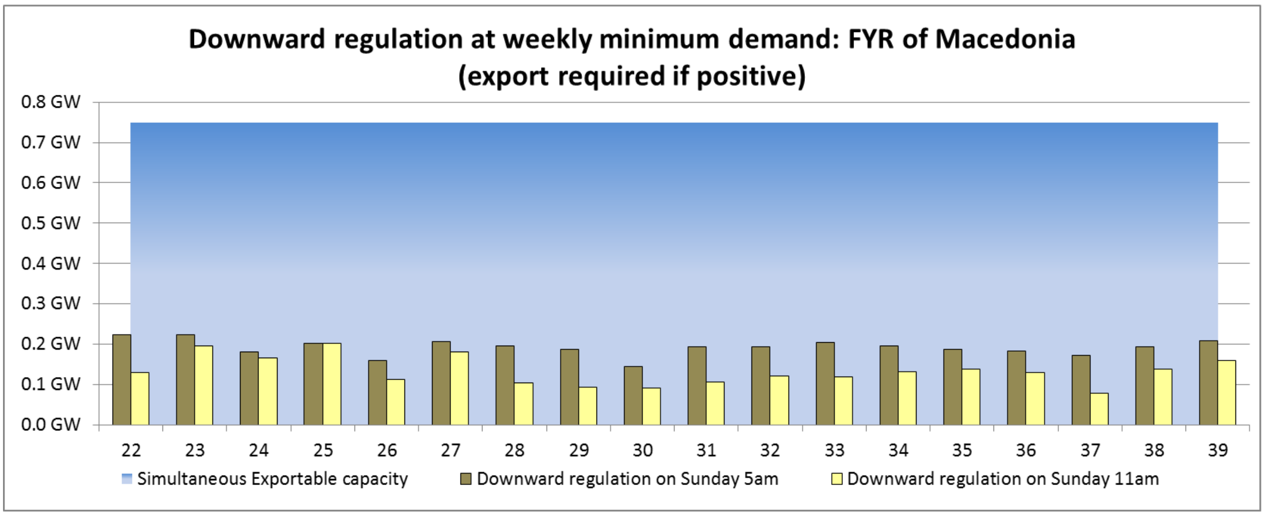
caused by an uncommon behaviour of the national consumption that followed a plateau instead of decreasing in the afternoon. This issue was under control on RTE side and margins were progressively recovered by the actions of the operators.

FYR of Macedonia: Summer Outlook 2017

Compared to previous years, this year is characterized by higher temperatures and, as a consequence, reduced consumption. The lack of snow in the past winter may result with a deficit of energy produced from hydroelectric facilities in coming summer.







Interconnections would have a key role in the summer period due to the large transit in north-south direction.

Cross-border transmission capabilities of the Republic of Macedonia is such that they can support all import or export electricity transactions to/out of the Republic of Macedonia, while allowing unobstructed transit of energy across the region.

FYR of Macedonia: Winter Review 2016/2017

General comments on past winter conditions

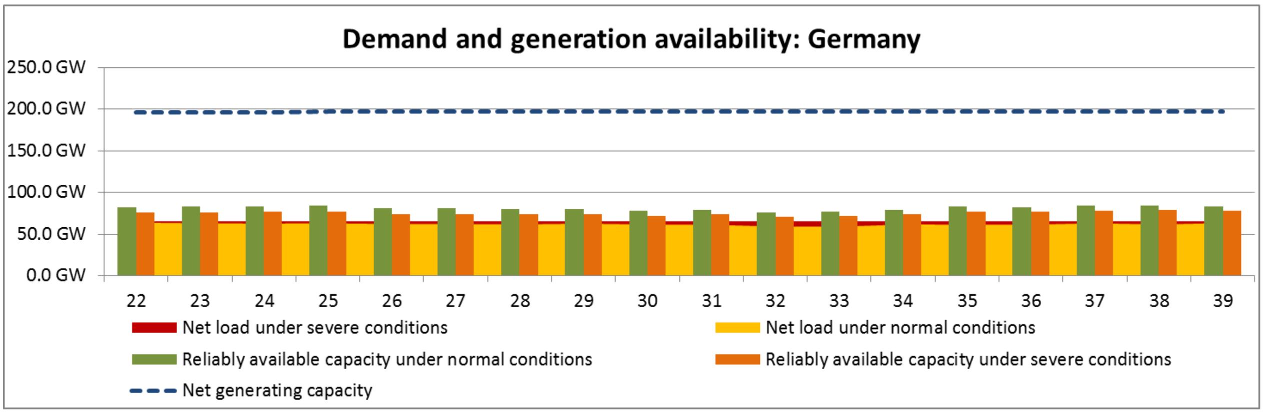
Generally this winter was with relatively low temperatures and with a small amount of snow.

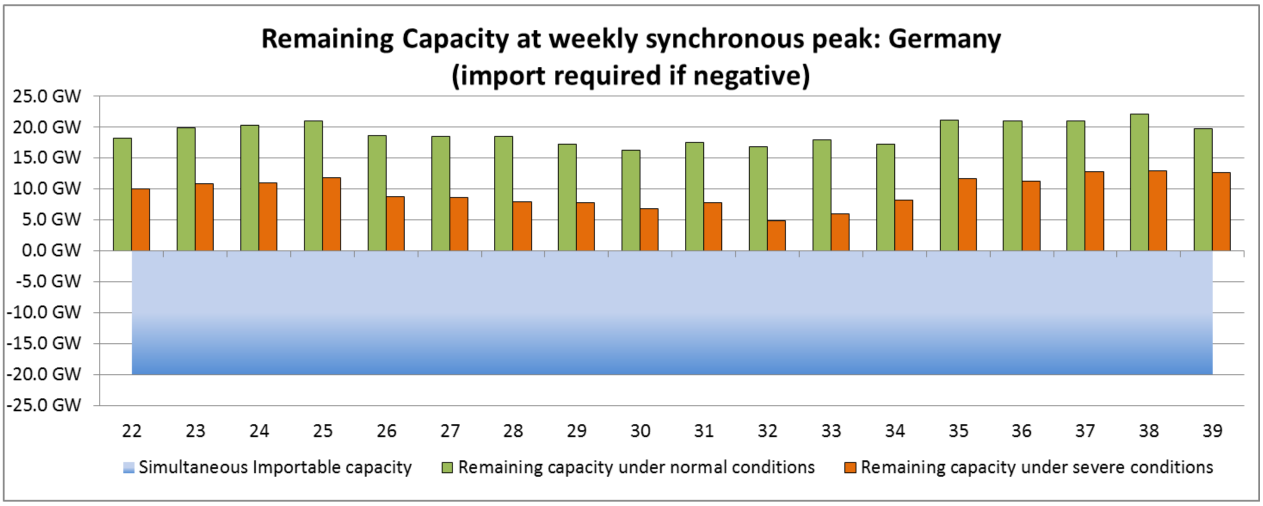
Specific events and unexpected situations that occurred during the past winter

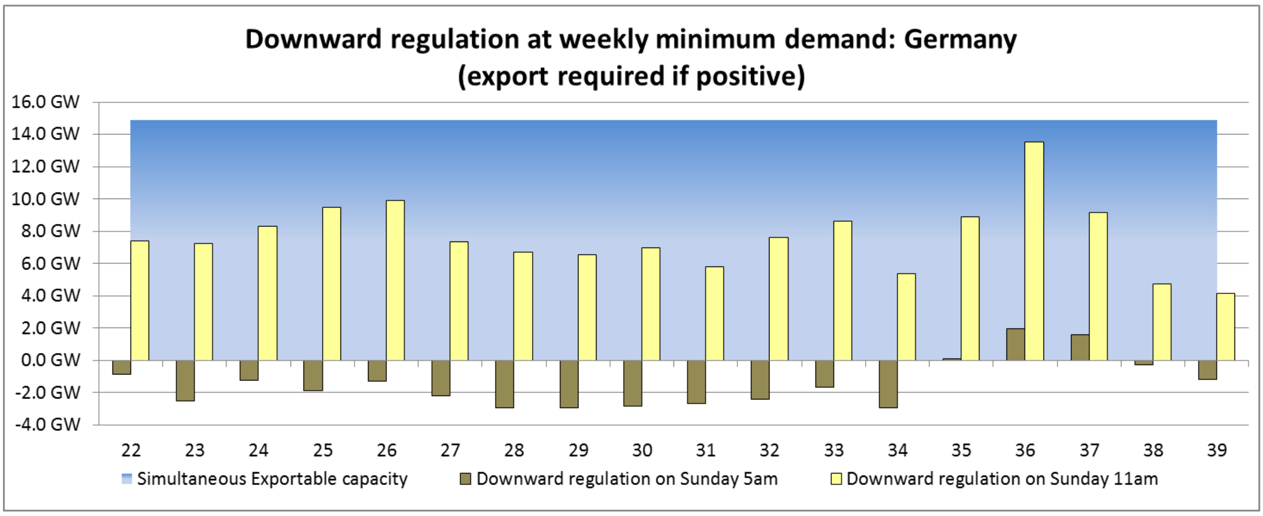
There was no unexpected situation during the winter period. The operation of power system was secure and reliable over all winter period.

Germany: Summer Outlook 2017

The German TSOs do not expect significant problems with the generation-load balance for the coming summer. The German load can be covered with the available capacity. Even under severe conditions Germany is therefore not expected to be dependent on interconnectors to maintain adequacy. However, both under Normal and Severe Conditions German grid reserve power plants were not subtracted as non-available. Nevertheless those power plants are not participating in the regular electricity market.







A longer hot and dry spell could lead to restrictions of 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.

Most critical periods for maintaining adequacy margins and countermeasures

No critical periods for maintaining adequacy are expected.

Most critical periods for downward regulation and countermeasures

Possibly the increasing photovoltaic (PV) infeed could lead to unexpected load flows in the German transmission system, especially if the RES infeed in the north of Germany is high and low in the south.

Specifically, the time around Whitsunday could be critical concerning voltage problems in case of low demand, no PV infeed in the south of Germany but a moderate infeed of wind energy. In periods with high renewable infeed and low (regional) demand high power flows on interconnectors 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 2016/2017

General comments on past winter conditions

According to the German Weather Forecast Service (Deutscher Wetterdienst, DWD), November 2016 was cooler than normal. The first half was quite chilly while December 2016 was the 3rd sunniest December since the beginning of the measurements, and exceptionally dry with only 35% of the expected precipitation. January 2017 was overall cold and dry with days with a lot of sunshine. Especially mid-January showed permanent frost and a (snow) storm on 13 January 2017 with the activation of Exceptional Contingencies. Last week of January was mostly mild.

Specific events and unexpected situations that occurred during the past winter

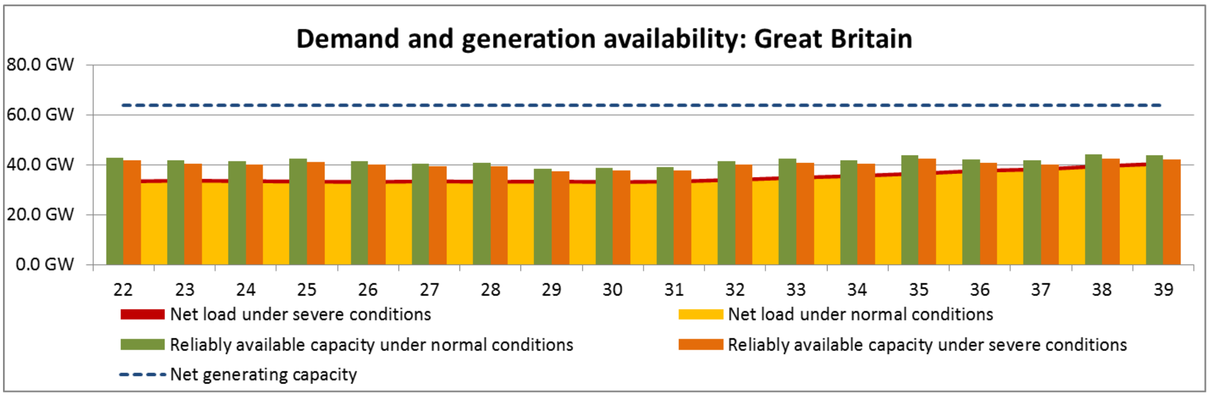
Especially in January the lack of adequacy in France and Belgium due to low availability of nuclear power plants (as foreseen in the Winter Outlook Report 2016/2017) and RES in Germany as well as the historically low level of the reservoirs in the alpine region (Austria and Switzerland) caused extremely high load flow in the German transmission system from north to south accompanied by high exports.

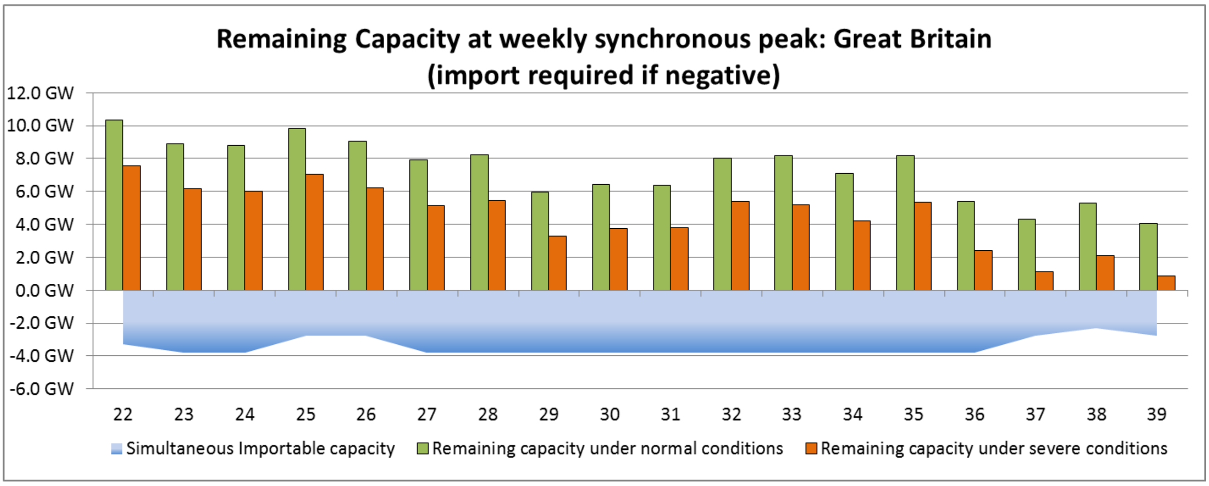
Triggered by the need for additional generation in southern Germany for congestion management the German TSOs activated an increased amount of grid reserve power plants to overcome this situation. The grid reserve power plants were needed to provide enough generation capacity in the south for the extraordinary high amount of redispatch which had to be activated to maintain the (n-1)-criterion. Despite these measures by the German TSOs the (n-1)-criterion was violated temporarily in mid of January. The information about these situations was provided via European Awareness System (EAS) to all TSOs.

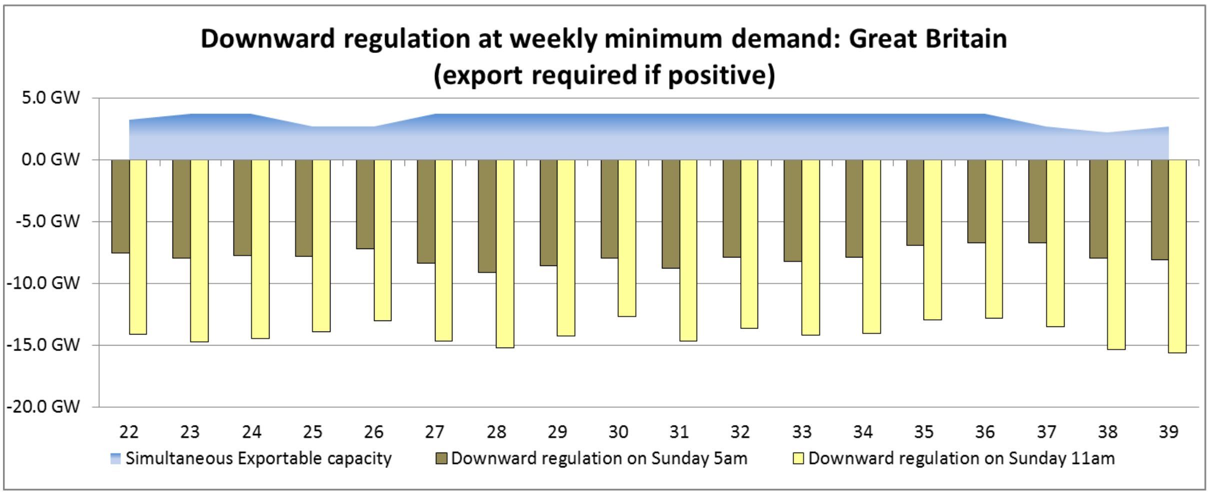
In general the last winter was characterized by several overlapping restrictions in conventional and hydro generation in Europe accompanied by a phase in January, with a very low RES infeed in the CWE Region during a sustained cold spell. This led necessarily to a very high infeed of conventional power plants in Germany during this period of time.

Despite the tense situation in several European countries and the high exports from Germany, the German TSOs didn’t face adequacy problems. Moreover, the German TSOs made a significant contribution for system adequacy within Europe as all actions taken were very well coordinated in the region by the TSOs involved.

Great Britain: Summer Outlook 2017







Most critical periods for maintaining adequacy margins and countermeasures

Our analysis uses two demand definitions; 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.

Some interconnector outages are forecast for all weeks this summer.

- We expect Interconnexion France – Angleterre (IFA) to be reduced from 2,000 MW to 1,000 MW in week 25 and week 26. Capacity will again be reduced to 1,000 MW for 19 days in September (weeks 37, 38, and 39).
- The 500 MW East West Interconnector (EWIC) will be on outage for 5 weeks, starting around mid-April (week 14 or 15) to end of May (week 22), when capacity will be reduced to zero.
- The Moyle Interconnector is expected to be reduced from its capacity of 500 MW to 250 MW for the whole of the summer, due to a fault on the subsea cable.

For Normal condition, our forecasted lowest operational surplus is 4.1 GW in week 39. Even during this week we expect to be able to export up to 4.0 GW on the interconnectors (depending on the actual capabilities at the time).

Using severe condition factors the lowest margin is in week 39 where we would still be able to export up to 850 MW on the interconnectors (depending on the actual capabilities at the time).

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

Most critical periods for downward regulation and countermeasures

We expect to see a continuing fall in electricity demand on the transmission system, with both lower peak and minimum demand levels. We will need to curtail flexible wind generation and it may also be necessary to instruct inflexible generators to reduce their output during periods of low demand. We expect there to be sufficient generation and interconnector imports to meet demand peaks.

We expect summer minimum demand to be 17.3 GW this summer, 500 MW lower than the 2016 weather corrected outturn. Similarly we anticipate the daytime minimum transmission demand to fall to 21.9 GW, compared to the weather corrected outturn we saw in 2016 of 22.7 GW.

The lowest downward regulation margin at night we expect this summer is forecast to be 6.72 GW overnight in week 37.Our current data also suggests that the lowest daytime minimum period, week 30, has the lowest downward regulation margin (12.73 GW).

Great Britain: Winter Review 2016/2017

General comments on past winter conditions

GB has had reliable generation supply this winter, lower than forecast transmission demand. Demand was lower because of higher than average winds, no significant cold spells, restrictions on some interconnectors (reducing export capability), embedded generation responding to price signals and good levels of customer demand management across periods of lower margins. On the supply side plant has been reliable, with no significant losses to the system, and responsive interconnector flows.

Specific events and unexpected situations that occurred during the past winter

Transmission demand has been lower than forecast across the winter due to warmer weather, high wind and in response to high prices. Peak demand was 51.2 GW on 5 December and then on 23-26 January, compared to forecast of 52 GW.

Lowest operating margins were on 1 December 2016, due to low temperatures, and on 11 January 2017, due to exports to France, Netherlands and Ireland.

Nuclear availability issues in France increased French power prices, and GB exported to France at peak on some days in December 2016 and January 2017.

Generation breakdown was near normal level.

There was a Bipole outage (cable fault) on the French Interconnector from 20 November 2016 to 16 February 2017. One pole remained out until 1 March 2017.

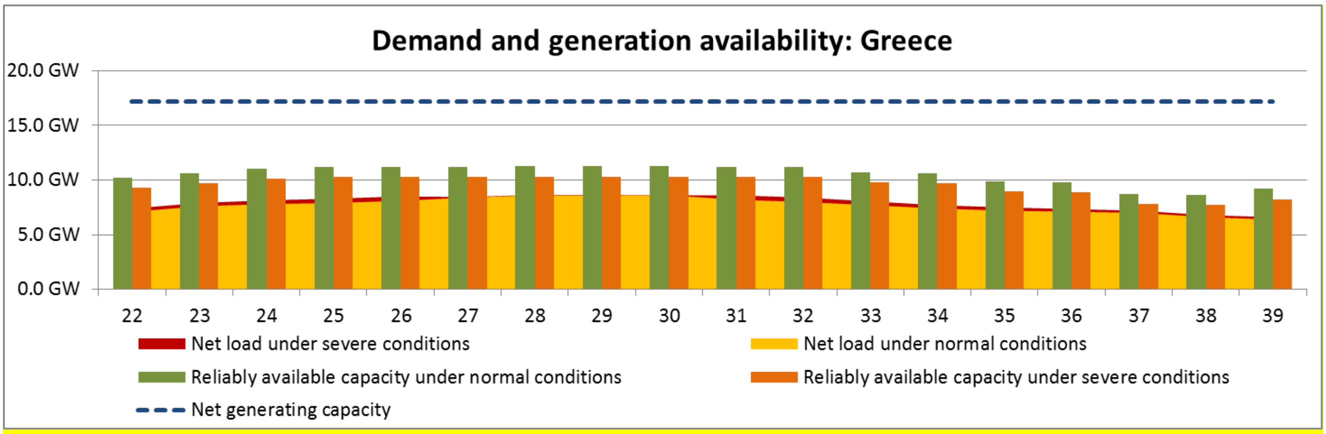
EWIC to Ireland was on breakdown from 10 September 2016 to 23 December 2016.

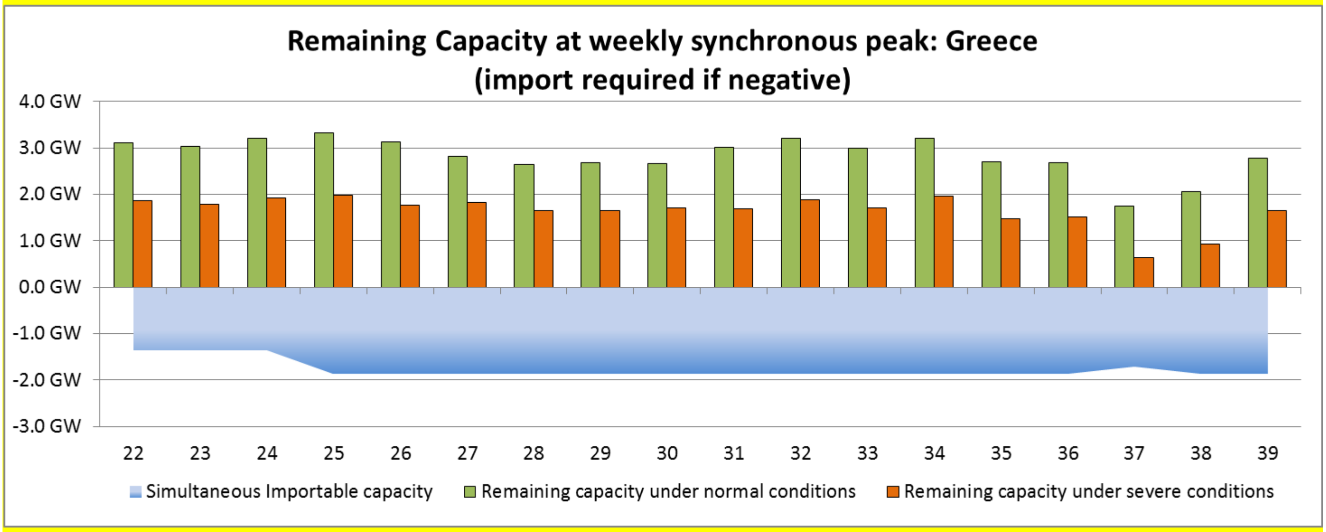
One pole faulted on the Moyle interconnector to Northern Ireland on 20 February 2017; it is expected to return on 30 September 2017.

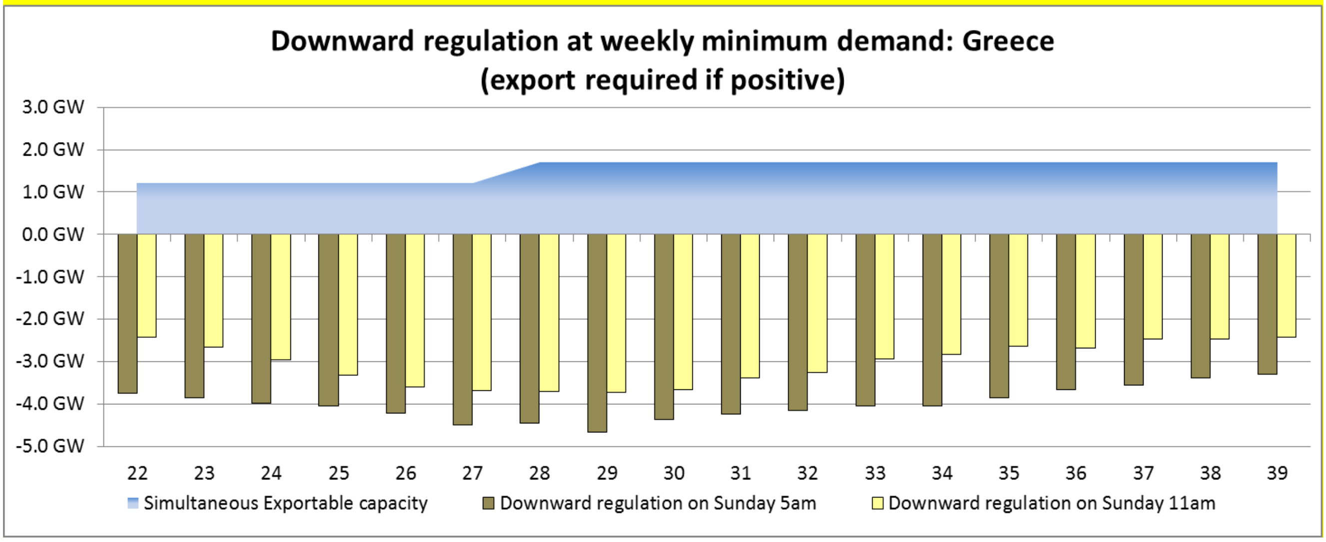
Greece: Summer Outlook 2017

The Greek system is expected to be balanced in the upcoming summer period (2017). The level of indigenous national generation and the good level of estimated hydraulic storage should ensure the adequacy and security of the Greek interconnected System, both under normal or severe weather conditions. There is planning for maintenance of one unit (approximately 300 MW) during this summer. Moreover the water reserves are expected to be at least at the last year level.

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







Most critical periods for maintaining adequacy margins and countermeasures

There is not critical period, but the most important period during summer is the 1st half of July, due to maximizing of the demand, annually. 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 in System demand. In this cases Greek TSO IPTO could export or import energy to/from other countries depending of the market prices.

Most critical periods for downward regulation and countermeasures

There is not critical period, but the most important periods for downward regulating capacity are usually from 00:00 to 06:00 EET (due to low demand) and from 11:00 to 17:00 EET (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 2016/2017

General comments on past winter conditions

During last winter there were severe climatic conditions with heavy snowfall periods in Greece. The temperatures decreased further than expected and for long periods, which led to increase of System demand.

Specific events and unexpected situations that occurred during the past winter

These winter severe weather conditions resulted in an increase of demand of both gas and electricity, as sequence of events.

Situation was worsened by outage of HVDC Link GR-IT interconnection, which was out of operation for months. Due to the extreme weather conditions in the whole European area, the Energy Market mechanism led to energy exports through the north interconnections. As a result, export NTC reduced to zero (curtailment on 11 and 12 January on all north borders) in order to ensure the security of supply.

The increased demand of natural gas, led to gas supply limitations and to major problems in residential and industrial level and in the production of electricity. To overcome the gas supply problem, some gas power units changed the fuel from gas to diesel. Moreover the hydraulic storage of hydropower stations was used to ensure the security and supply of the power system.

In addition, another critical event of this winter period there were a lot of malfunctions and damages to power units, causing extra challenging conditions to the power grid of Greece.

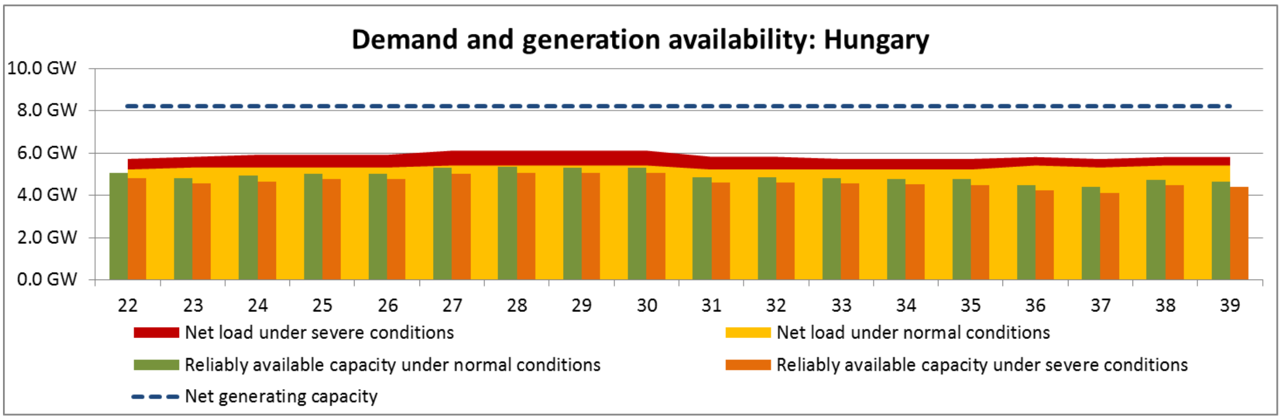
Hungary: Summer Outlook 2017

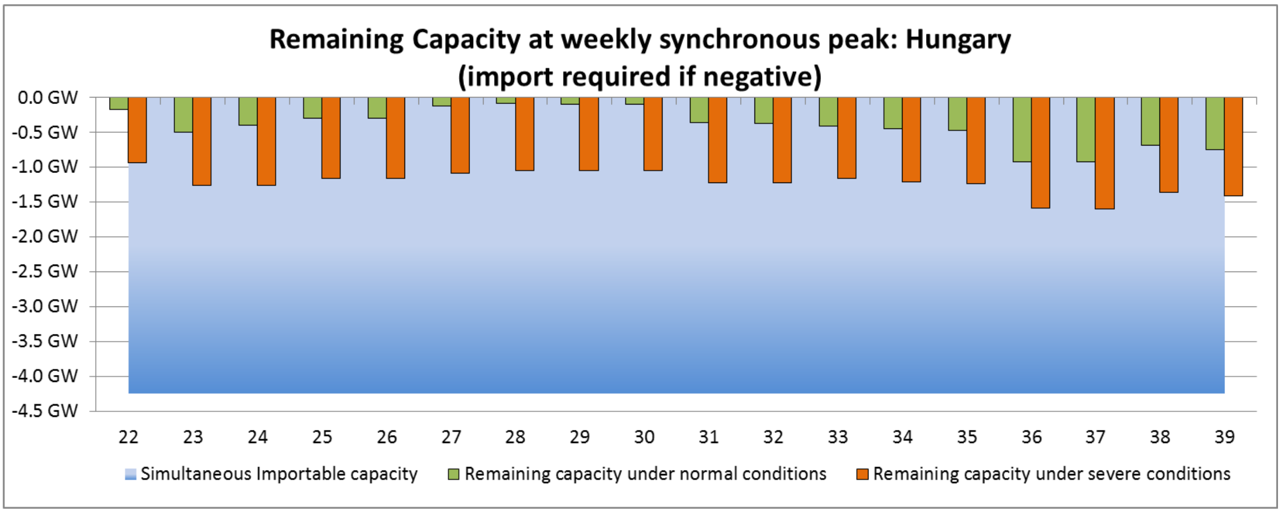
As a result of the constantly growing demand, there is no period of time when the import could be ignored. The unavailable capacity has increased in recent years, which strengthens the dependence on the import and decreases the flexibility of the system.

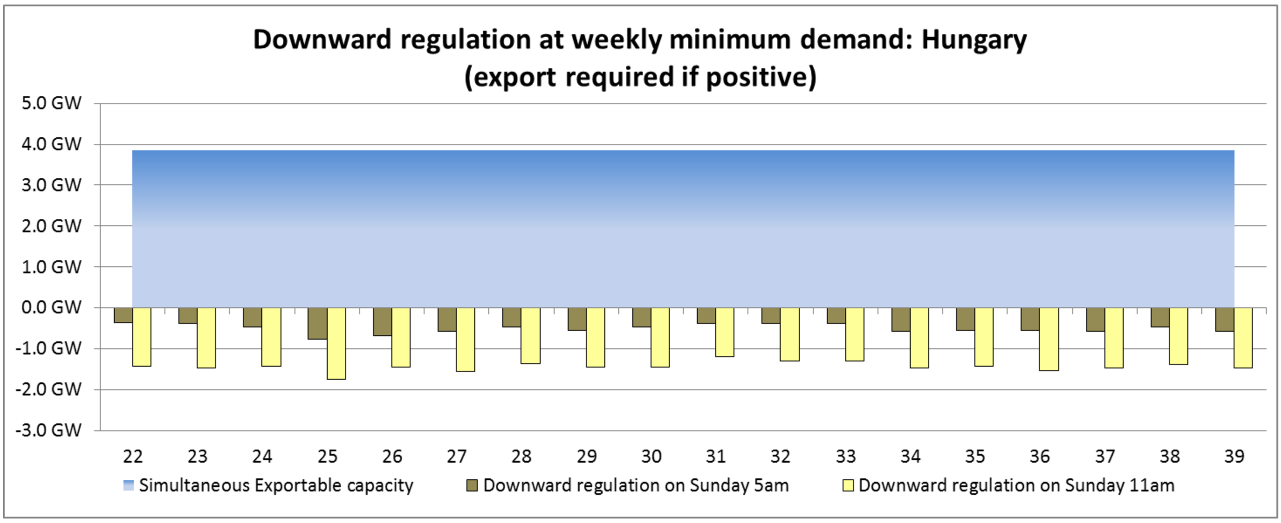
High transit flows can be expected through the interconnections in summer as well.

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

The increasing level of PV generation could not cause any balancing problems yet.







Most critical periods for maintaining adequacy margins and countermeasures

The level of maintenance is normal level during the summer. It is mainly between 300 and 500 MW. The most critical periods are the first weeks of September, when the level of maintenance is over 1000 MW.

Most critical periods for downward regulation and countermeasures

There are no critical periods because of the constant value of minimal demand, must-run power and downward regulation reserves. Downward regulation capacity is a constant value which can be decreased by the growing PV capacity. Also the deviation of the actual generation of on-shore wind and solar units from that calculated by using the RES load factors in the table can have similar effect of a few hundred MW.

Hungary: Winter Review 2016/2017

General comments on past winter conditions

During the winter time, the load level of the Hungarian system was significantly higher compared to the historical data. The main reason was the prolonged extremely cold weather. Sometimes the temperature at night was below -20ºC. The Hungarian power system experienced a new record for peak load on 11 January 2017 with 6780 MW.

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

Specific events and unexpected situations that occurred during the past winter

In the first half of January, generating units had some difficulties which were mainly due to the extreme cold temperatures. Maximum unplanned unavailable capacity was approximately 1.2 GW during peak demand periods. During these periods, the reserves as well as import were able to cover the deficit in power which was lost due to the outages. The availability of the transmission lines was not impacted.

Iceland: Summer Outlook 2017

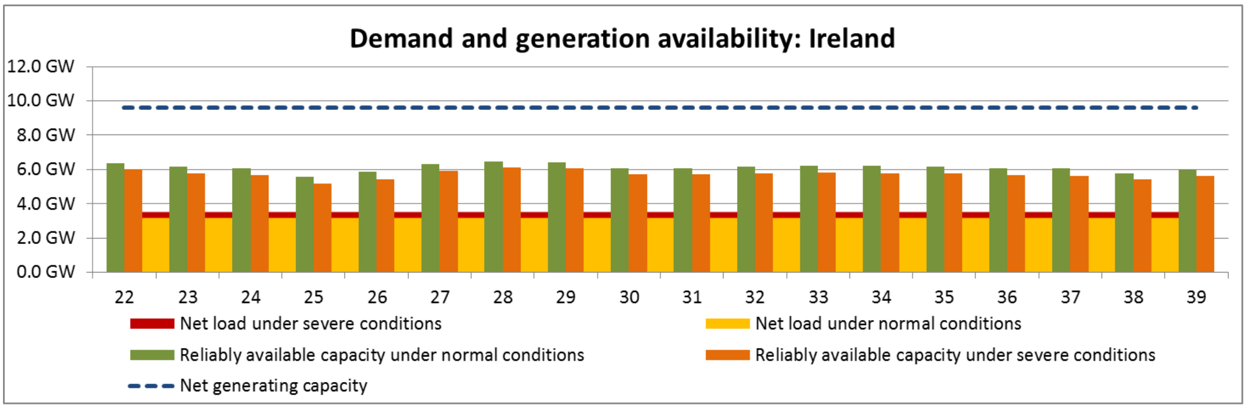
No adequacy issue is expected in Iceland for coming summer.

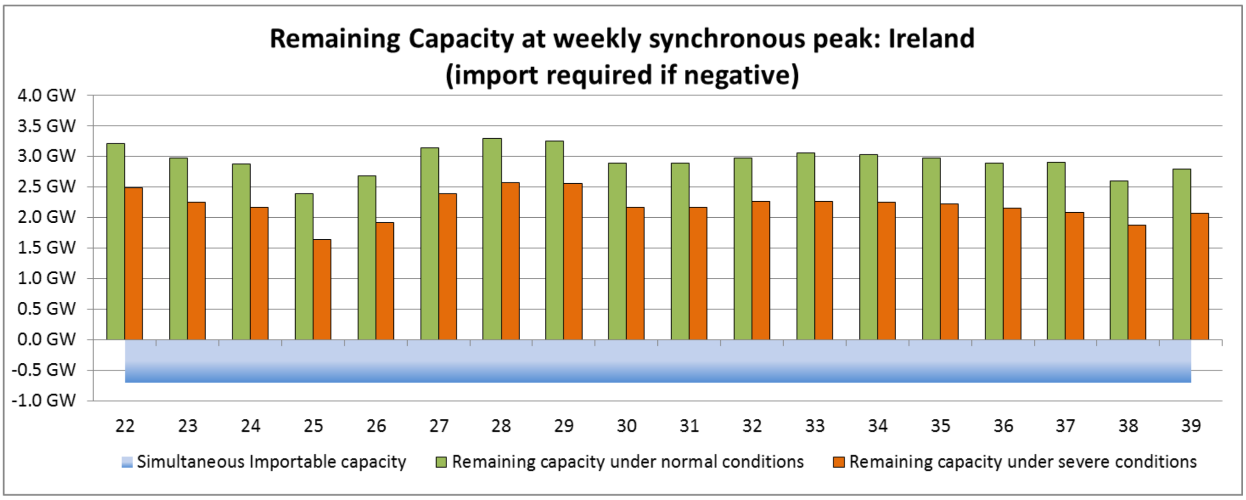
Iceland: Winter Review 2016/2017

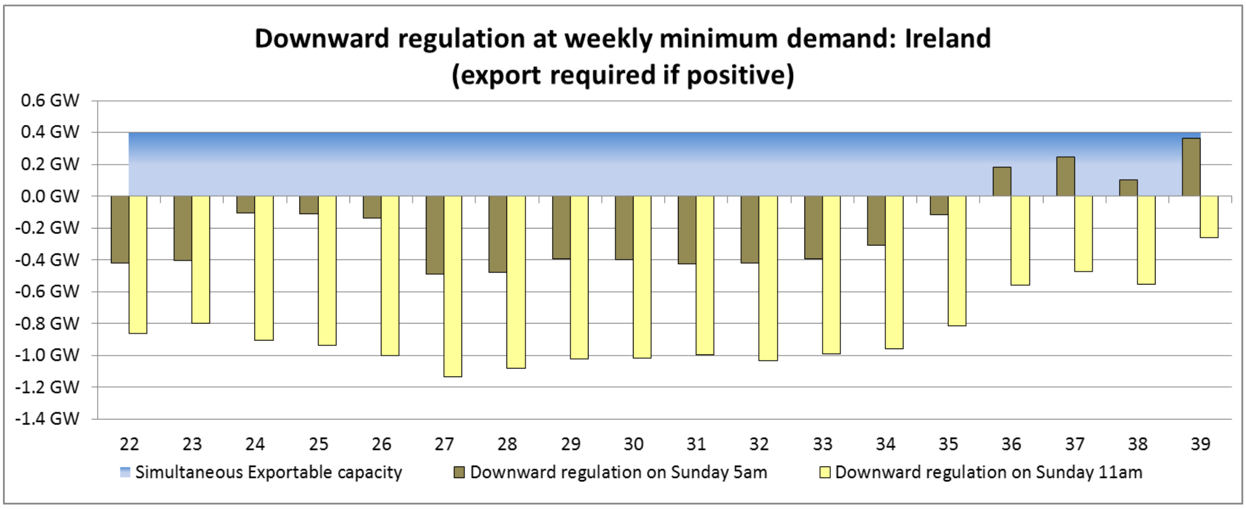
No adequacy issue is expected in Iceland was identified in past winter.

Ireland: Summer Outlook 2017

Ireland does not expect capacity issues in summer 2017.







Ireland: Winter Review 2016/2017

General comments on past winter conditions

Ireland did not experience capacity issues in winter 2016.

Italy: Summer Outlook 2017

Upward adequacy margins

In recent years, the Italian Power System has faced a significant reduction of the conventional (thermoelectric) power fleet. The growth of intermittent (e.g. wind and PV) generation, together with a drop in demand, is putting commercial pressure onto traditional generators, leading to the decommissioning of the oldest power plants. Between 2012 and 2016, the following phenomena affected the power system operation and adequacy in Italy: about 15 GW installed generation phased out. The total amount of installed conventional power plants fell from 77 GW down to 62 GW and additional 5 GW conventional power capacity is not available due to environmental/ legal constraints and mothballing. This trend can be observed on the Figure below. This phenomenon has been seriously affecting the power system adequacy in Italy and some important warning signals in terms of adequacy on the national level scarcity were already registered in last years (2015/2016) during the summer period as well as during 2017 winter.

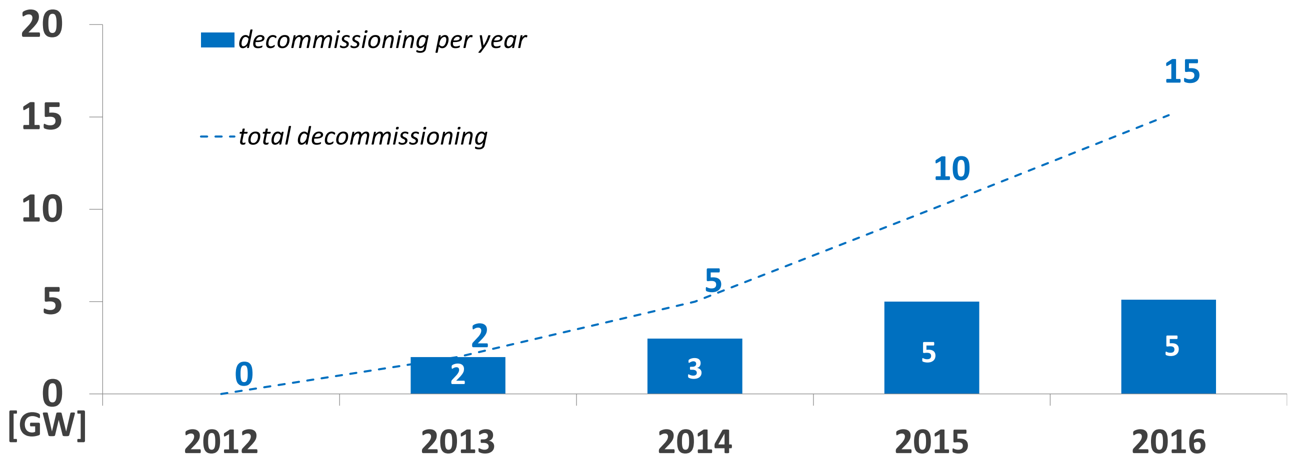
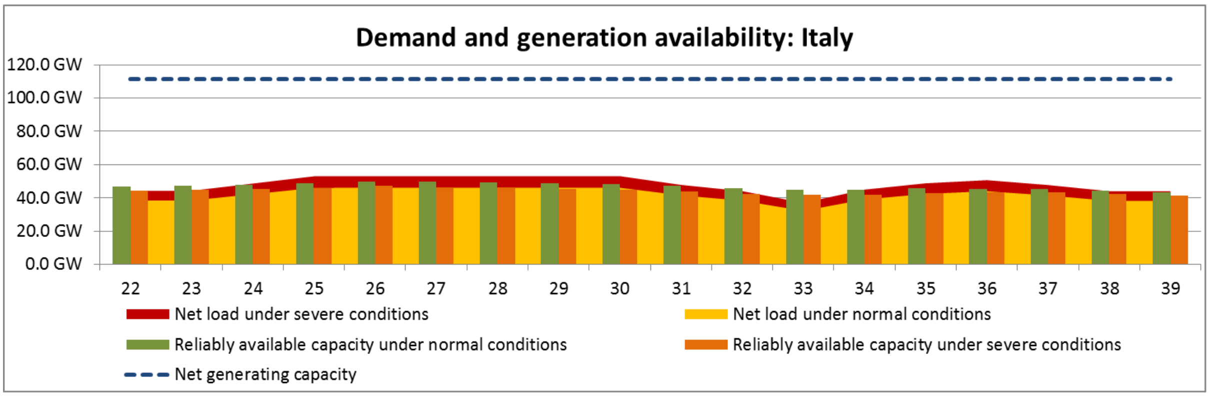
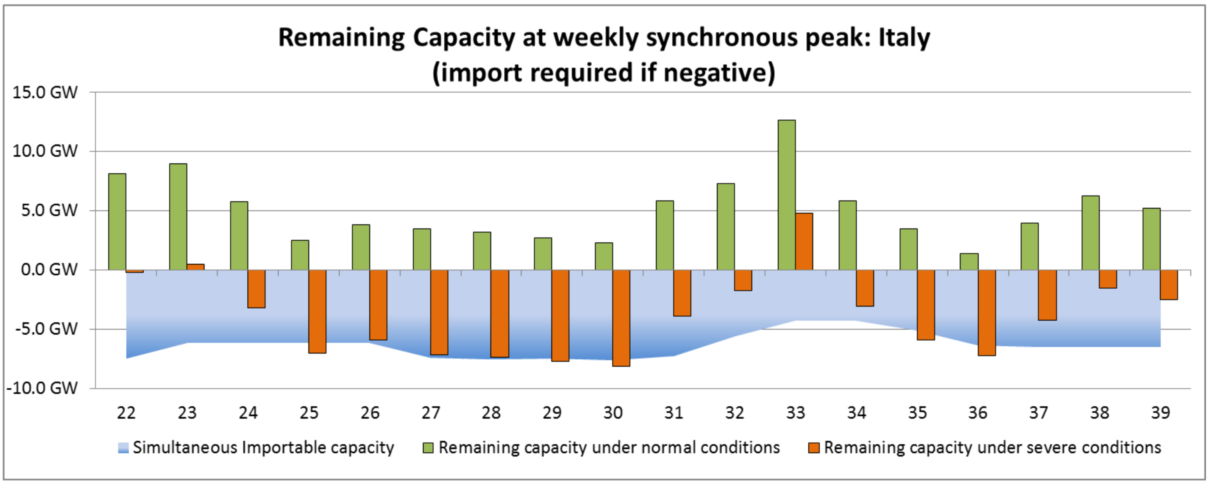


Figure 18: Decommission of the thermal plants 2012-2017 in Italy

For the upcoming summer, before mentioned alarming situation is amplified by the hydro situation. The updated values of the SWE (Snow Water Equivalent) indicator show that the trend is aligned with the critical year 2007. Thus, if the meteorological framework does not alter before the summer season, it could have a negative effect on the production of the hydroelectric plants, but also harm the thermoelectric availability due to potential lack of cooling water. Therefore, in both normal and severe conditions, it has been decided to consider the reduced water availability with consequential reduction of both the hydro production and thermal availability.





In normal conditions, it is expected that the margins are comfortable across the whole summer period, with high PV infeed during daytime and available conventional generation capacity that is expected to be able to cope well with the evening peak load.

The severe conditions take into account a high temperatures scenario, which causes on the one hand the thermal plants lower production ability as the result of higher outage rate than in normal condition, and on the other hand, more importantly, the increase of the demand. In Italy, the trend of the demand is strongly dependent on the temperature (especially in the “cooling" part of the curve, with. increasing of 1.5 GW per additional °C). Once the temperatures exceed 27/28°C, this dependence additionally increases to 2.0 GW/°C or more. The following Figure shows the load-temperature dependency in Italy.

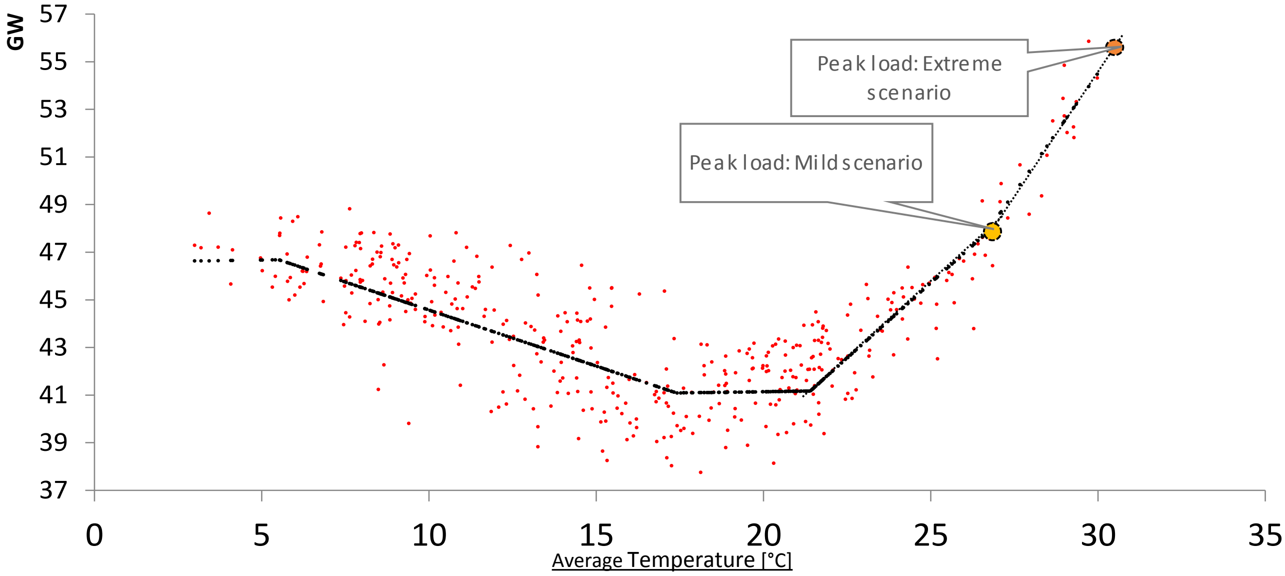


Figure 19: Load-temperature dependency in Italy

Under these conditions, remaining capacity expected during the summer could become negative during entire period excluding the mid-August week. Therefore, the import from neighbouring countries will be necessary and sometimes insufficient to cover the peak load.

It is important to point out that the described situation could be more critical if the values from another hour were reported: ENTSO-E's methodology foresees to present the data referring to a predefined synchronous European peak hour (19:00 CEST) identified as the most critical for Europe as a whole. However, in Italy, the maximal load, in the last years, is reached between the hour 16:00 and 17:00 CEST or, in certain days, during the morning, around 11:00 CEST (see Figure 20 here below). On the other side, in the case of significant solar production, maximal residual load, i.e. the most critical moment for the system, can occur also during the evening peak. Consequently, the situation of the minimal margin is verified between the hour 16:00 and 22:00 CEST depending on the renewable production. In case of the low renewable production, the most critical hour for the system is 16:00 or 17:00 CEST. Therefore, during the day, the critical values could be higher than those highlighted in this document.

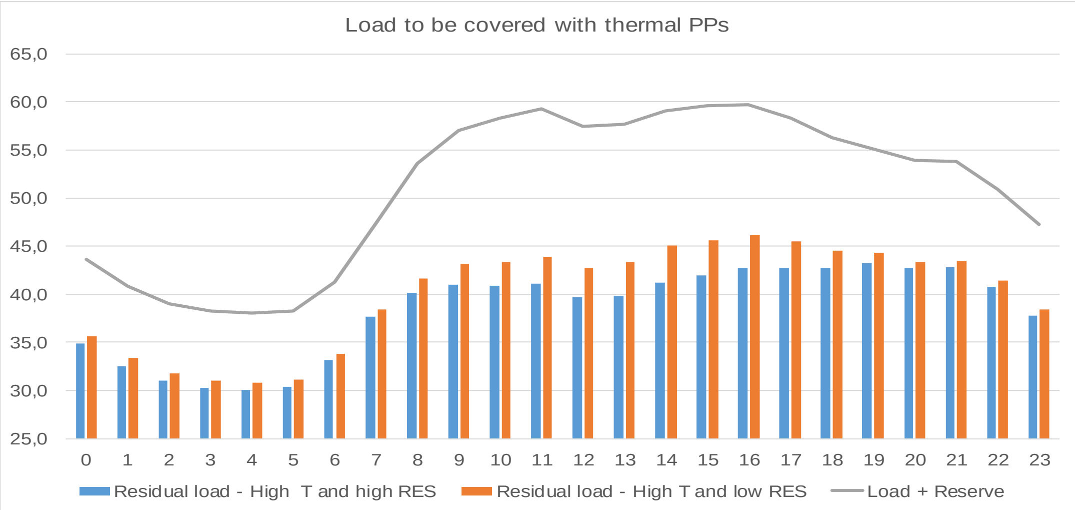


Figure 20: Load curve in Italy and residual load (load to be covered with thermal power plants) profile

Most critical periods for maintaining adequacy margins and countermeasures

The worst period for maintaining adequacy in severe conditions is from week 25 to week 30 (although the severe negative margin is expected from June until September, excluding the mid-week of August). During this period, Italy might be strongly dependent on the import from the neighbouring countries. Due to the high amount of expected import, the capacity of the interconnectors might not be sufficient, especially in the most critical hours of the day, sometimes differing from the European synchronous peak hour.

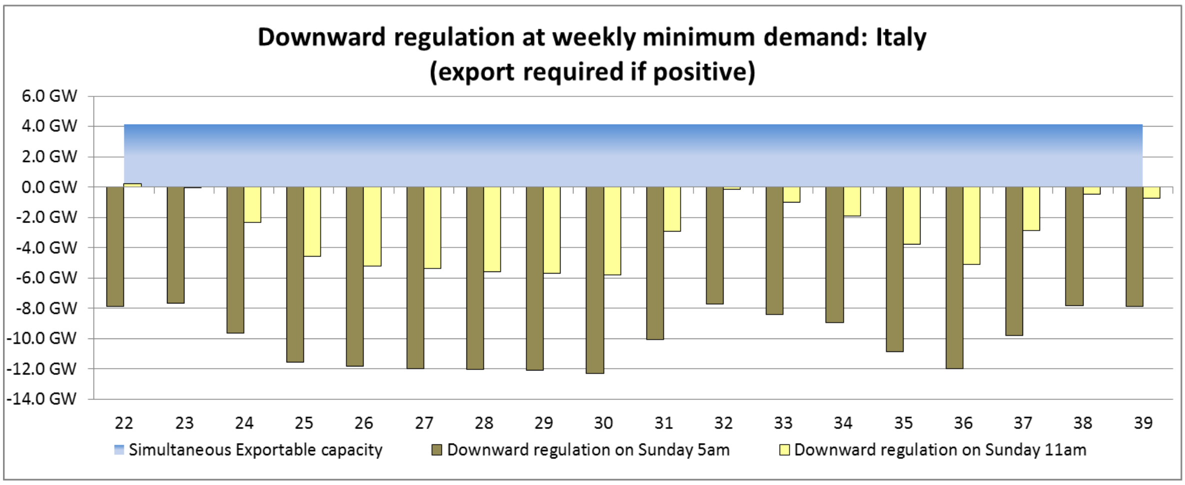
Italian TSO Terna could use the following countermeasures:

- maximising the capacity available during the critical periods;
- integrating demand side response in the Ancillary Service Market;
- maximising the import from the neighbouring countries.

Downward regulation margins

During the low load night hours, it is expected that the downward margins are comfortable across the whole summer period.

On the other side, in case of low load during week end daily hours, high import levels are not sustainable over the whole period and even negative downward margins may occur in weeks 22, 23 and 32. High renewables production (wind and solar) together with the level of the other inflexible generation, lead to a possible lack of downward regulating capacity even considering transmission capacity for exports. This phenomenon is particularly enhanced in the southern part of the country due to the large output of renewable and limited transfer capacity towards northern part.



Most critical periods for downward regulation and countermeasures

The worst periods for maintaining adequacy are in weeks 22, 23 and 32 in case of low load daily hours (Sunday daily hour), when the high renewables production (wind and solar) together with the level of the other inflexible generation, lead to a lack downward regulation margins, even considering export capacity.

In order to guarantee the system security, Terna could adopt special remedial actions, such as the enhanced coordination with DSOs (Distribution System Operators), curtailment of non-flexible generation and some NTC reductions, to be planned in cooperation with neighbouring TSOs. In some situations, the need of reduction of the energy import could arise or, in extreme case, the reduction of the export to the neighbouring countries.

Italy: Winter Review 2016/2017

General comments on past winter conditions

Seasonal assessment (see ENTSO-E Winter Outlook Report 2016/2017) showed that under severe conditions remaining capacity in Winter 2016/2017 was expected to become really tight and even negative in some weeks.

In this situation, taking also into account the situation in Europe, the secure operation of the system was expected to be at huge risk and, consequently, several preventive measures have been implemented in the last months of 2016:

- Enhanced inter-TSO coordination in forecast studies and daily operation among TSOs (facilitated and supported by Coreso):

    - Improvement of Short & Medium Term Adequacy service (part of the 5 coordination services assigned to RSCs in System Operation Guidelines);
    - Extraordinary operational information exchanges among TSOs of the North Italian Borders
    - Available transfer capacity recalculated in D-2 on the Italy North borders
    - Rescheduling of maintenance work in order to reduce the impact on cross border exchange.
    - Activation of Mutual Emergency Assistance Service (MEAS) exchange on France-Italy border Actions taken
- Return to operation of some mothballed power plants;
- Procurement of additional instantly interruptible load resources in order to face more severe security conditions;
- Call for 1000 MW of demand side resources to be activated with 15 minutes advance notice;
- Request to come back to operation to certain generation power plants that had filed for decommissioning.

In line with such expectations, temperatures during the winter 2016/2017 were lower, than the averages, especially in January 2017 (approx. 2.5°C below the reference temperatures). As a consequence, high consumption values were recorded both at national level (+4.8% in January 2017 vs January 2016) and in the northern area of Italy (+3.5% in January 2017 vs January 2016).

Specific events and unexpected situations that occurred during the past winter

Expected operating conditions for the Italian system in mid. January were tight. Forecasts available for the days from 16 to 20 January revealed temperatures below historical averages, expected consumption close to winter historical peak value, negative margins for the northern area (i.e. bidding zones Italy NORD - Italy CNOR) in case of no import from neighbouring TSOs and electricity flows from southern Italy to North close to security limits.

On 16 January, a severe snowfall affected the central part of Italy creating an evolving situation of risk for the transmission network of that area.

On 17 January one 380 kV line in central Italy connecting the South to the North went out of service due to a permanent fault.

On 18 January the huge snowfall caused the unplanned permanent outages of other two important 380 kV transmission lines in central Italy.

As a result, the transmission capacity between South and North decreased of about 40% with problems in fulfilling operational security limits (i.e. power flows from South to North up to the security limits).

On 18 January Terna moved its System State on European Awareness System (EAS) to alert state until 20 January and took the operational actions needed to maintain the Italian system within its operational security limits.

In this situation, additional preventive measures have been taken:

- Informed neighbouring TSOs that, in order to avoid violations of operational security limits, the allocation of constraints, in export direction from Italy, was likely.
- Procedure for the procurement of reserve from abroad (Terna has not resorted to the activation of this measure)

The cross-border capacity reductions were communicated by Terna to the involved TSOs and Joint Auction Office (JAO) according to the agreed regular operational procedures in force between Terna and the relevant parties: they have been applied for the following periods:

- 18 January: maximum 500 MW at the Northern Italian Border from 17:00 to 21:00 CET;
- 19 January: maximum 0 MW at the Northern Italian Border from 17:00 to 21:00 CET.

Latvia: Summer Outlook 2017

The installed capacity in power plants in area of Latvia during whole summer period is around 2.97 GW. During the summer only one of two Riga CHP2[25] units is in operation. In the first part of summer second unit of Riga CHP2 is in maintenance (around 419 MW) and in the second part of Summer the first unit of Riga CHP2 is in maintenance (413 MW). The production capacity is limited on Daugava HPPs as well. The production capacity is reduced from around 240 MW till 480 MW but it doesn't make so significant influence because water inflow is main limiting factor for hydro generation. Some units of Plavinas, Kegums and Riga HPPs are in maintenance during whole observed period.

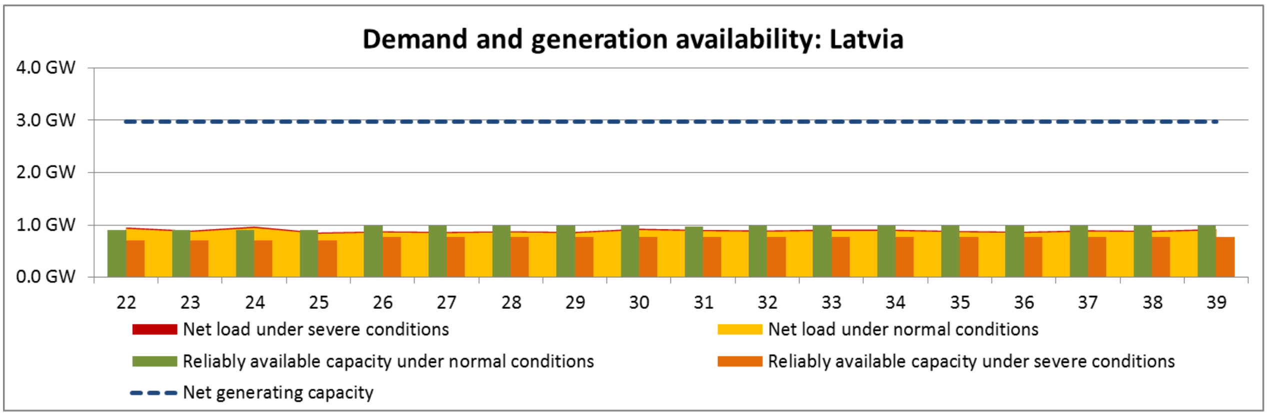
In the normal conditions it is assumed that there is no production reduction on gas power plants. The gas supply is unlimited. The reduction of capacity relates to Biomass and Biogas power plants (around 20 MW) and HPPs on Daugava River which are dependent on water inflow in the river. It's assumed that in normal conditions the available capacity in HPPs on Daugava River is around 300 MW. In the severe conditions the generation from gas power plants is reduced by 100 MW. It is assumed that all small gas power plants which are distributed in the area of Latvia have restrictions (economical or gas supply) in electricity production. The production in Biomass and Biogas power plants is reduced by 30 MW. The production of hydro power on Daugava River is assumed 200 MW to cover a peak load.

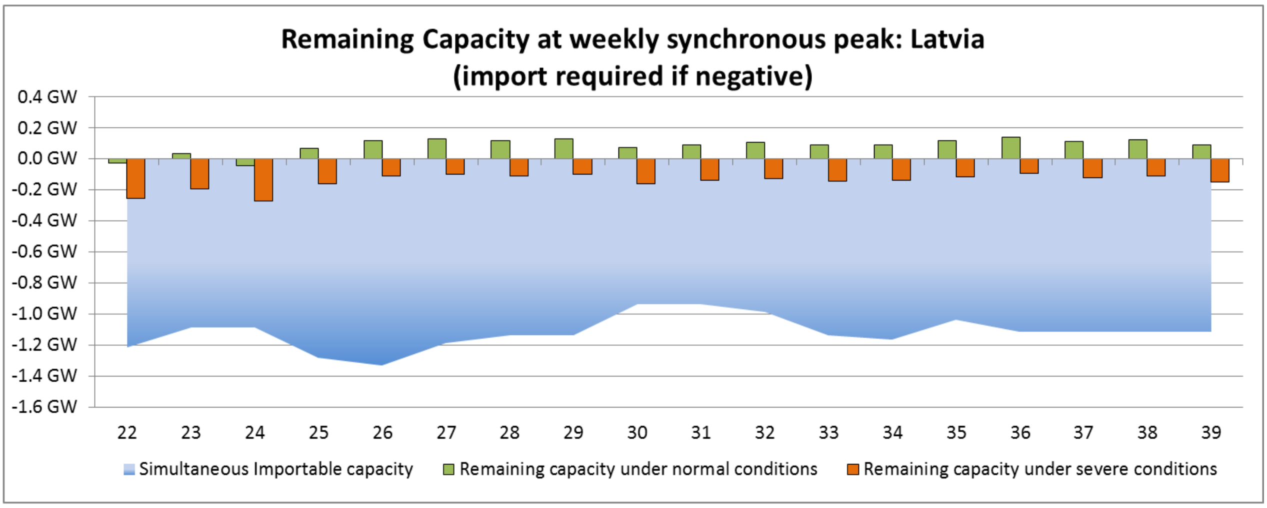
The system service reserve is 100 MW during whole year according to the BRELL[26] agreement.

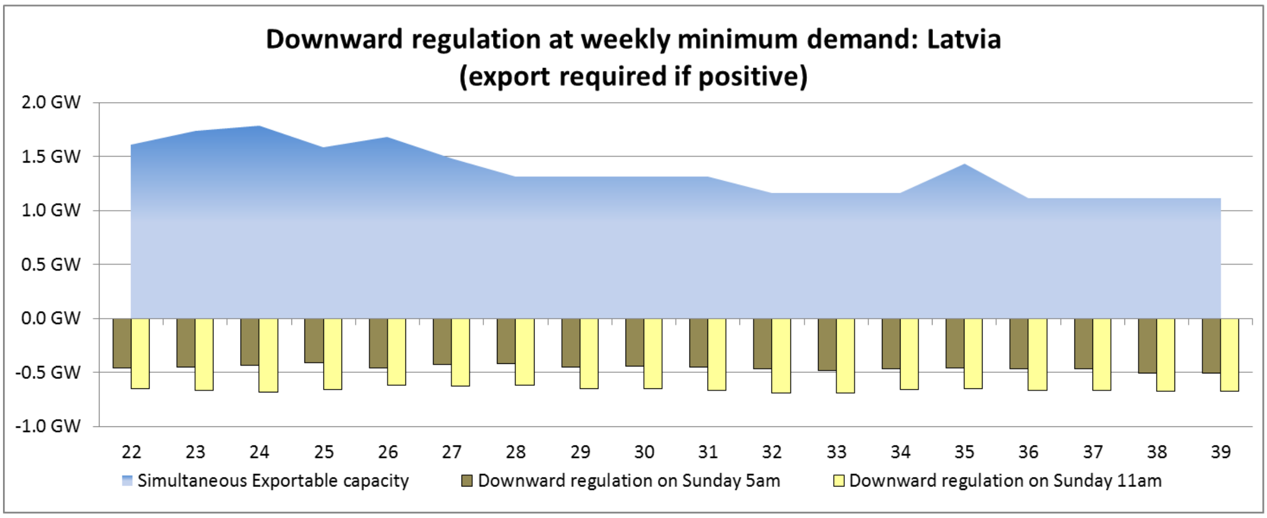
The peak load in the normal conditions is assumed by 1% higher as in the previous year, but in the severe conditions it is assumed by 3.6% higher as in the previous year. The expected average peak load increase in 2017 is around 1.8%. The minimum load during the night minimum is assumed as post-factum values from previous year.

[25] CHP: Combined Heat Power

[26] BRELL agreement between Belarus, Russia, Estonia, Lithuania and Latvia on operating and use of the networks in the Baltic States.







Most critical periods for maintaining adequacy margins and countermeasures

The most critical weeks for Latvian power system in normal conditions are weeks 22 and 24 when reliable available capacity is below expected load. During the rest of summer the reliable available capacity can cover the load. In the severe conditions the reliable available capacity can't cover the expected load during the whole observed period. Latvian TSO expects to import the missing capacity from neighbouring countries via cross-border interconnectors.

Most critical periods for downward regulation and countermeasures

Not expected.

Latvia: Winter Review 2016/2017

General comments on past winter conditions

The average air temperature in Latvia was higher as normal air temperature during December and January. The air temperature was also higher as in previous winter.

The actual load during the whole winter period was very close to a planned load and the significant deviations are not observed.

The water inflow in Daugava River in December and January was higher as expected and production of hydro almost whole assessed period was higher than 500 MW. Starting from February the generation in hydro power plants was decreased below a forecast but it doesn't make serious problems for Latvian power system.

Regarding to the import cross-border capacities between Latvia and Lithuania the actual figures were lower than the forecast. The import cross-border capacities between Estonia and Latvia were higher than the forecast. During whole winter period Latvian TSO could rely on electricity import from neighbouring countries. About the export cross-border capacities between Latvia and Estonia almost whole winter period post-factum values were lower as planned and similar situation has been observed on cross-border Latvia – Lithuania. These deviations of plan doesn't cause any trouble for security of supply in area of Latvia and the updated capacities were used for power exchange within Baltic States.

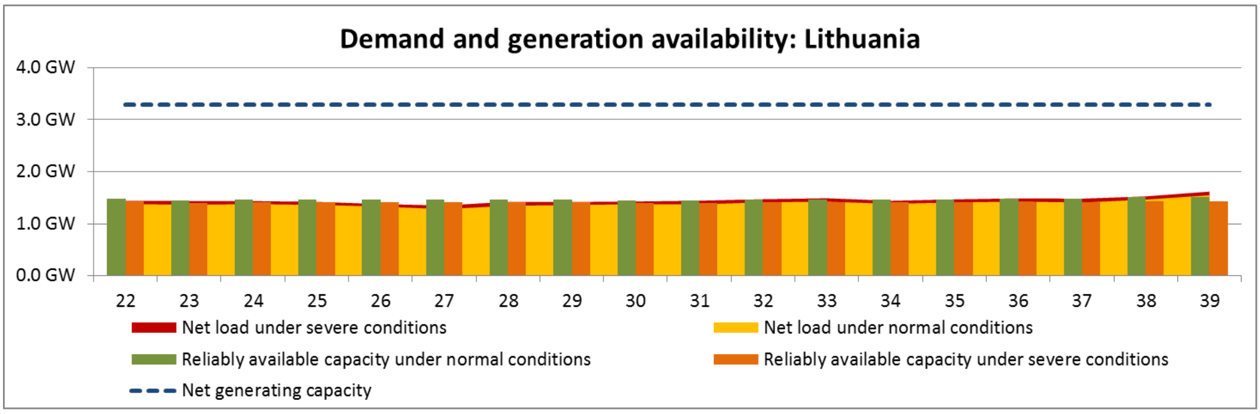
Lithuania: Summer Outlook 2017

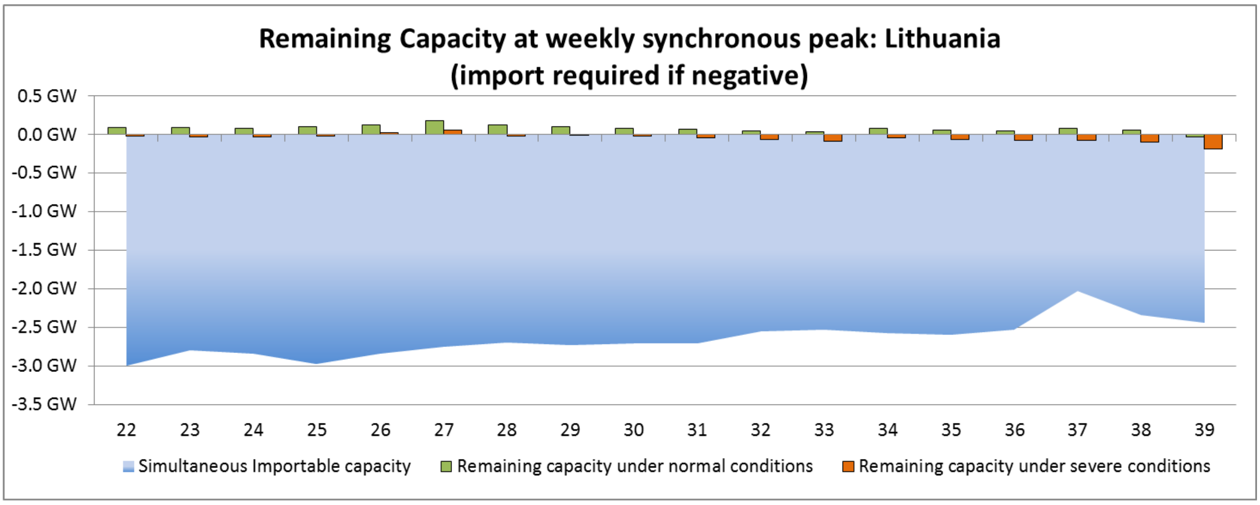
The load estimation for normal conditions is based on statistical data of previous three years. The load was increasing during these years, therefore it is forecasted that the load will be 4.5% higher than in 2016, that matches the percentage increment between the early (January – February) 2017 and the same period of 2016. Total peak load under normal conditions is forecasted to be around 1630 MWh (in the end of September). For the coming summer season, the maintenance schedule is not intensive and has low impact to adequacy level.

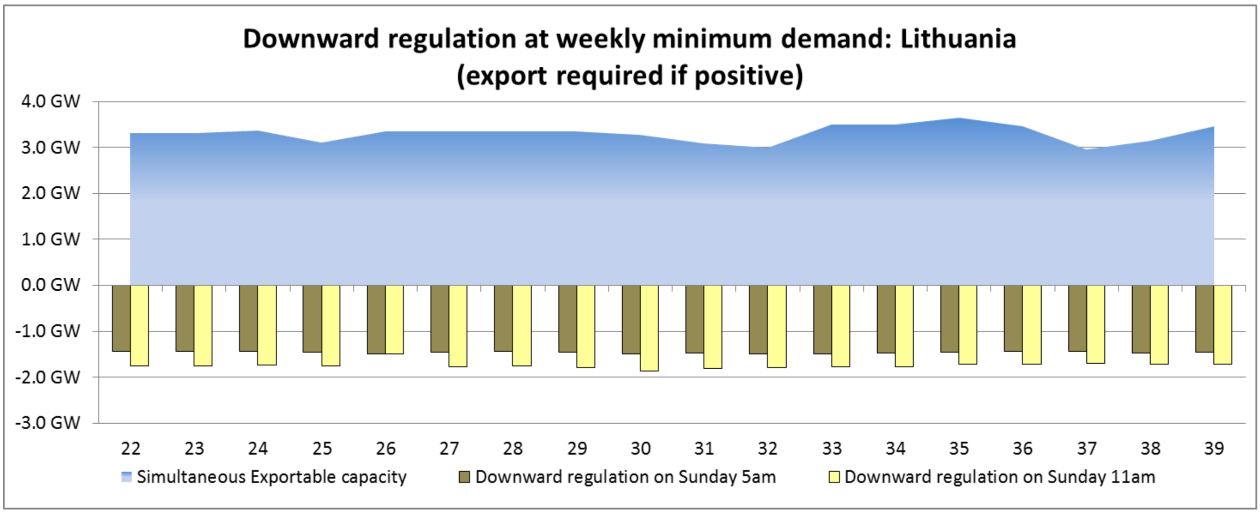
Total volume of frequency restoration reserves and replacement reserves will be similar as in previous summer and will be equal to 884 MW that is 27% of NGC. Average adequacy level of Lithuanian power system during upcoming summer season at reference time point is expected to be positive, however due to the large capacity of system services and higher expected consumption level the deficit adequacy level is expected in Lithuanian power system in week 39. On the other hand, deficit adequacy level is expected at weekly local peak load during all summer season. Nevertheless, total import capacity will be sufficient to maintain system adequacy.

Lowest simultaneous importable capacity is forecasted to be in week 37 due to planned maintenance of HVDC interconnection with Poland.

All import volume from third countries (Russia, Belarus) based on power flow calculations and allocated at Lithuania-Belarus interconnection highly depends on Estonia-Latvia interconnection capacity, which is reduced during summer period because of higher ambient temperature and planned maintenance activities on the interconnection lines. That causes significant import restrictions from third countries to Lithuanian PS for the whole summer period. Import ability of Lithuania power system also depends on available generation in Kaliningrad region. Import restrictions are foreseen for week 39 due to planned maintenance activities of Kaliningrad Thermal Power Plant.







Most critical periods for maintaining adequacy margins and countermeasures

No adequacy risks were identified.

Most critical periods for downward regulation and countermeasures

No downward issue was identified.

Lithuania: Winter Review 2016/2017

General comments on past winter conditions

In the previous winter, national consumption was 3.4% higher than in winter before. Consumption mostly increased in December – by 6.7%. One of the reasons that caused this increment is that the temperature of December 2016 was lower than in December 2015 by 1.8°C. Maximum load (1893 MW) was reached in the beginning of January (11 January 2017), while the average temperature of that particular day was -8.1°C.

In general, winter balance portfolio consisted of 33% of local generation and 67% of imports from neighbouring countries. During the 2016/2017 winter, total generation was lower by 9.5% in comparison with 2015/2016. The largest part of imported electricity was from Russia (42%) and from Latvia (41.6%). DC interconnections with Poland (LitPol Link) and Sweden (NordBalt) covered 12.5% of import.

During winter period, import capacities from third countries to Lithuania power system had no significant deviations from yearly plans. Most of the limitations were caused by restrictive interconnection Estonia-Latvia. Another interconnection limiting capacity from third countries was Belarus-Lithuania, its capacity reduced due to the reconstruction of Belarussian grid and maintenance activities on interconnection lines.

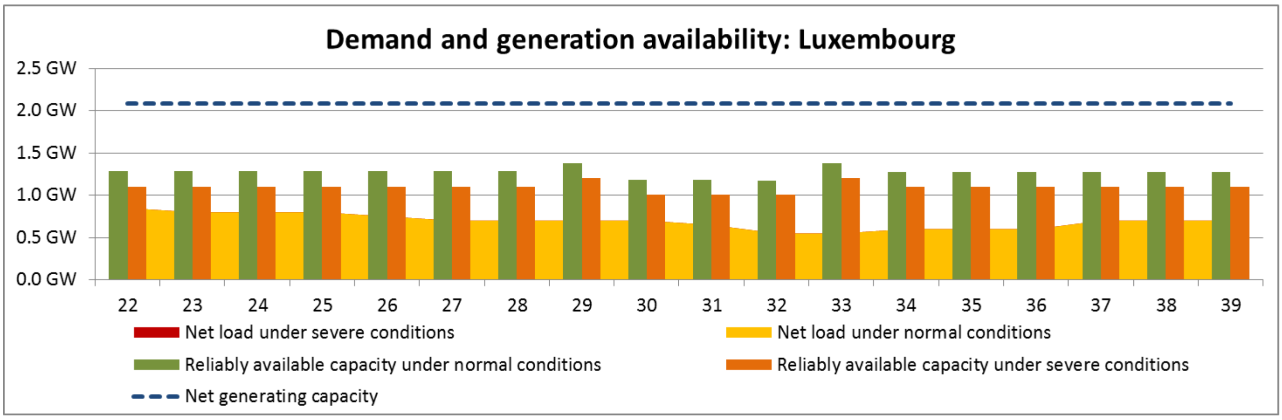
Furthermore, import and export capacity of Lithuania power system was reduced by unplanned outages of NordBalt HVDC interconnection during week 49 of 2016 and weeks 3-4 and 6-7 of 2017.

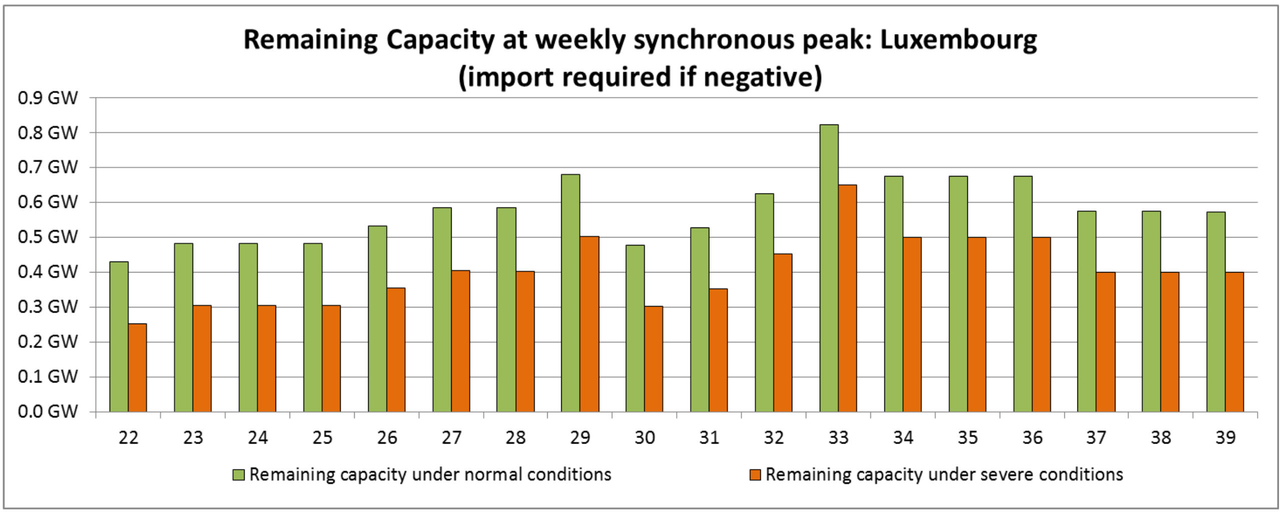
Specific events and unexpected situations that occurred during the past winter

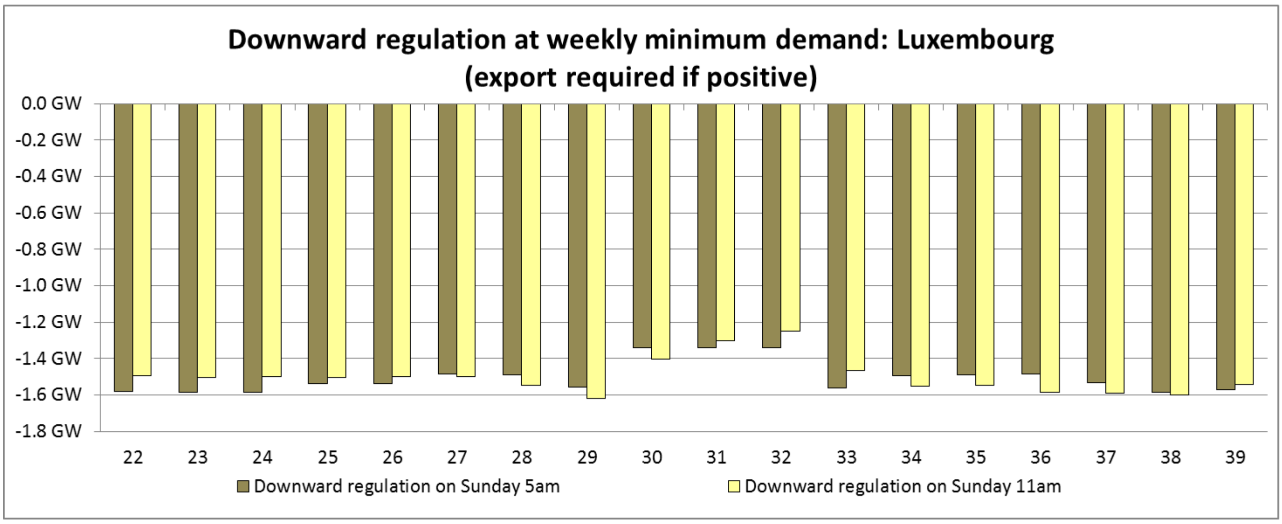
Due to the increased wind net generating capacity (by 16.9% from 432 MW in December 2015 to 517 MW in February 2017), wind generation from December 2016 until February 2017 was 16.5% (57.458 GWh) higher than the year before. However, special weather conditions resulted in ice formation on wind turbines, hereby leading to reduction of availability of wind net generating capacity. Highest wind net generating capacity unavailability 53.5% (228 MW) was observed at 7:00 CET on 17 January 2017. Balancing reserve capacity was sufficient to compensate actual imbalances.

Luxembourg: Summer Outlook 2017

Even in severe condition, no adequacy issue is expected in Luxembourg for coming summer.





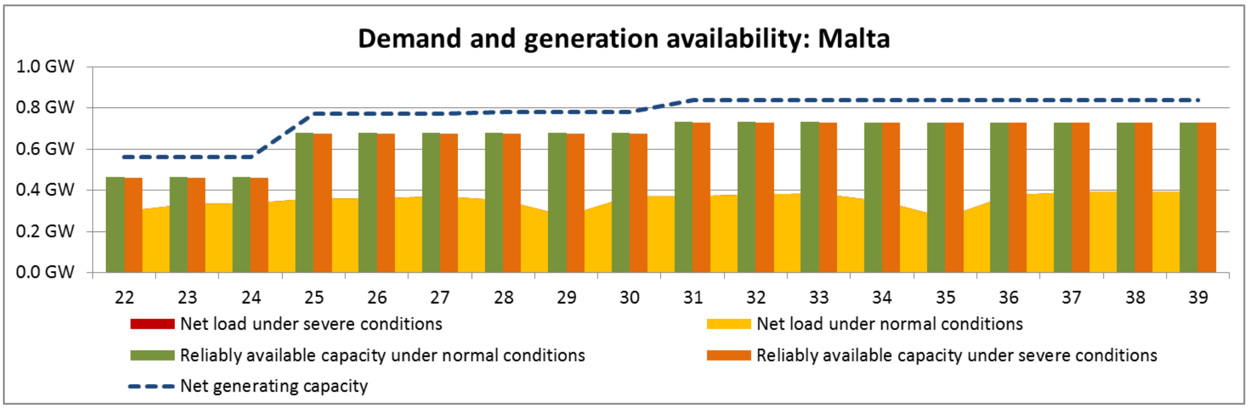


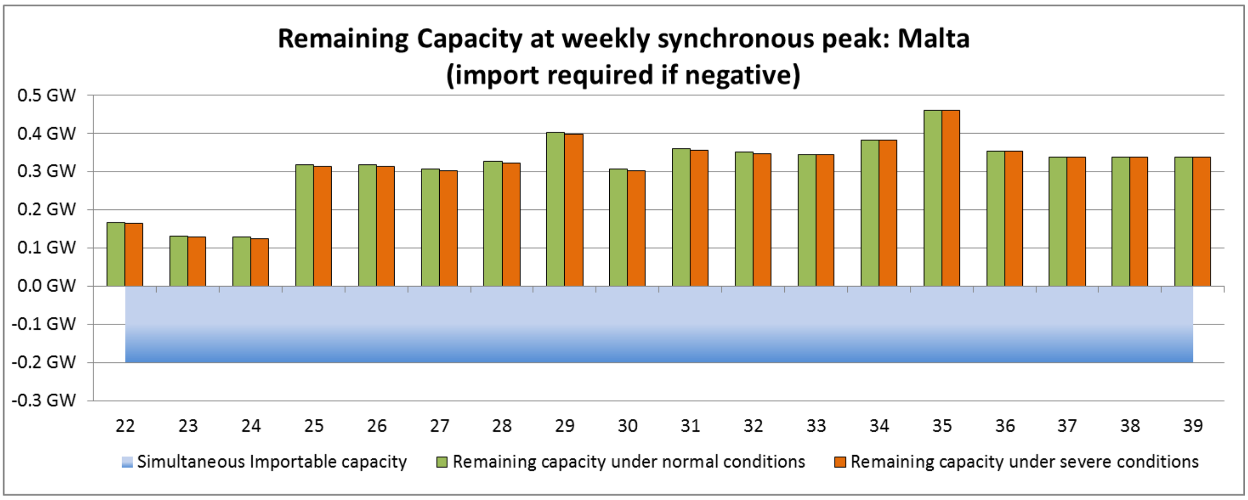
Luxembourg: Winter Review 2016/2017

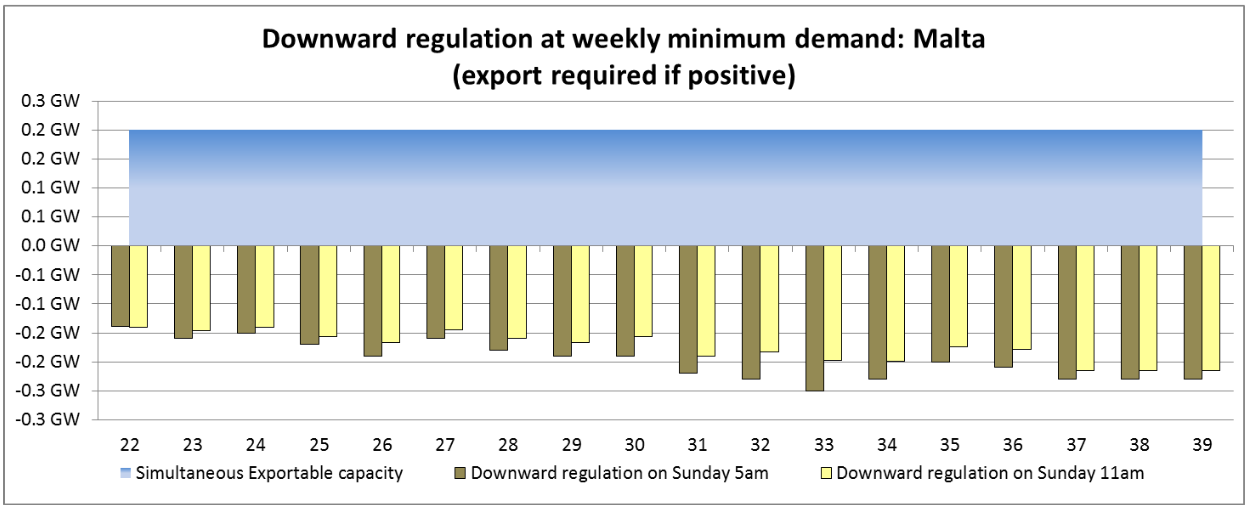
No adequacy issue was identified in Luxembourg during the past winter

Malta: Summer Outlook 2017

Even in severe conditions, no adequacy issue is expected in Malta for coming summer.







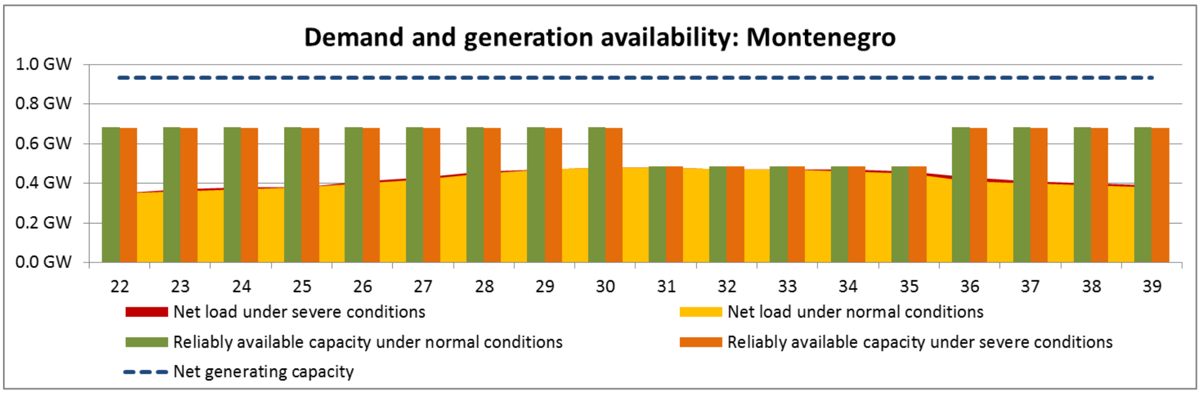
Malta: Winter Review 2016/2017

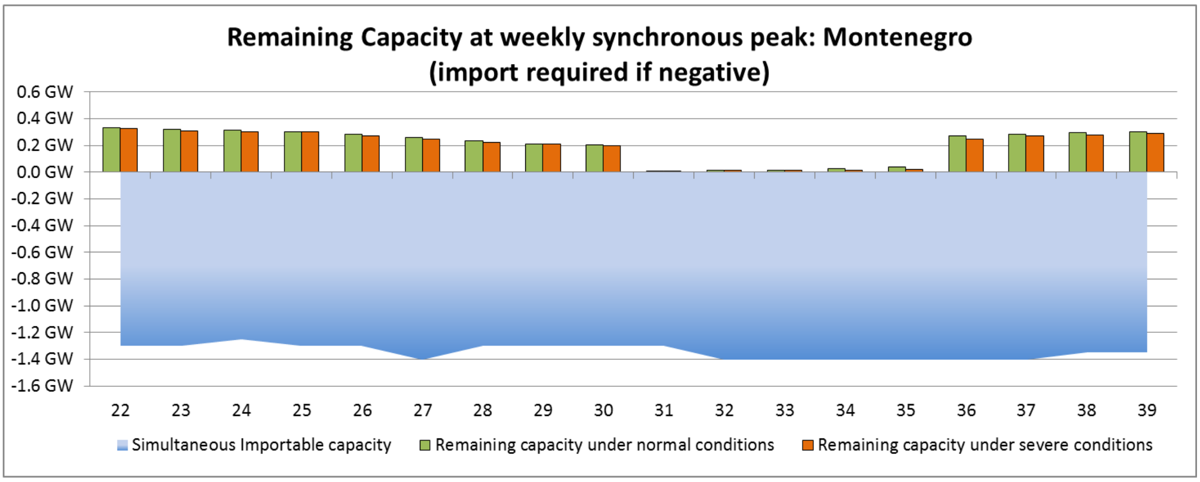
No adequacy issue was identified in Malta during the past winter.

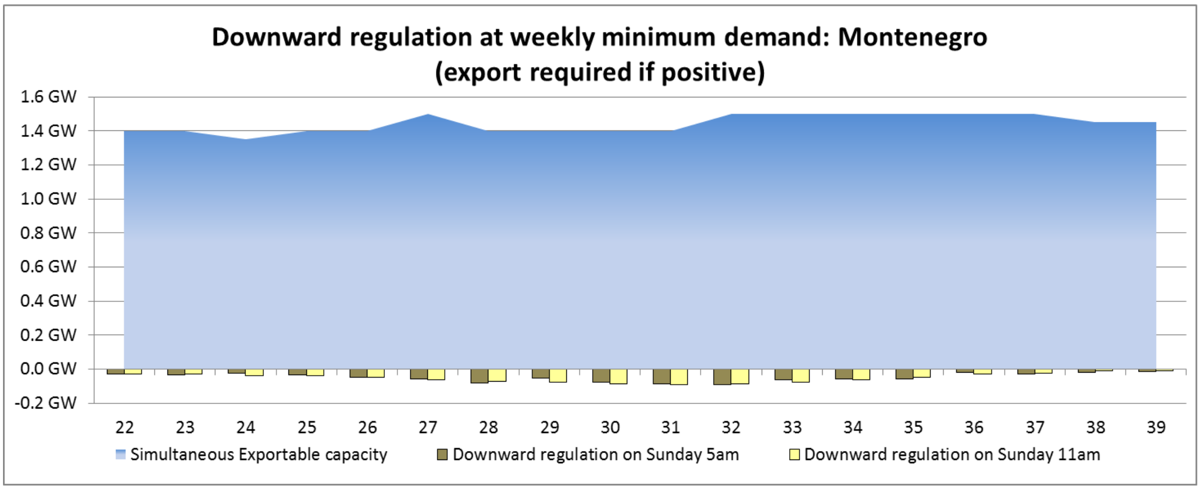
Montenegro: Summer Outlook 2017

Our best expectations are that generation – load balance problems, under normal conditions, are not being expected in the summer 2017. The main period of stress is in August 2017 when the load is max and the temperatures are high. The main factor can be high demand and bad hydrological conditions. Difference between consumption and production in the critical period will be covered with energy from import. Also, due to high influence of aluminium and steel industry on Montenegrin power demand, some mistakes in demand prediction can be expected.

Variations of the interconnection capacities are not expected during the summer.







Montenegro: Winter Review 2016/2017

General comments on past winter conditions

During the January temperatures in Montenegro were below average and production lower than expected. Low rainfall during the period from December to January, of the years of average of 447 l/m2, hardly has reached 40 litres. Power consumption at the distribution level, as a result of extremely low temperatures recorded in first 10 days of January, has reached record in Montenegro. At the beginning of February rain and melting snow have significantly enhance the power of the inflow of the river, which completed the level of hydropower reservoirs. Also, thanks to good operational readiness of thermal power plant Pljevlja (which during the first months of this year produced 126 GWh of electricity, or 96% availability), and to import of electricity, the situation was under control in Montenegro.

Specific events and unexpected situations that occurred during the past winter

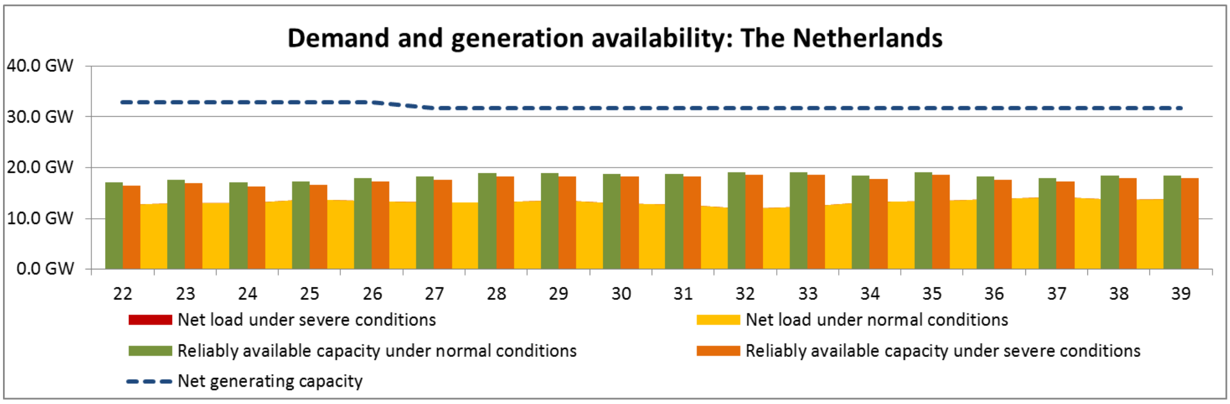
There were no critical outages/events in the Montenegrin transmission network.

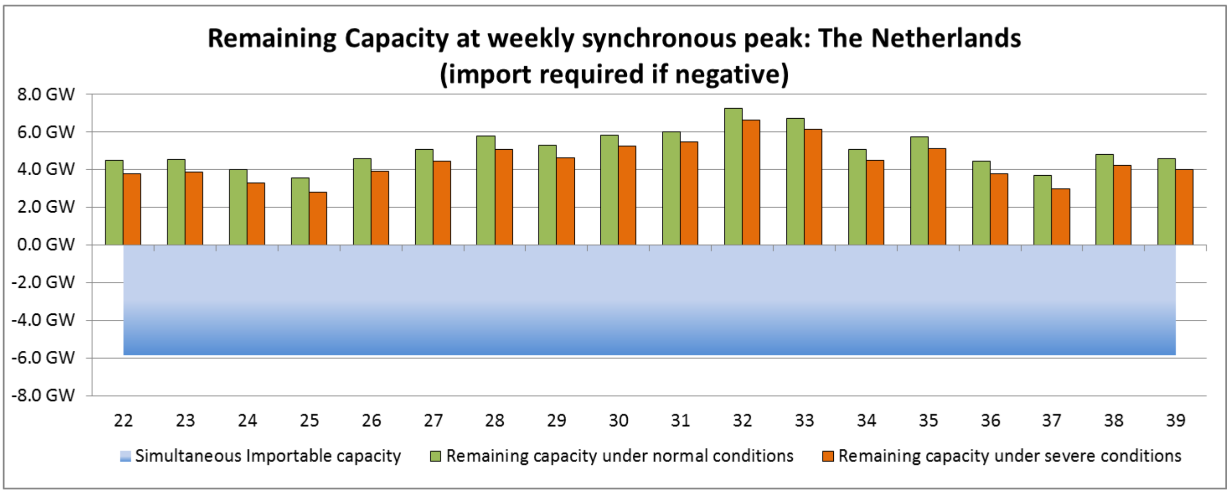
Netherlands: Summer Outlook 2017

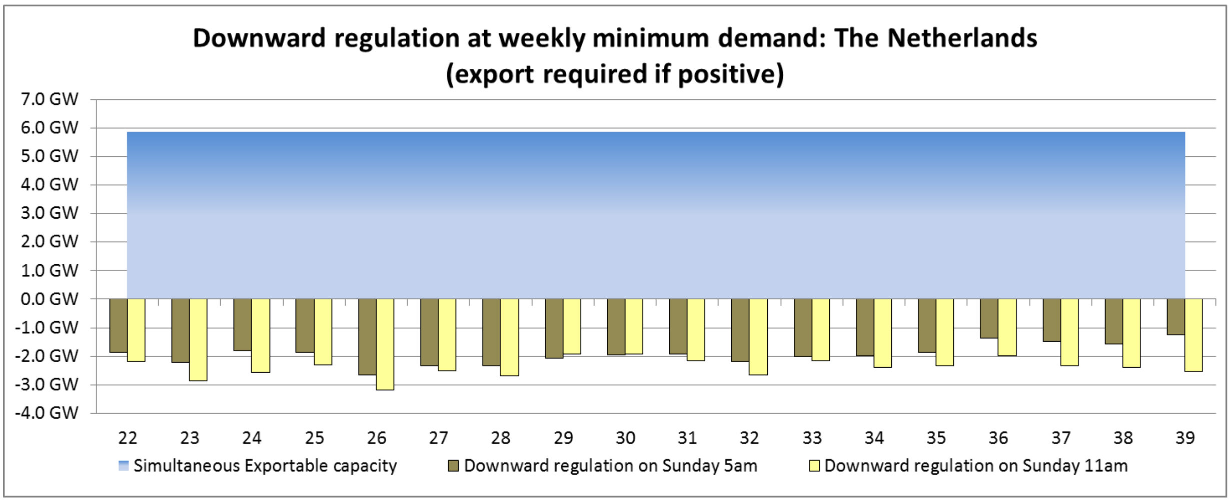
The Dutch TenneT TSO is not expecting any adequacy problems during the summer period. Due to the SER Agreement on Energy for Sustainable Growth (so called 'Energieakkoord', http://www.energieakkoordser.nl/doen/engels.aspx#) the older coal-fired units of Maasvlakte (1.1 GW) will be closed down in the summer. Furthermore it is to be expected that a gas-fired unit will de-mothballed at the same time (0.8 GW).

The forecasted NTC values represent the best estimates based on currently available information however in the Netherlands the system of flow based interconnection capacity is used. These values may therefore be updated at a later date, also with regard to volatile renewables, and be updated intraday.

Potential risks were considered within our Generation adequacy (so called 'Monitoring') report available at www.tennet.eu.







Most critical periods for maintaining adequacy margins and countermeasures

There are no critical periods foreseen in the upcoming 2017 summer period.

Most critical periods for downward regulation and countermeasures

No critical periods are to be expected. High wind and sunny periods will create more flows through our network from North to South.

Netherlands: Winter Review 2016/2017

General comments on past winter conditions

The winter period of 2016/2017 was a relatively mild winter with one short cold fortnight.

There have not been any difficulties within the Dutch grid during this period.

The expected winter period peak was around 18,000 MW, the actual peak was somewhat higher 18,243 MW and occurred on 20 December (between 17:00 – 18:00 CET).

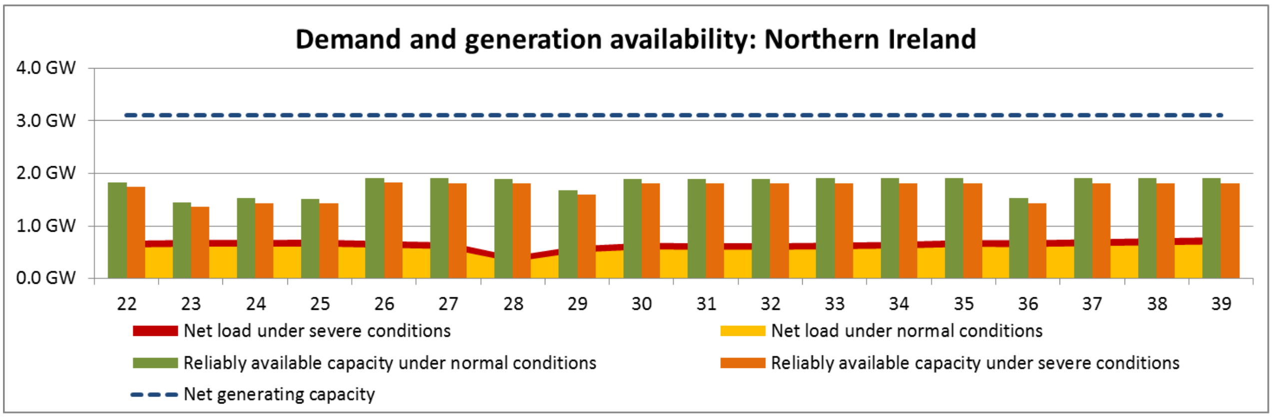
The maximum temperature on that day was 1.0°C and the lowest was -2.7°C. The lowest load during the winter period was reached on 2 October (9,508 MW)

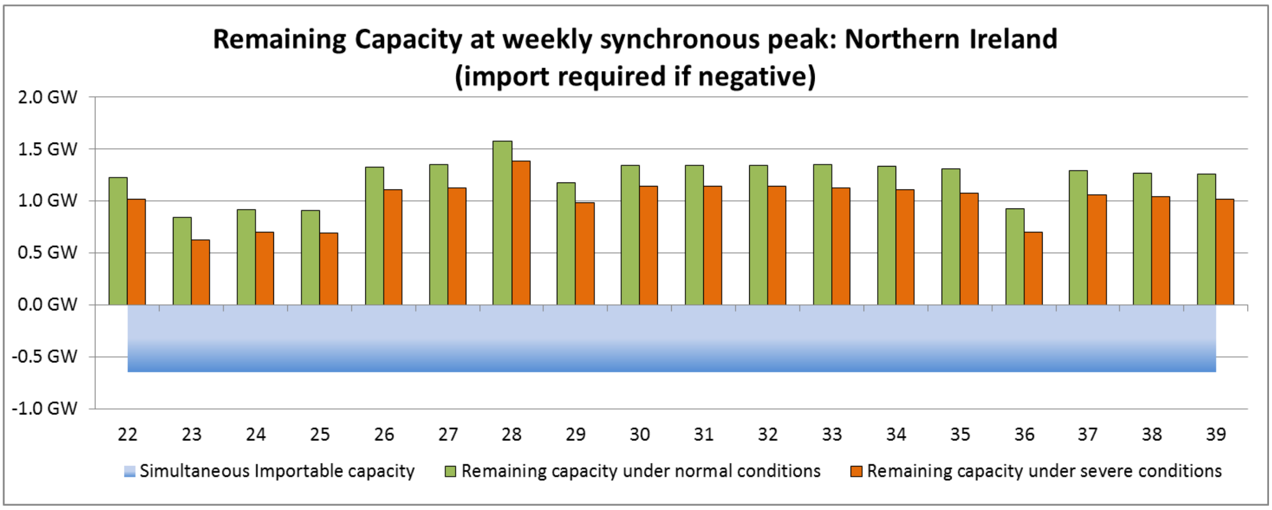
Specific events and unexpected situations that occurred during the past winter

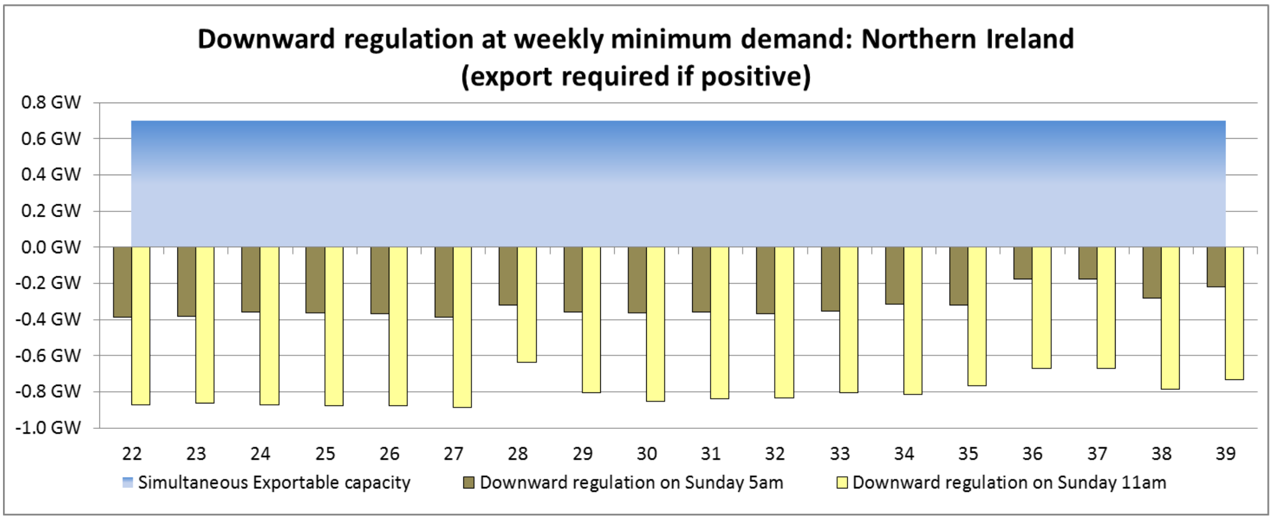
There have not been any critical outages or events during the winter.

Northern Ireland: Summer Outlook 2017

There are sufficient capacities in NI to meet all supply scenarios.







Most critical periods for maintaining adequacy margins and countermeasures

Planned outage managed to ensure minimal overlap throughout the year, no foreseen issues

Most critical periods for downward regulation and countermeasures

Not applicable

Northern Ireland: Winter Review 2016/2017

General comments on past winter conditions

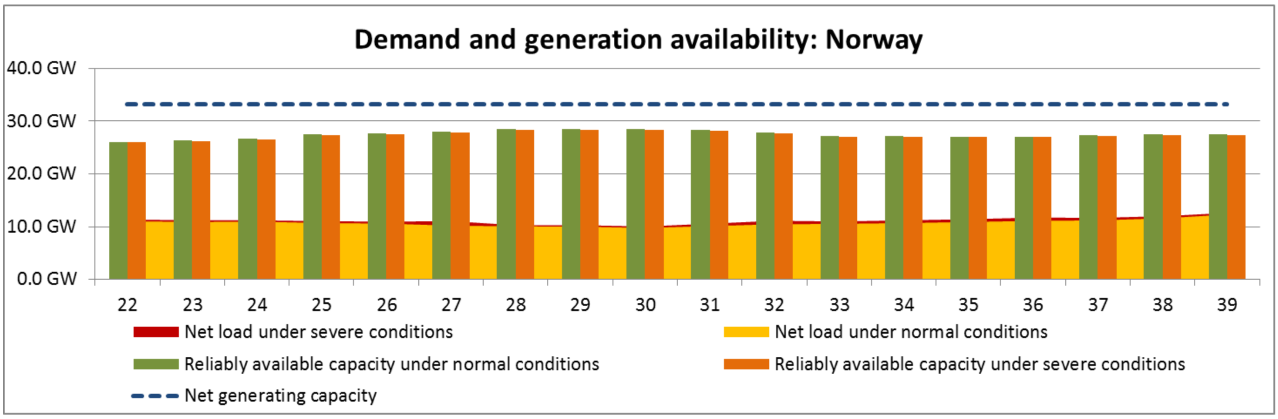
No issues over the winter period

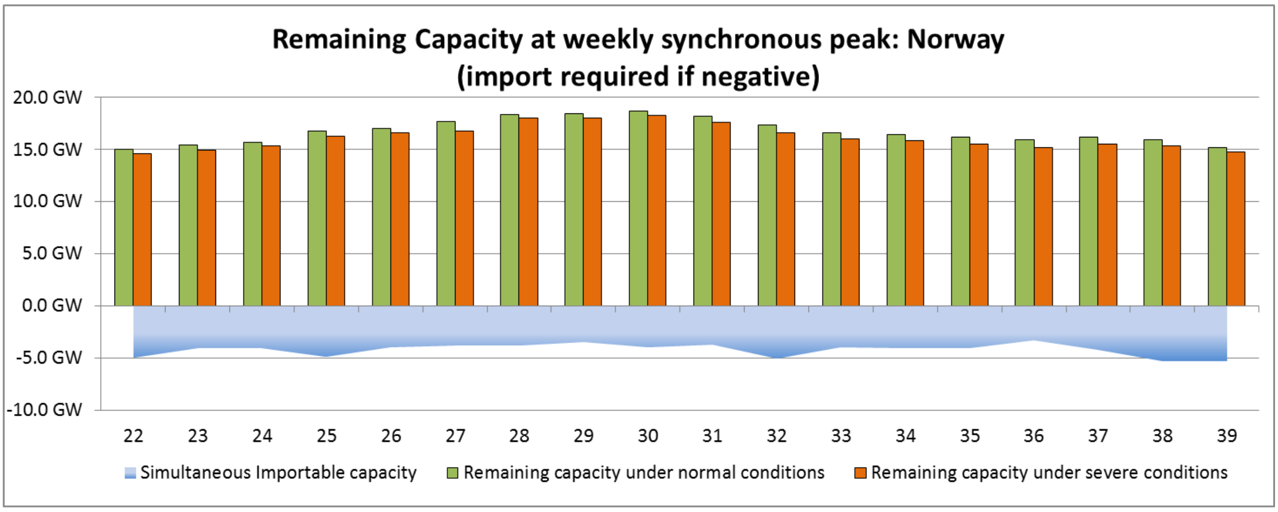
Specific events and unexpected situations that occurred during the past winter

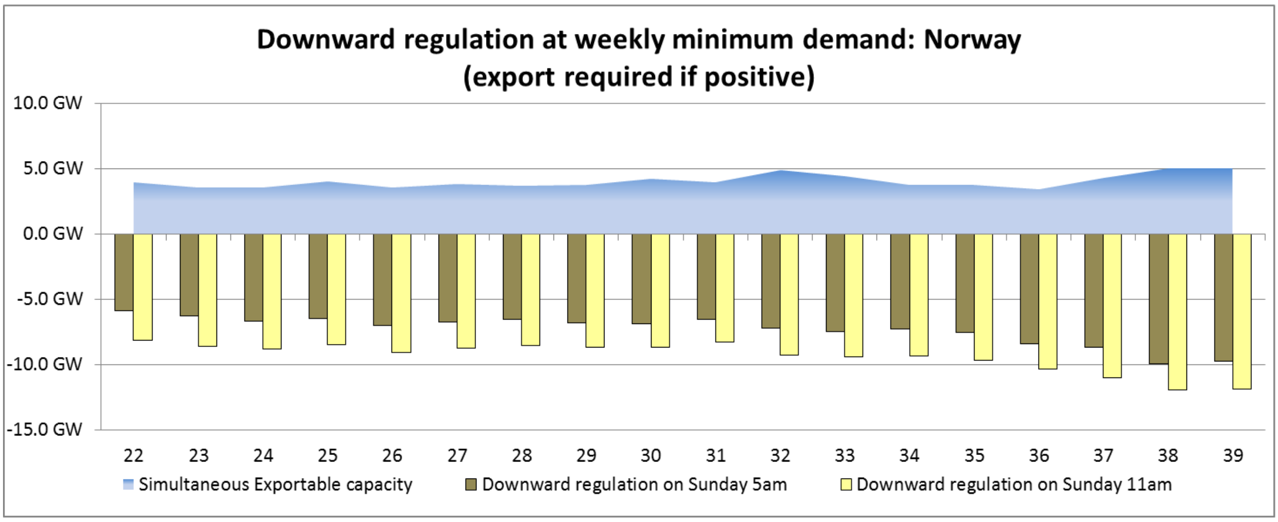
Cable fault on Moyle Interconnector which has reduced jurisdictional flows from NI to GB to 250 MW.

Norway: Summer Outlook 2017

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







The water and snow reservoirs are lower than normal by the end of February, but we expect that the hydrological balance will develop towards normal levels before the summer. Reservoir levels normally decrease during the winter to about 33% late in the spring. After that, the reservoirs will increase during the summer to about 87% early in autumn. Only if the reservoir falls significantly below the normal minimum level, we can expect a substantial decrease in production capacity (MW) from hydropower.

During the summer, there will be a considerable amount of maintenance and reinforcement work on transmission lines, influencing the exchange capacity to Denmark and Sweden. We do not expect that this work will influence adequacy or downward regulation in this period. These reinforcements will increase foreign exchange capacity and improve adequacy when finished.

Norway: Winter Review 2016/2017

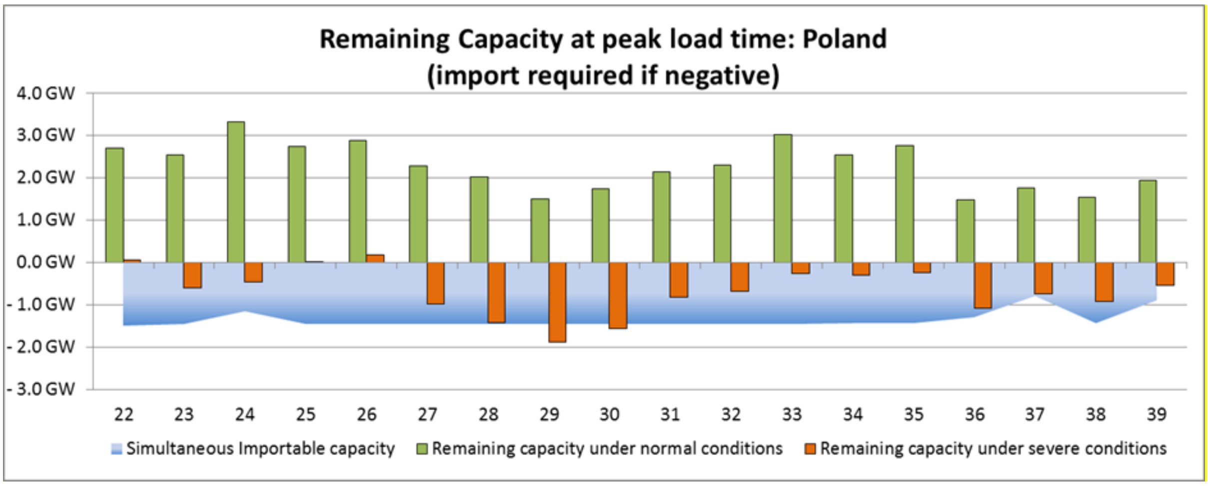
In contradiction to expected problems last fall, the hydrological balance this winter has been satisfactory in all areas in Norway. This has resulted in a surplus of production, net export and power prices lower than expected in much of the period.

After the autumn, we haven't had any long-lasting periods of frost, which increased the demand and prices for some weeks the previous winter. A high and stable nuclear production in Sweden has also contributed to this satisfactory situation from an adequacy point of view in Norway.

Poland: Summer Outlook 2017

Power Balance forecast / upward adequacy

As mentioned in chapter 3.1 of this report, the time of the European synchronous peak reference point was shifted to 19:00 CEST, as Midday European load is fed by high amounts of photovoltaic generation. As solar power in Poland is still negligible and Polish peak load during the main summer period is taking place between 13:00 and 14:00 CEST, the power balance 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 below descriptions about situation in Poland refer to sensitivity on country peak time.



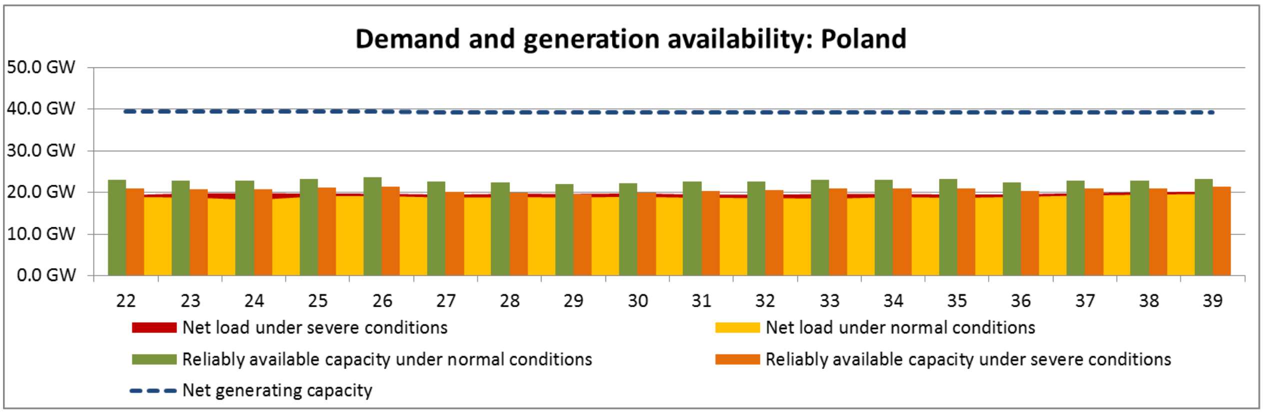
Summer Outlook 2017 power balance results are in general similar compared with previous Summer Outlook ones. In normal conditions at all reference points, PSE forecasts surplus power and does not expect any problems for balancing the system this forthcoming summer. Under severe conditions, PSE observes a negative balance for almost all analysed reference points. In two reference points, importable capacity forecasted in a yearly horizon may not be enough to balance the system, because import capacity on the synchronous profile is significantly limited by unscheduled flows through the Polish power system (the issue is at length described in previous Outlooks report). Extremely severe balancing conditions in the summer period may take place in case of long lasting heat spells leading to significant deterioration of Polish power system. This causes an increase of load 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 for cooling some thermal power plants).

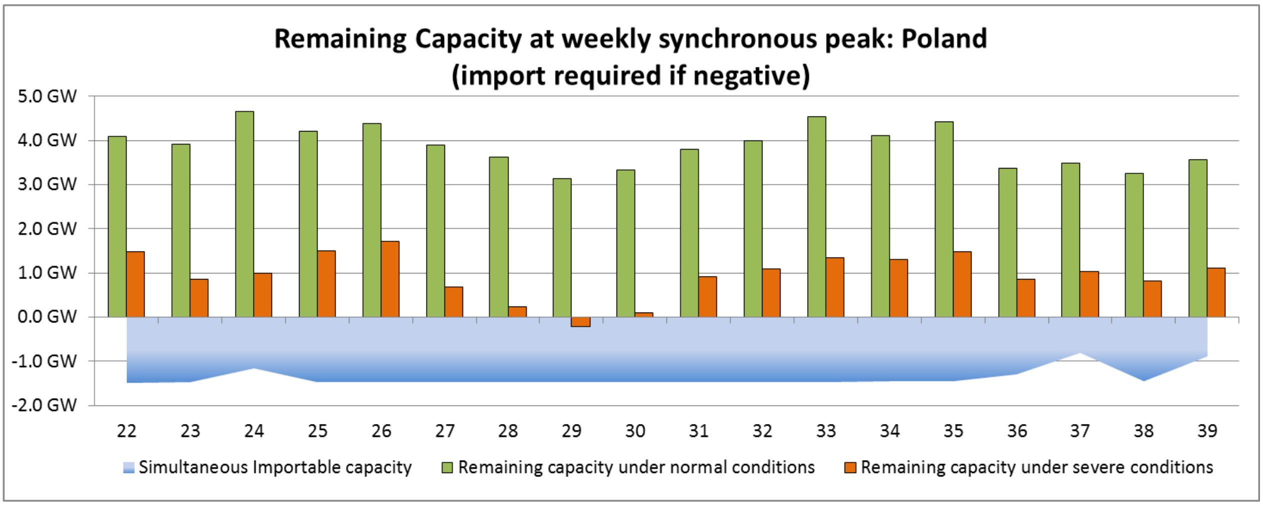
The risk of high unscheduled flows through the Polish system (from the west to the south) during such weather conditions is high as a result of development of solar generation in

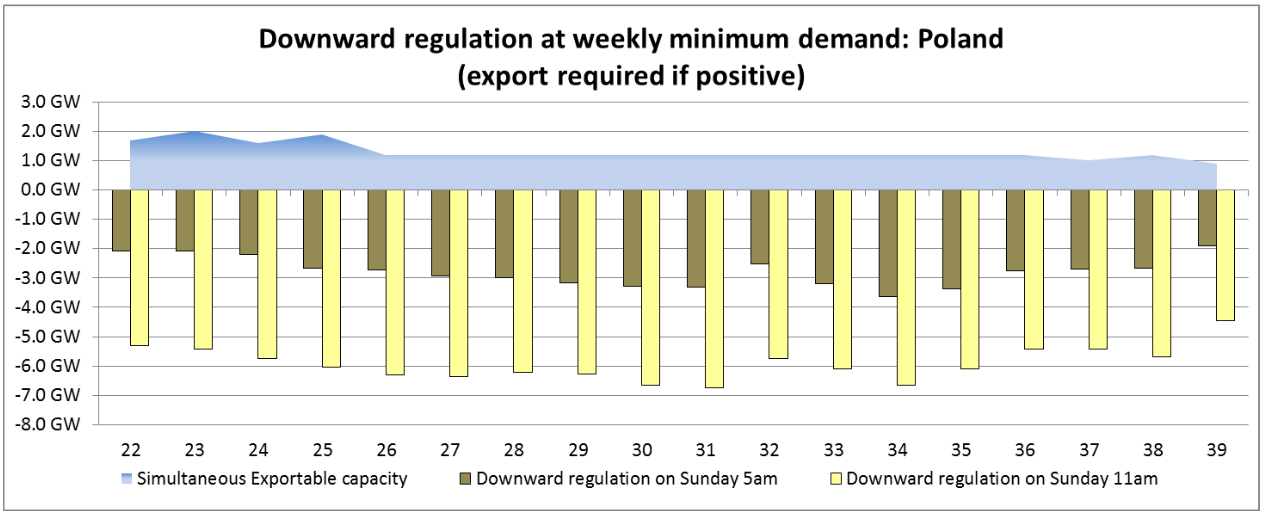
Germany and high volume of market transactions. In such a situation, if necessary from power balance point of view (to recover minimum generating capacity reserve margin required), additional import on synchronous profile towards the Polish system can be realized under the condition of simultaneous multilateral 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 sure because it depends on the availability of up regulation power in the TSC area and the possibility to decrease generation in 50Hertz. Such situation happened on 15 September 2015 and was described precisely in Summer Review 2015 part of 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 Summer Outlook 2016 report.

At the moment PSE has contracted 151 MW of DSR, which may be activated in case of inadequacy. In the forthcoming summer the Polish TSO assesses to increase DSR level till 500 MW, which should give a possibility to balance the system, in particular for weeks 29 and 30, when negative Remaining Capacity exceeds forecasted level of import capacity.

It is worth saying, that all mentioned remedial actions/counter measures should be treated as operational, extraordinary ones, not a routine TSO tools. Poland takes the view, that simultaneously to the ongoing work on implementation of European common market (which should significantly increase the capacity towards Poland), supplementary solution to the Energy Only Market, means capacity market should be introduced. Capacity market will reduce missing capacity problem (limited amount reliable capacity being currently commissioned in EU causing serious adequacy threats) and will address current market distortions caused e.g. by extensive RES support. Polish government has announced capacity auctions model implementation and commenced drafting of dedicated legislation. According to the plans capacity market will secure proper amount of reliable capacity for the whole year (starting from 2021) by procuring it several years ahead.







Operational conditions

Operational conditions for the forthcoming winter look to be favourable as well. 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 PL-DE border. This reconfiguration consisted of the utilization of Phase Shifter Transformers (PSTs) in one of two double circuit tie-lines with simultaneous disconnection of the second double circuit tie-line. More details can be found in Summer Outlook 2016 report.

Based on Polish TSO experience from summer 2016 and winter 2016/2017, PSE still assesses that some commercial transmission capacities in the direction to Poland will be possible to offer to the market. Nevertheless, such capacity might be offered only in day ahead and intraday horizon. To the report 200 MW of import capacity was assessed, however real level will depend on operational conditions. 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 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. flow-based approach in the proper region, which means Continental Europe East, West and South with properly configured bidding zones (control blocks at least). More details referring to unscheduled flows problem can be found in the previous Outlooks reports.

On 22 September 2016 a failure of one from four PSTs in Mikułowa substation took place. Since that date the ability to control the flows are lower. Re-commissioning of this unit is forecasted in mid-summer 2017.

Except from existing PSTs in Mikułowa substation (and forecasted PSTs in Vierraden), in January 2017, in Hradec substation, first two (from four planned) PSTs were commissioned. The next two are forecasted to be in operation before summer 2017. Additional PSTs in the region are foreseen for installation in the second half of 2017 in Röhrsdorf substation. As they are / will be in operation in the close neighbourhood and possibly influencing each other, it is very important to coordinate tap settings of these PSTs. Ongoing work in trilateral working group should allow working out the rules referred to tap setting coordination:

Figure 21: Existing (solid line) and planned / under construction (dotted line) PSTs in the region.

Downward regulation and countermeasures

PSE does not expect problems with renewable infeed at 5:00 and 11:00 CEST on Sundays. Solar generation (which is c.a. 0.2 GW) is still negligible in Polish power system.

Poland: Winter Review 2016/2017

General comments on past winter conditions

Winter conditions 2016/2017 were normal ones, no balance problem occurred. Nevertheless new, historical peak load was reached. On 9 January 2017 at 17:30 CET load amounted c.a. 24.1 GW.

As forecasted in Winter Outlook 2016/2017 during the Christmas nights PSE had problem with downward regulation as the combination of low load and high RES infeed simultaneously with conventional must-run generation. PSE had to use extraordinary countermeasures to avoid wind onshore switching off.

In spite of the failure of 1 from 4 PSTs in Mikułowa on 22 September 2016, PSE was still able to offer some import capacity on synchronous profile, what was almost impossible before June 2016:

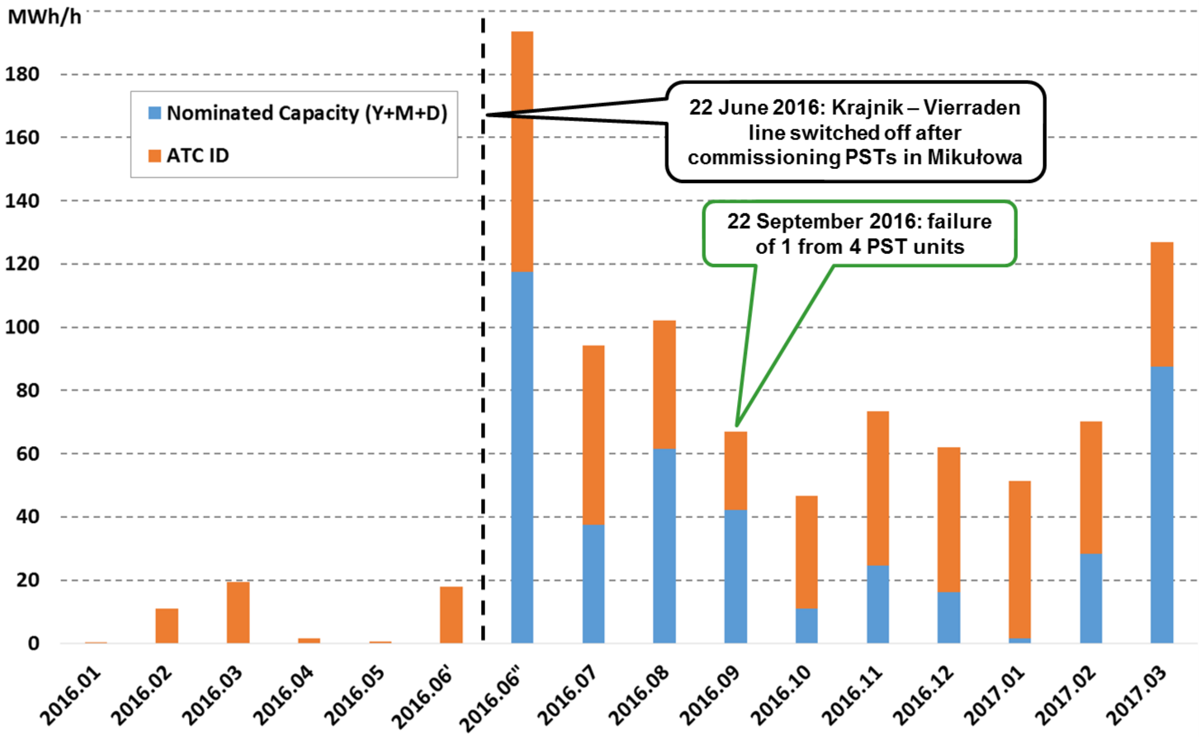


Figure 22: Average monthly import capacity on synchronous profile with DE+CZ+SK before and after reconfiguration on PL-DE border.

Nevertheless the import capacity level is still extremely low, comparing to theoretical capacities resulting from the thermal capacity of 8 Extra High Voltage[27] cross-border lines. Read more about capacity limitations on synchronous profile (resulted from unscheduled flows) in national comments to Summer Outlook. As mentioned in Summer Outlook part, PSTs are a kind of non-costly remedial action, which can only partly decrease negative impact of unscheduled flows, but does not solve the origin of unscheduled flows problem.

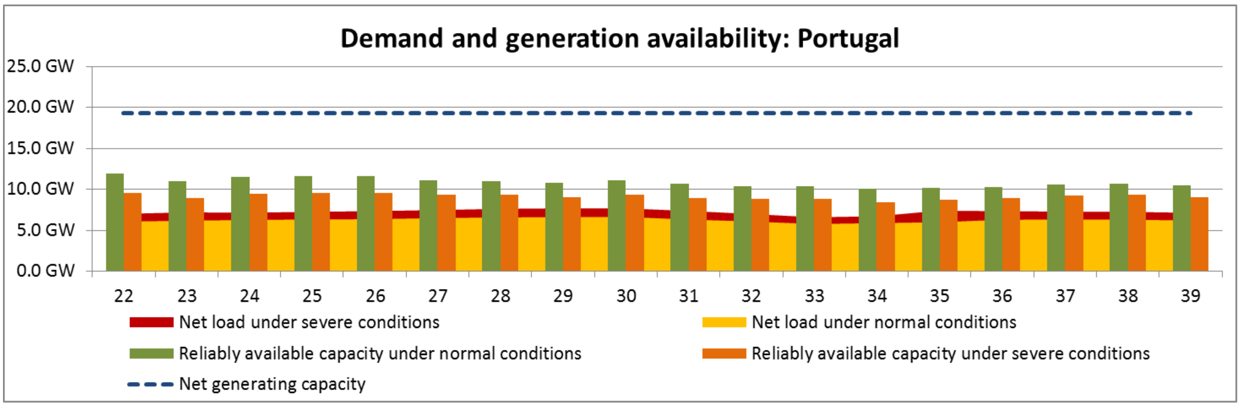
[27] On synchronous profile with DE+CZ+SK there are 10 Extra High Voltage ines, of which 1 double circuit line with DE is switched off. Read more about reconfiguration in Summer Outlook 2016.

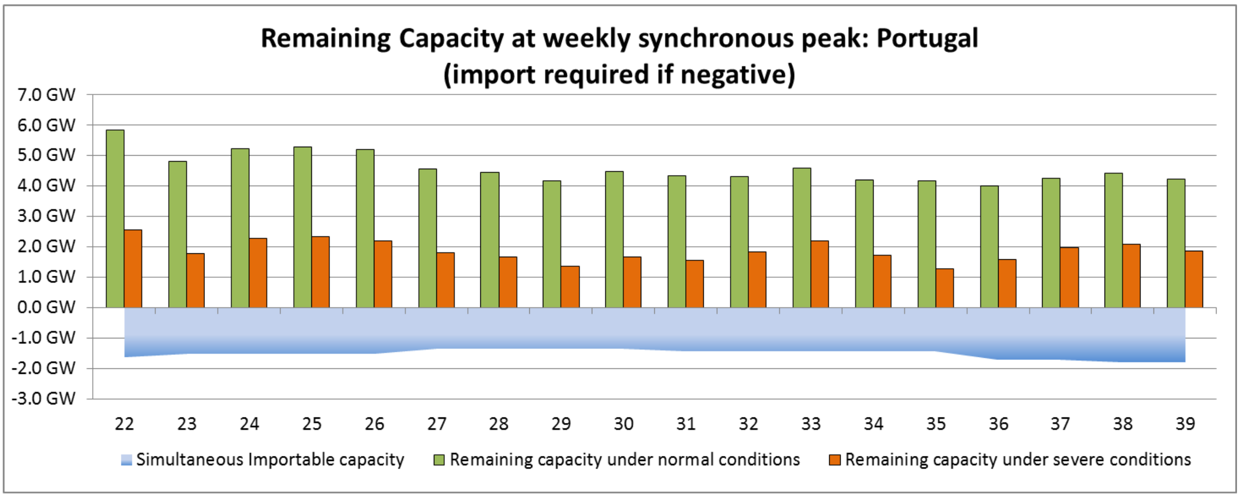
Portugal: Summer Outlook 2017

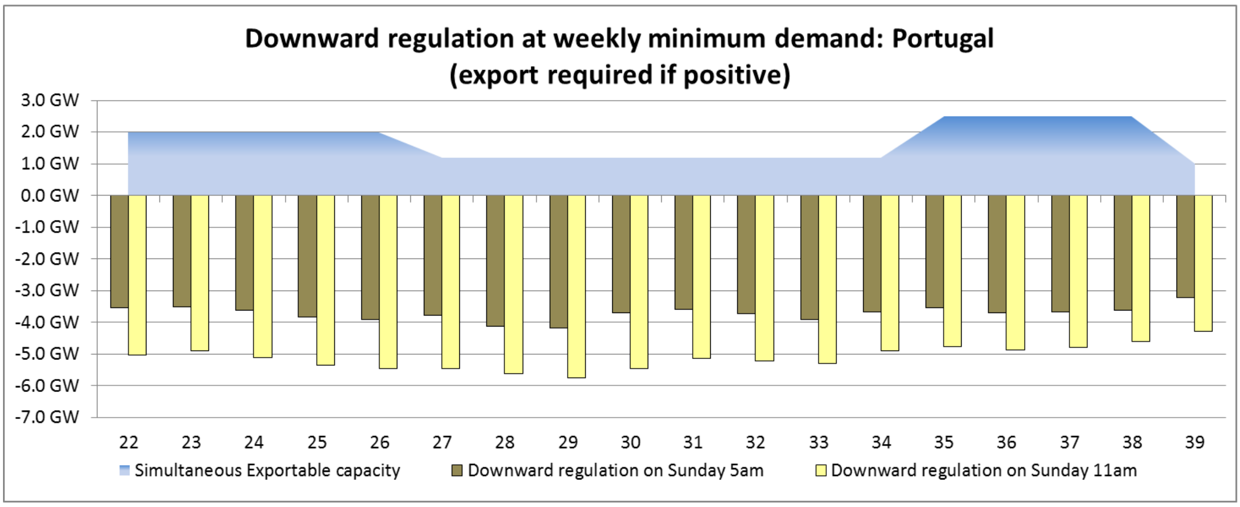
In the upcoming 2017 summer season, the Portuguese system is expected to be in balance.

Remaining capacity is sufficient to cover peak loads during the whole period, both in normal and severe condition and, with the commissioning of Foz Tua (reversible units totalizing 261 MW), hydro capacity reliability will be improved from last year level's.

Regarding system's downward regulation capability, our assessment has identified appropriate margins to deal internally with the excess of inflexible generation.







Portugal: Winter Review 2016/2017

General comments on past winter conditions

During the 2016/2017 winter season temperatures did not had a distinctive mark, having occurred instead an alternation of periods slightly above the normal values with others slightly below.

On the other hand, throughout the whole season hydro inflows were permanently below the average.

In January, hydro generation was only 36% of the average values for this month, the fourth lowest since the beginning of the records in 1971.

Wind generation was in general in line with the figures stated in the normal scenario in WOR, ranging from 92% of the average in January to 108% in February.

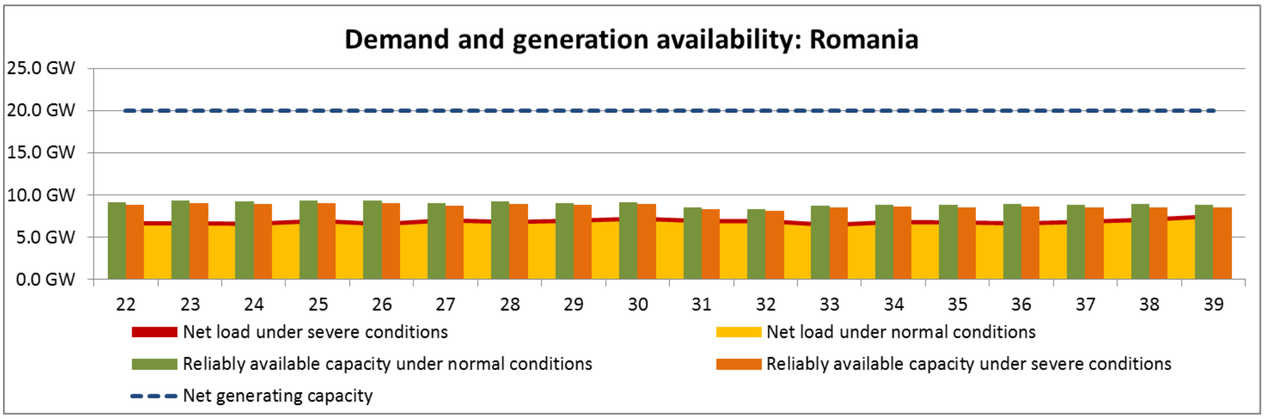
The exchange balance kept the export trend verified since January 2016. In February it accounted for 16% of national consumption and, on 2 January at 18:00 CET, the national system registered the highest ever export value, with 3,643 MW.

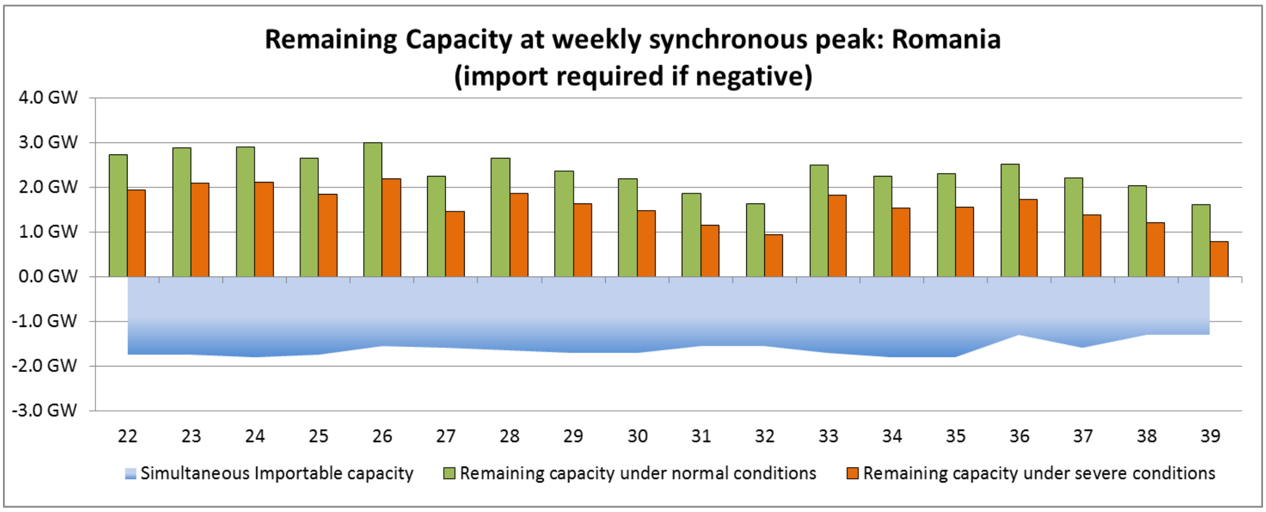
Specific events and unexpected situations that occurred during the past winter

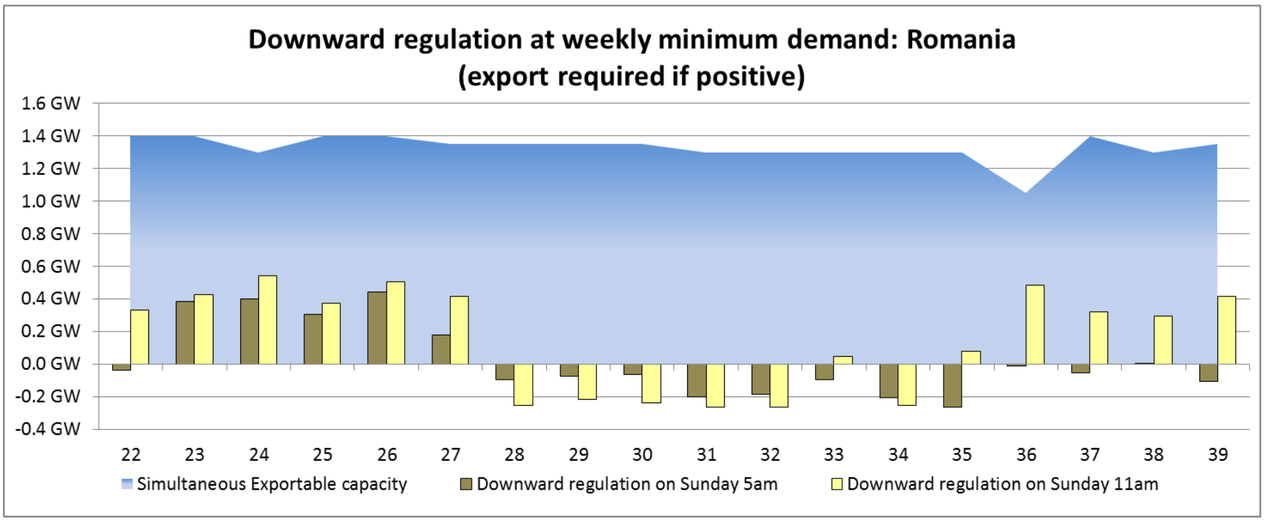
No events to report.

Romania: Summer Outlook 2017

During the summer 2017, we do not expect critical time intervals, even under heat wave circumstances.







Romania: Winter Review 2016/2017

General comments on past winter conditions

Romania was affected by the January cold spell. In particular:

- High level of commercial deficit was needed to cover the hourly load curve.
- High system load has led to very high use of reserves, but without exhausting all the reserves and breaking the N-1 criterion.
- There were no limitations on interchange capacity and/or export schedules.
- The Government Decision no. 10-13 January 2017 related to safeguard measures (e.g. curtailment of exports) was preventively issued for the cold spell between 16 January and 15 February 2017, but was not applied (just preparing the legal framework for eventually applying). No Force Majeure was applied.

Specific events and unexpected situations that occurred during the past winter

During January 2017, certain bad weather events were occurred in specific intervals in terms of strong wind and gusts, high amount of snow, fog and frost in large areas of the country. Very low temperature values were recorded. The average minimum low temperature in the country was in the range of -11°C and -15°C, and the lowest reached local value was -32°C.

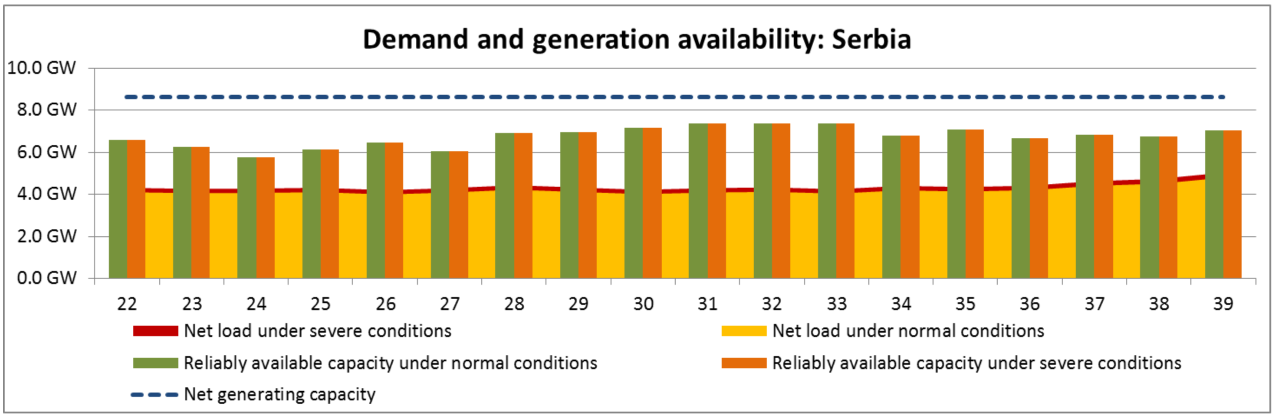
Within the cold spell, the following events were encountered:

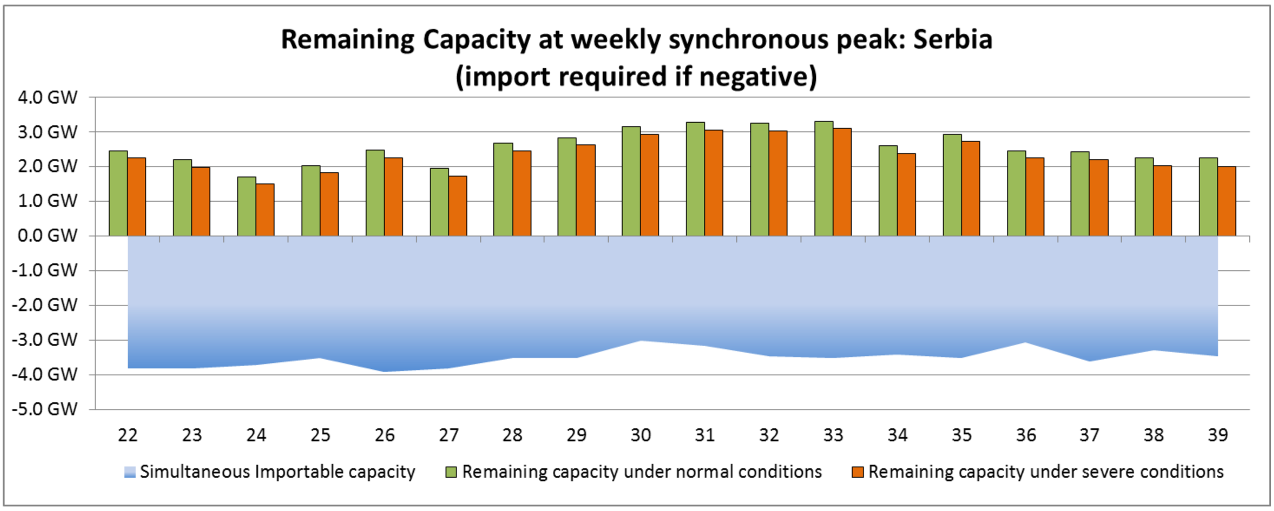
- One nuclear unit (714 MW) outages occurred on 6 January 2017 (07:26 – 21:16 CET) and between 10 January at 21:49 and 11 January at 05:12 CET;
- recurrent/random outages of some thermal units (old thermal generation park) and a part of wind generation (over speed of wind) were recorded;
- high level of commercial deficit on load curve covering (some intervals almost up to 30% of the system load) was occurred permanently during the cold spell. Sale offers were smaller than buy offers (no use of previous markets before balancing market);
- dramatic decrease of the Danube River flow (1,900 – 2,000 m^3/sec. against 4,950 m^3/sec. which is the yearly statistical mean) was recorded between 10 and 16 January 2017;
- high use of inland waters, plights on coal transportation and delivery towards some thermal power plants, low coal quality (humidity, frozen coal) were occurred permanently during the cold spell.

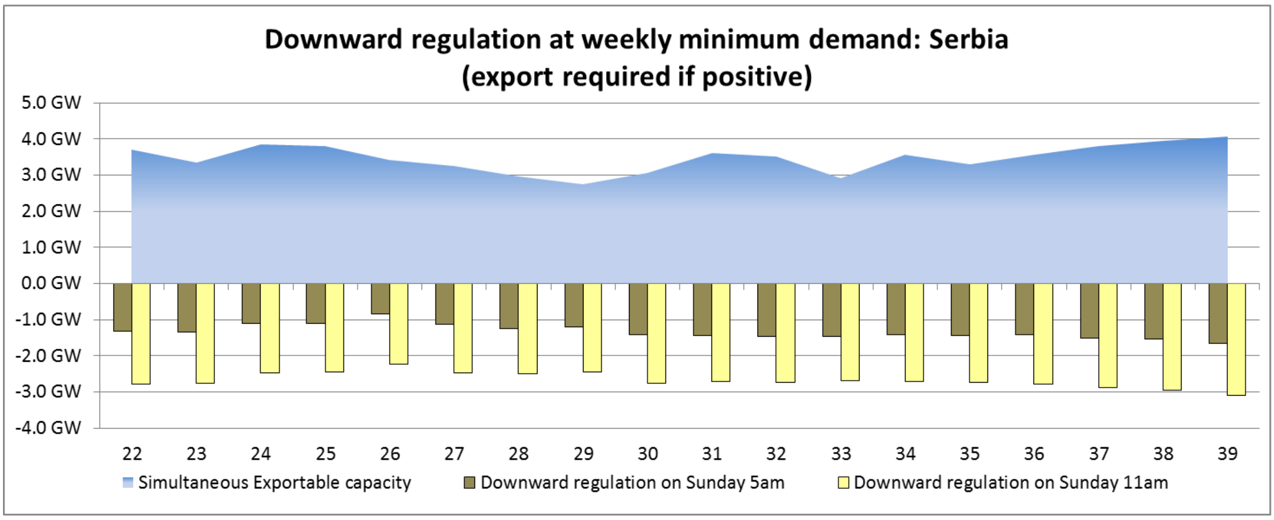
Despite of above mentioned events, the Romanian Power System was operated under safe conditions and keeping the export contracts alive. There were no limitations on interconnection capacity (NTC) and/or export schedules.

Serbia: Summer Outlook 2017

For the upcoming summer, we do not expect problems in covering demand and energy exports are expected under normal weather conditions.







Slightly higher levels of maintenance are planned for the June and first half of July, but it will not affect generation-load balance. For the rest of the summer, the level of maintenance will be normal and significant energy export is expected, particularly from the second half of July till the end of August.

Under severe weather conditions, i.e. extremely high temperatures and longer dry periods, extremely high peak loads might occur which might lead to a reduction in the planned export of energy, or even in the energy import needs for covering the demand.

Serbia: Winter Review 2016/2017

General comments on past winter conditions

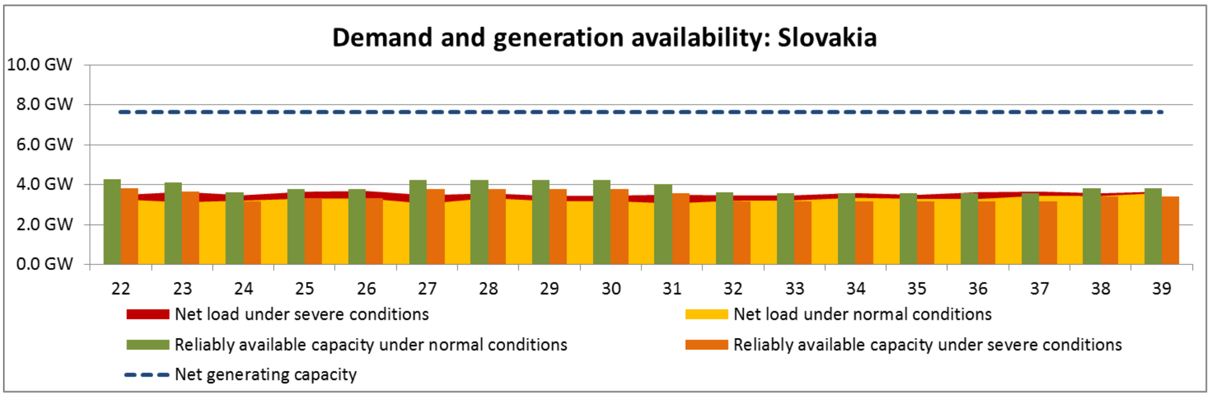
Apart from a short period in January, last winter passed without major problems. Climatic conditions were generally normal and energy import was realized in December, January and February, as planned.

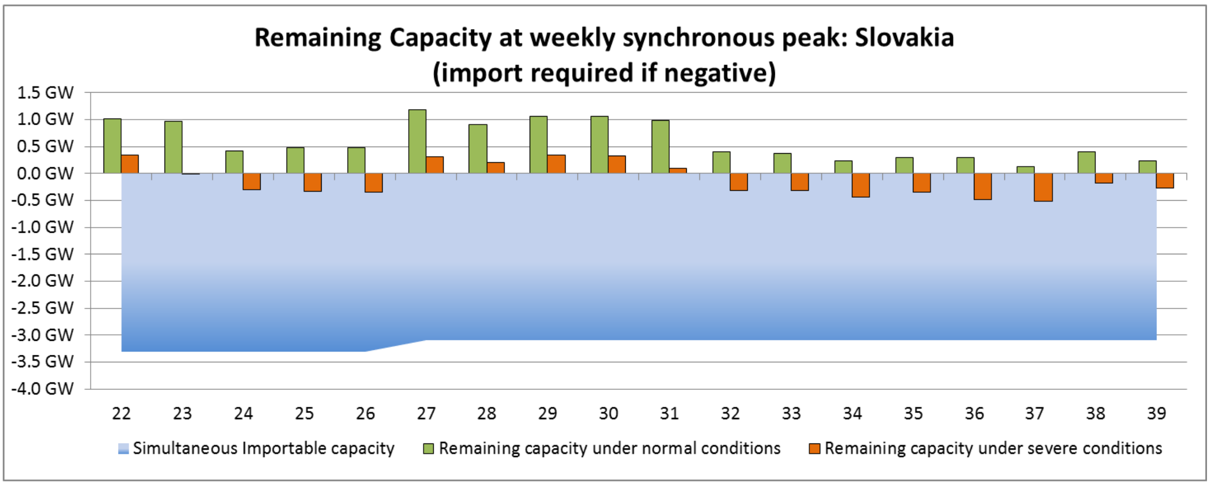
Specific events and unexpected situations that occurred during the past winter

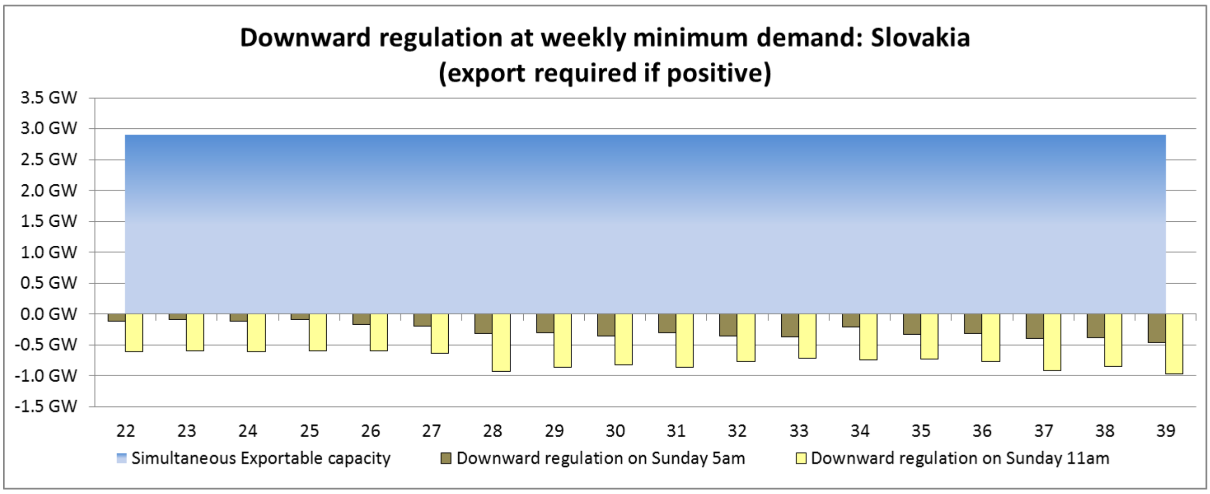
The Cold wave that hit the region in January did not significantly affect the power system of Serbia. In a few days, peak loads were very high which caused a lack of energy and an additional amount of energy was bought on the market to cover the demand.

Slovakia: Summer Outlook 2017

No adequacy risk is identified in the summer outlook 2017 of 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. The real peak load in summer 2016 was 3,753 MW (1 July at 1:00 CEST). Forecasted peak demand for summer 2017 is 3,590 MW under normal situation and 3,690 MW under severe conditions. Taking into account severe conditions scenario, the remaining capacity is sufficient only in July. The rest of summer shall face the shortage of power under severe conditions. However cross-border capacities for electricity import are sufficient.







Most critical periods for maintaining adequacy margins and countermeasures

Summer is a regular period for maintenance of generation units. In June and in the last week of September nuclear unit maintenances (500 MW) are scheduled.

Most critical periods for downward regulation and countermeasures

The regulating capacities have the same level as in the previous year, no critical periods of regulating capacities are foreseen in the summer 2017.

Slovakia: Winter Review 2016/2017

General comments on past winter conditions

Winter 2016/2017 was much colder than previous year. Average temperature during winter months from December 2016 to March 2017 was 0.7°C (winter 2015/2016 was 2.8°C). This winter was the coldest month January (-6.7°C).

Cold winter had impact on consumption and load. Increased consumption compared with the previous winter (from December to February on the average 107%) was filled by higher production and high import. The share of import in consumption increased, it was on the average 10.2% (previous winter 6.3%).

The peak load 4,550 MW (11 January at 19:00 CET) reached its historical maximum (4,471 MW in December 1989) and it was by 200 MW higher than forecasted value.

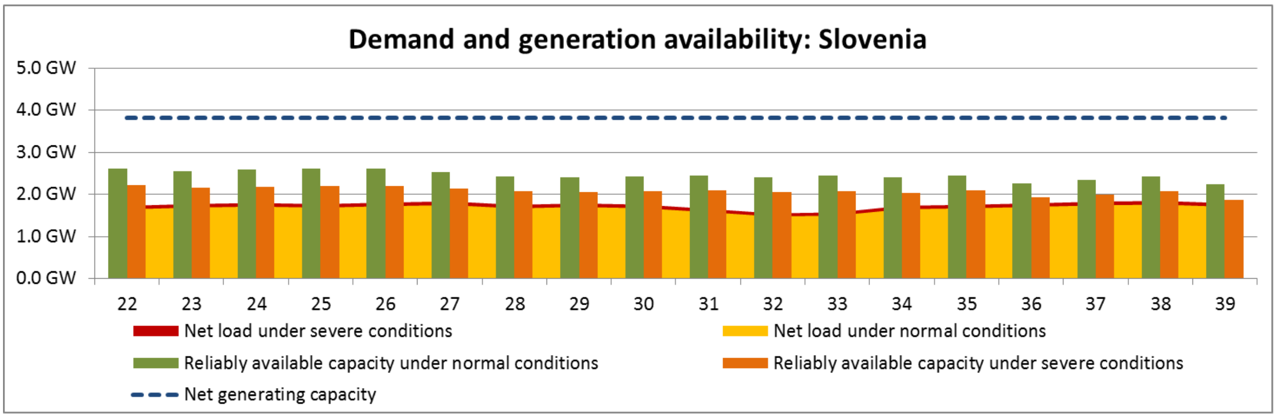
Specific events and unexpected situations that occurred during the past winter

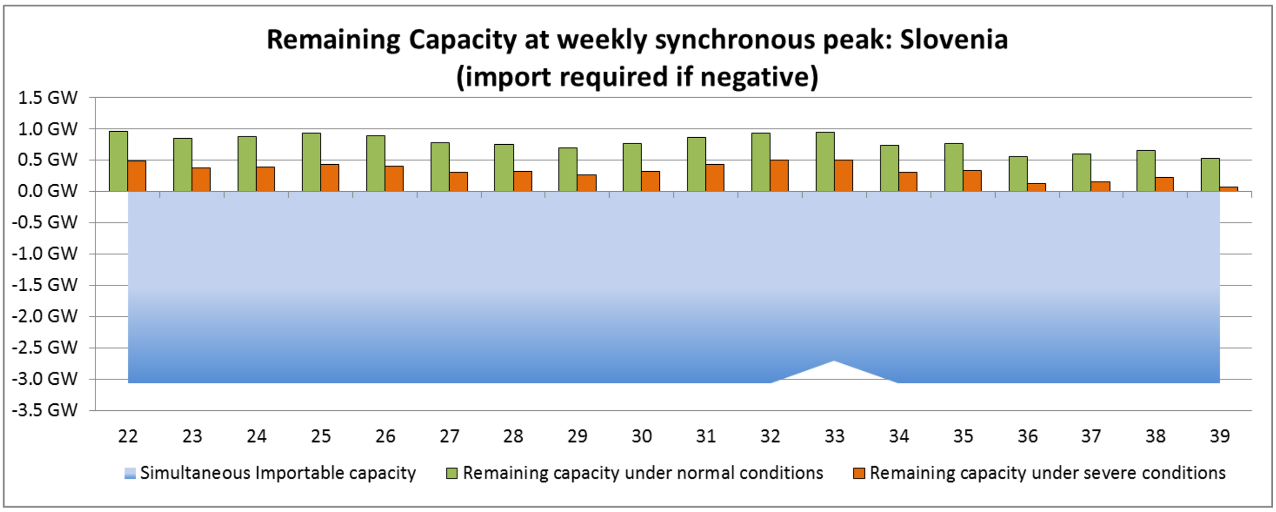
On Saturday 7 January, the emergency delivery of electricity from neighbouring TSOs, lasting 2 hours in the evening peak, and upward activation of ancillary services were necessary to meet high demand and shortage of power caused by the outage of one nuclear unit (470 MW). High demand and trading with electricity were behind strong shortage of power on Tuesday 24 January. Upward activation of all ancillary services in full range lasting for two hours and significant emergency delivery from neighbouring TSOs helped to overcome the shortage of power on 24 January.

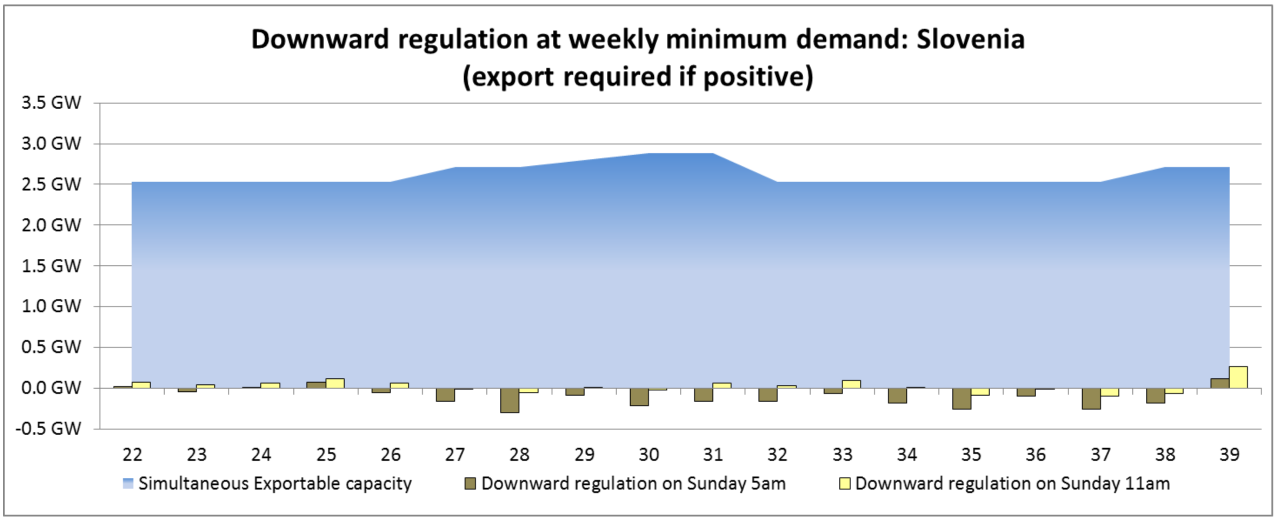
High cross-border physical flows had impact on the N-1 criteria fulfilment. Changes of basic switching state of boundary substations as remedial actions were performed several times in January and February. Accordingly neighbouring TSOs were informed via real-time awareness and alarming system about endangered states of the power system of Slovakia.

Slovenia: Summer Outlook 2017

No adequacy issues are expected this summer in Slovenia.







Slovenia: Winter Review 2016/2017

General comments on past winter conditions

In average, winter temperatures in Slovenia were substantially lower than normally, but there were more sunny days. The amount of precipitation was lower in December and higher in February. Low temperatures resulted in increased consumption and in January 2017, the maximum peak load was reached.

Specific events and unexpected situations that occurred during the past winter

An outage of a 400/110 kV transformer in RTP Divača in the end of October caused increased loadings in the surrounded part of the power system, especially during low hydrology periods. In order to operate securely, operation of a 180 MW pumping power plant had to be limited. However, this event did not affect adequacy and this winter, Slovenia did not meet any adequacy issues.

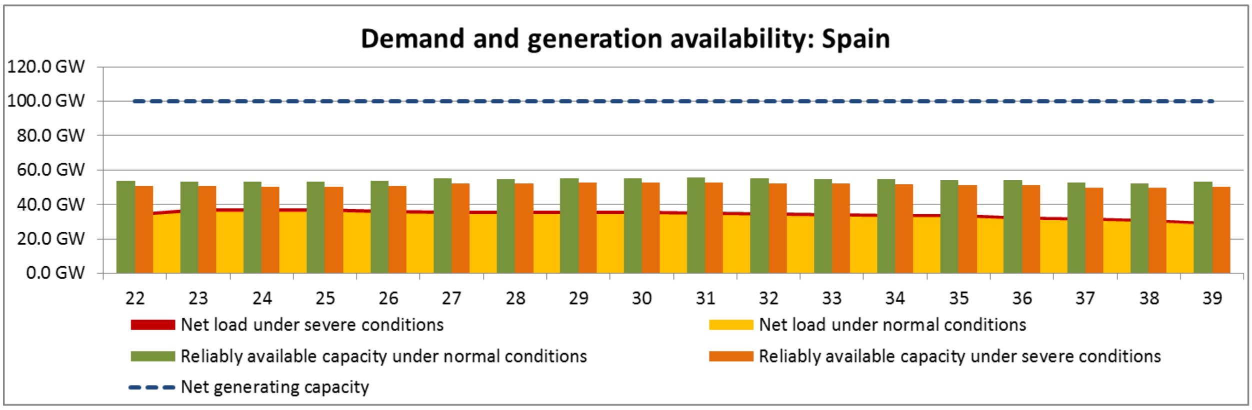
Spain: Summer Outlook 2017

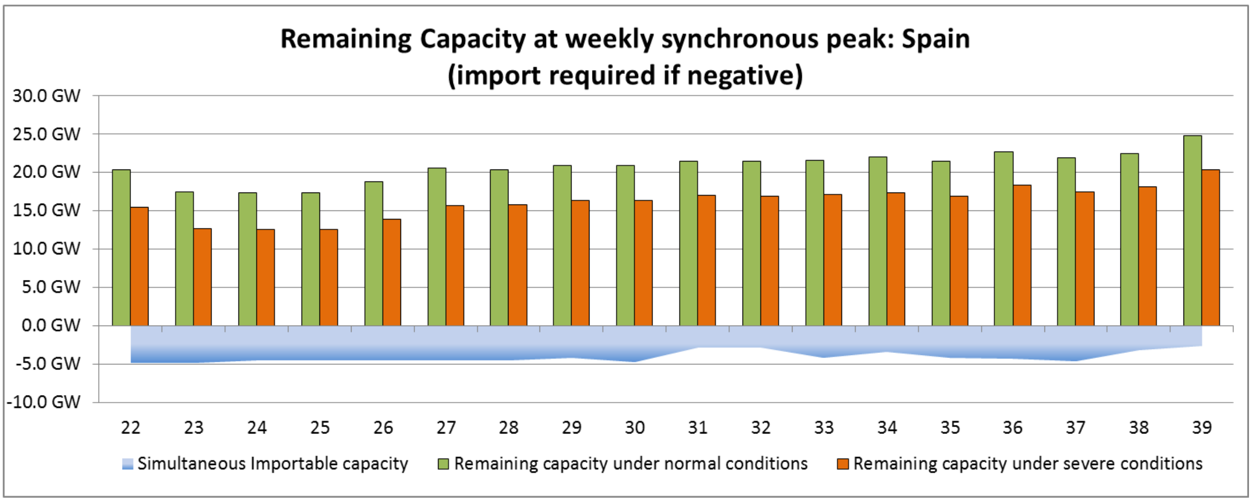
From the point of view of upward adequacy, there's no detected risk situation in the Spanish peninsular system for the upcoming summer. Good generation/demand adequacy can be expected regardless imports from neighbouring countries. If average conditions are considered, remaining capacity around the hour considered for Summer Outlook (19:00 CEST) will be over 17 GW. In the case of severe conditions, assessed remaining capacity is still over 12 GW.

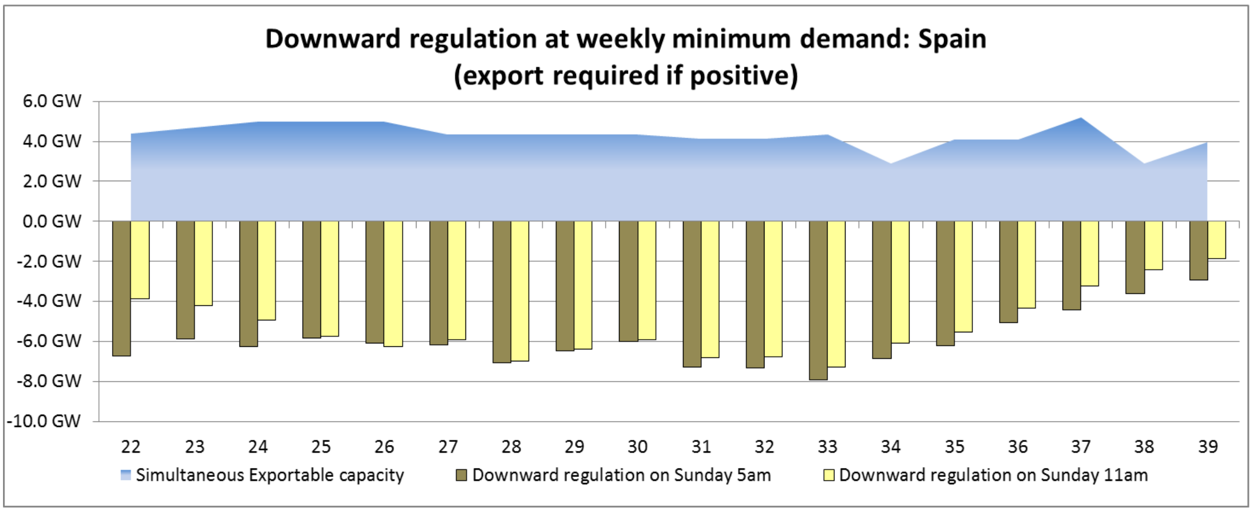
In Spain, peak summer demand usually takes place around 12:00 and 14:00 CEST. Even in the case of simultaneous extreme peak demand, very low wind generation (less than 10% of wind installed capacity), drought conditions and a high thermal forced outage rate, assessed remaining capacity is still over 8 GW.

Hydro reservoirs levels are currently lower than the historical average values. However, reservoir levels have sharply increased during February, after very drought conditions from mid-2016 until the end of January 2017.

Although there are not assessed adequacy risks, the factors which could reduce remaining capacity during the next summer in the Spanish system would be the sensitivity of the load to temperature in extreme weather conditions, persisting drought conditions, and gas availability to combined cycle thermal plants during situations of low RES.







Assumptions

It is expected that the total demand in 2017 will slightly increase, continuing the trend of the last 2 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 historical demand values. The highest 2016 demand values took place at the end of the summer, due to very high temperatures, and for the first time, yearly summer peak was higher than yearly winter peak demand.

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 Net Transfer Capacity (NTC) values are calculated taking into account forecast scenarios that are shared with neighbouring countries, with different time scopes. Weekly

Most critical periods for downward regulation and countermeasures

With the RES percentiles used for the calculation of downward regulation, there are no periods with significant risk of RES spilling. 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 of renewable energy, mainly wind power. Another point of worthy mention 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.

The Spanish TSO has a specific control centre for renewable sources (CECRE), which is permanently monitoring the RES generation. Downward regulation reserves may be composed by renewable power plants; first thermal production is reduced upon security criteria compliance. If additional reduction is needed, renewable control centre (CECRE) sends a new set point and supervises renewable production to keep a balanced situation.

Spain: Winter Review 2016/2017

General comments on past winter conditions

Climatic conditions are detailed below, month by month:

December 2016:

Temperatures were higher than average (1ºC). Hydro production was Water inflows in reservoirs were lower than average (60% lower). Wind production was 24% lower than December 2015, and wind load factor was 16% (the average value for December is 29%).

January 2017:

Temperatures were lower than average (-1ºC). Water inflows in reservoirs were lower than average (70% lower). Wind production was 14% lower than January 2016, and wind load factor was 29%, similar to the average value in January.

February 2017:

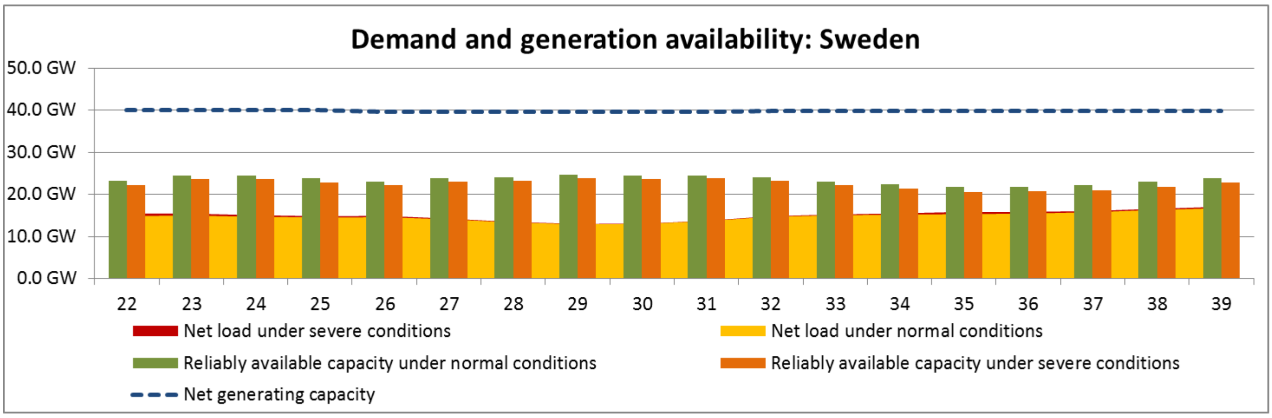
Temperatures were higher than average (1ºC). Water inflows in reservoirs were higher than average (10% higher). Wind production was 20% lower than February 2016, and wind load factor was 31%, 2% lower than the average value in February.

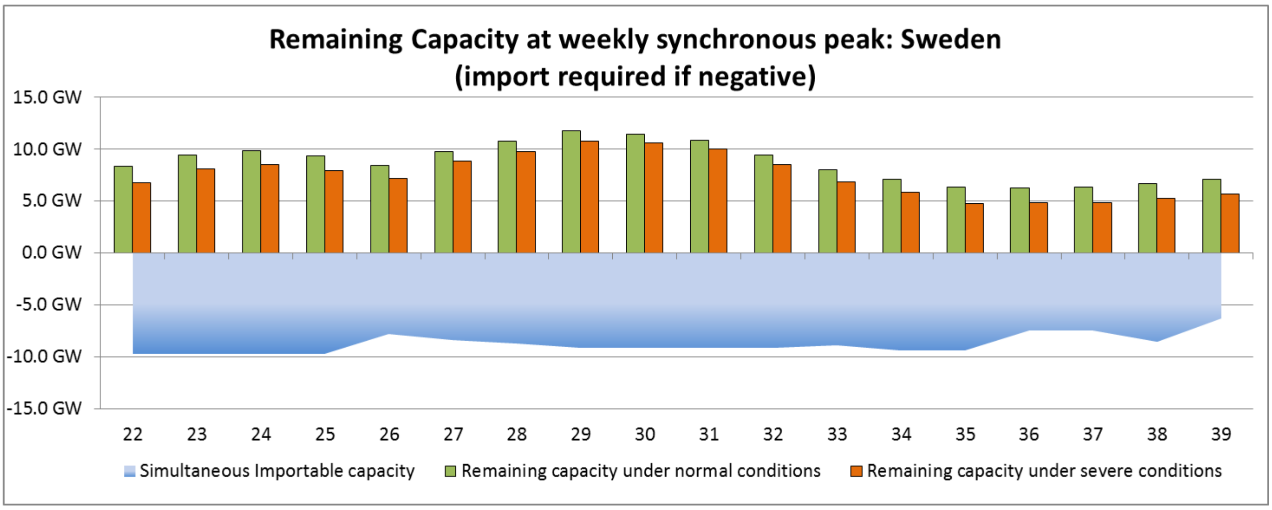
Specific events and unexpected situations that occurred during the past winter

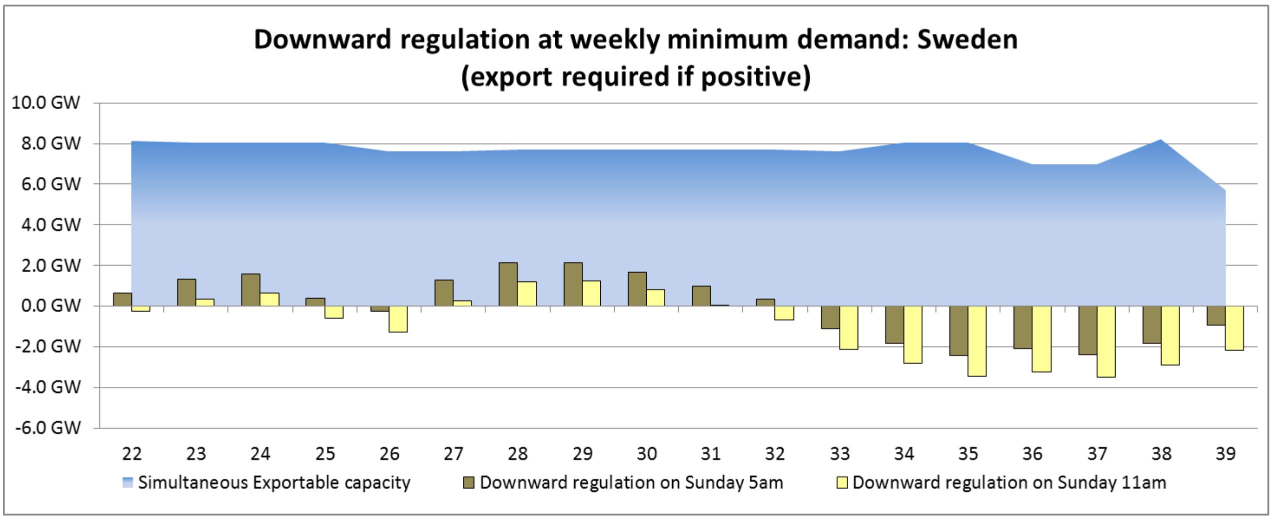
Water inflows were low as from summer 2016. Hydro reserves level during January reached low values, near to the historical minimum for that time of the year. However, inflows increased from the beginning of February and the level of the reserves increased considerably.

The demand peak value during winter was 41,380 MW, reached on 18 January during a critical period for adequacy in several parts of Europe. Not adequacy problems took place in Spain; export levels were high during peak hours due to scarcity in the rest of Europe.

Sweden: Summer Outlook 2017







Most critical periods for maintaining adequacy margins and countermeasures

During summer time, adequacy problems are not expected in Sweden since electricity demand is strongly dependent on outdoor temperatures and peak load occurs at times with cold weather. However, although there is a surplus of remaining capacity during the whole period, the situation is not as satisfying as it looks since internal congestions are not accounted for in the analysis. This means that all the remaining capacity should not be assumed to be available for export. In late August and September half of the installed nuclear power capacity is on maintenance, which increases the need for import to the south of Sweden.

Most critical periods for downward regulation and countermeasures

Thanks to a high share of flexible hydro power, excess of inflexible generation can normally be handled. However, the flexibility in the system is decreasing with an increased share of non-controllable production. In June and July, at hours when the demand is low and a high proportion of the installed wind generation is running together with an expected high share of nuclear production, there will be a dependency of export to handle excess of inflexible generation. During several weeks when a high proportion of installed nuclear power is running and when transmission capacity is limited, the situation will be challenging and additional downward regulation capacity is expected to be needed.

Sweden: Winter Review 2016/2017

General comments on past winter conditions

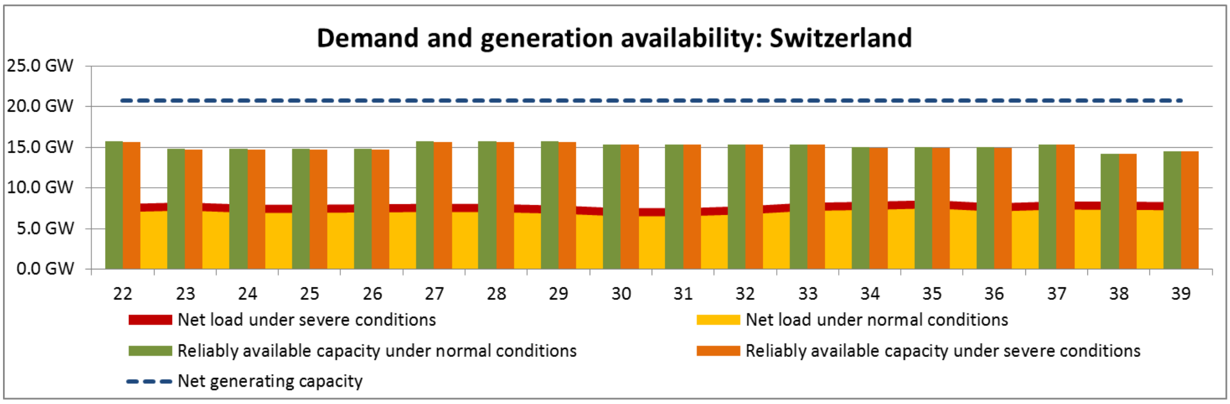
The weather conditions were mild during the past winter and the operation of the power system was generally stable. Because of the mild weather, the limited transmission capacity between Sweden and Norway did not have a serious impact on adequacy.

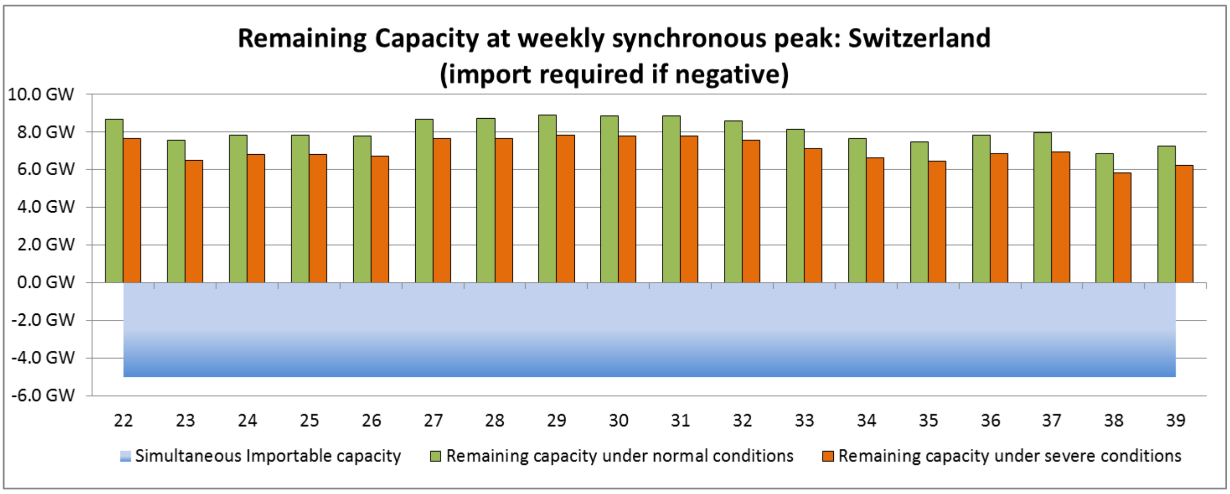
Specific events and unexpected situations that occurred during the past winter

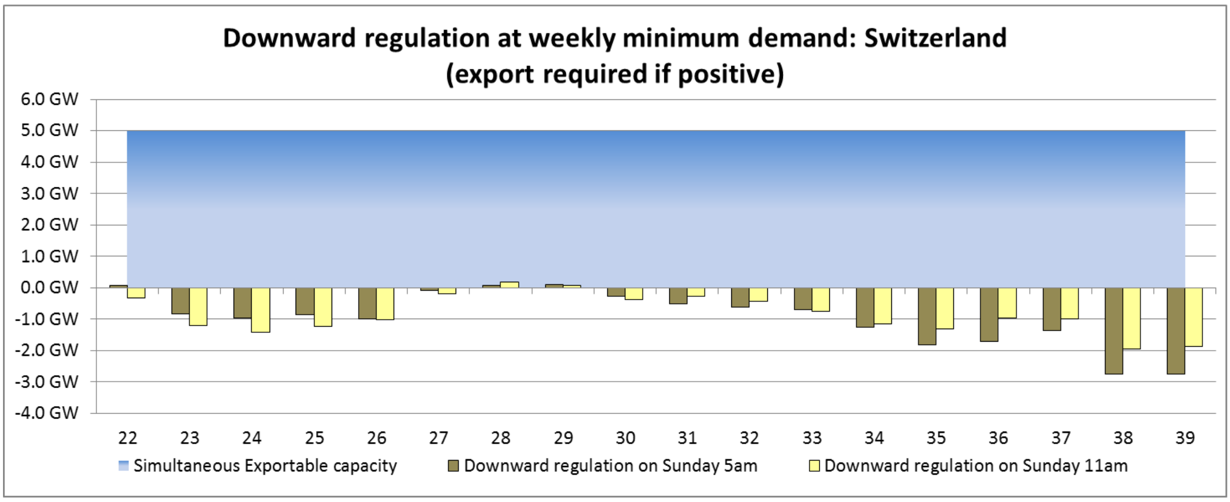
The HVDC-Link NordBalt between Sweden and Lithuania which was commissioned last year has proven important for the security of supply with import to Sweden during high load and high price situations. The link however still suffers from problems with cable faults and problems with cooling and control equipment and has been out of operation several times during the winter.

Switzerland: Summer Outlook 2017

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







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

Furthermore, 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.

Switzerland: Winter Review 2016/2017

General comments on past winter conditions

The winter 2016/2017 was particularly dry. The average temperature in Switzerland was 0.6°C higher than the norm for the period 1981 – 2010. In most regions of the country, the sunshine hours were higher than the norm.

Specific events and unexpected situations that occurred during the past winter

The low amount of water reserves led to difficulties in system operations. The below figure [Source: SFOE (data), Swissgrid (visualization)] shows the winter 2016/2017 hydro reservoir level (red line in the following graph on the top) compared to median historical value (dark grey line in the graph on the top),

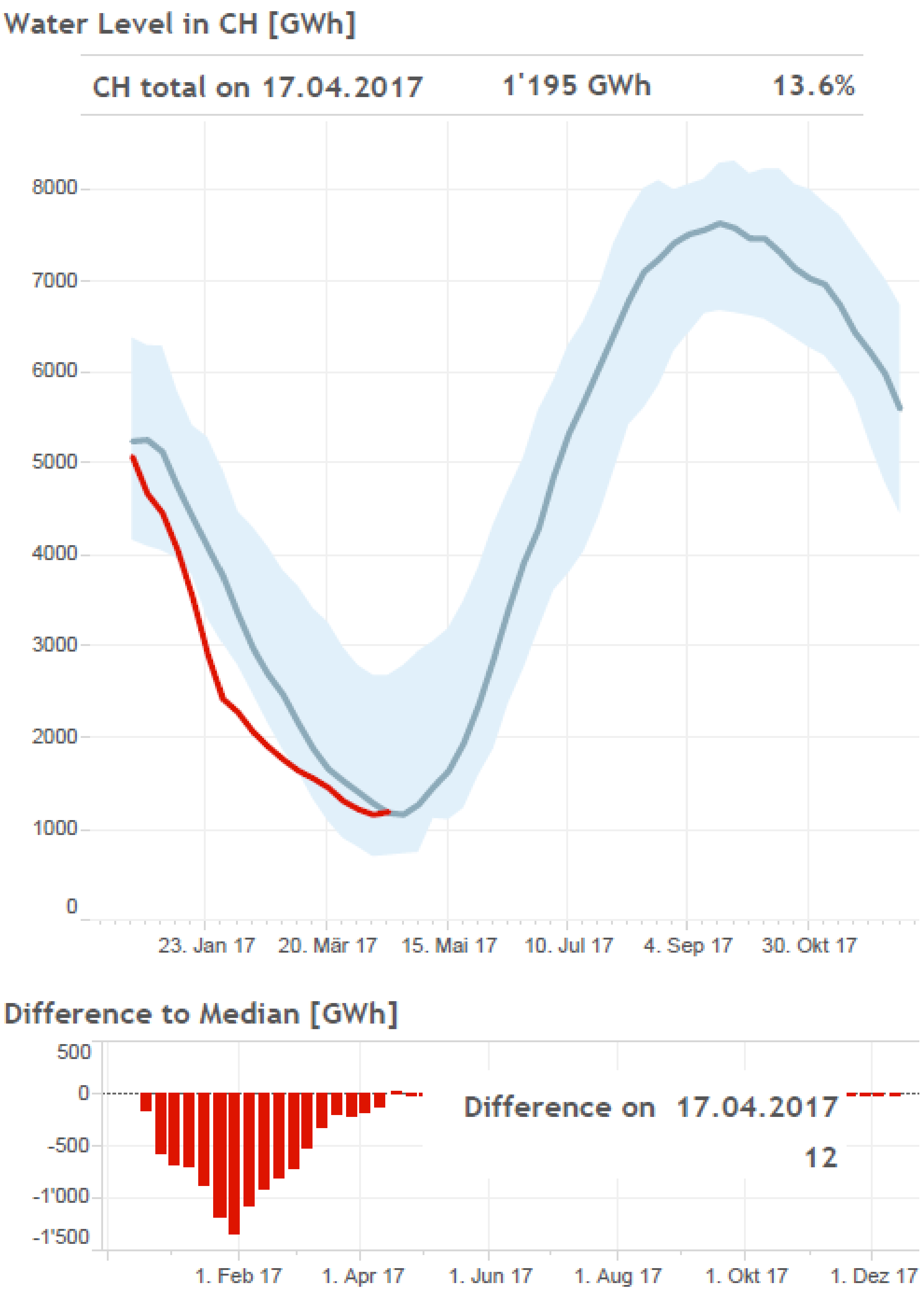
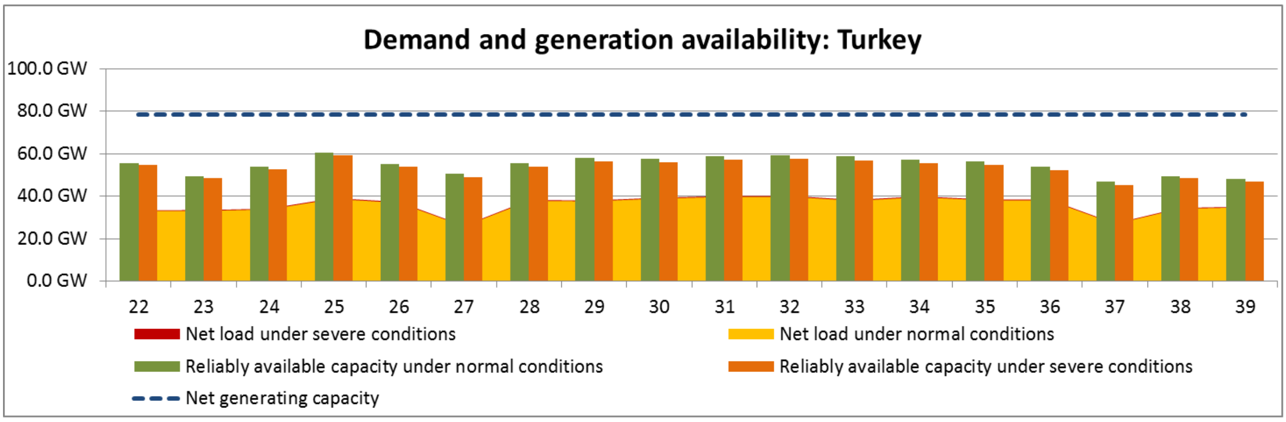


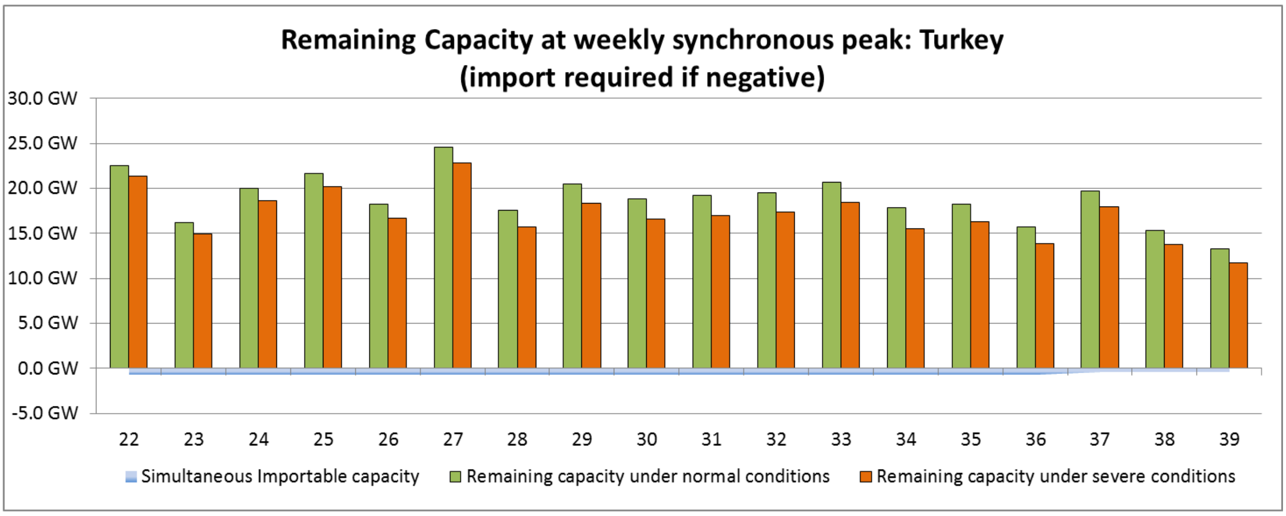
Figure 23: Winter 2016/2017 hydro reservoir level in Switzerland

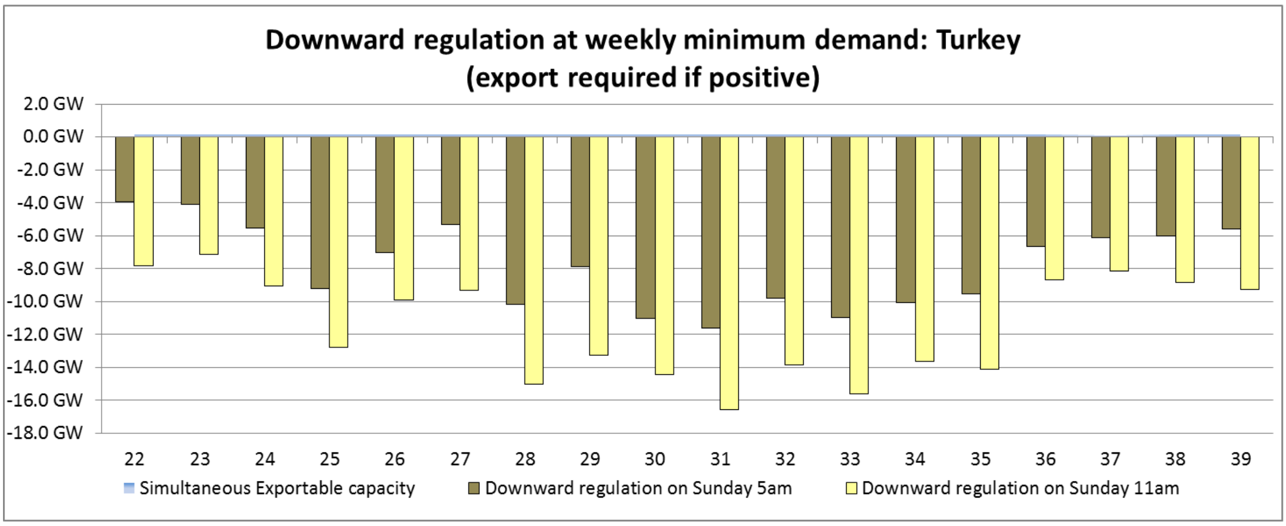
In January 2017, during the cold-spell period, a potential critical network situation, due to forecasted simultaneous high exports to France and to Italy, was countered with D-2 NTC reduction from Switzerland to Italy by up to 2,500 MW.

Turkey: Summer Outlook 2017

Even in severe condition, no adequacy issue is expected in Turkey for coming summer.







Turkey: Winter Review 2016/2017

No adequacy issue was identified in Turkey during the past winter.

Appendix 2: Daily average temperatures for normal weather conditions – reference sets

Calculation of a country population 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.[28]

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:

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

5. Collect data for the normal monthly average temperatures of the selected cities[29]:

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

6. Define the country population weighted normal monthly average temperatures

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

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

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

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

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

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

29 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.

$\mathbf{ND_{imonth}}$- number of days of month j

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

to the dates corresponding to the middle of each month:

$CPWNDAT_{1\ 16} = CPWNDAT_1$ 16 January

$\boldsymbol{CPWNDAT_{2\ 14}} = \boldsymbol{CPWNDAT_2}$ 14 February

$CPWNDAT_{3\ 16} = CPWNDAT_3$ 16 March

$CPWNDAT_{4\ 15} = CPWNDAT_4$ 15 April

$CPWNDAT_{5\ 16} = CPWNDAT_5$ 16 May

$CPWNDAT_{6\ 16} = CPWNDAT_6$ 15 June

$CPWNDAT_{7\ 16} = CPWNDAT_7$ 16 July

$CPWNDAT_{8\ 16} = CPWNDAT_8$ 14 August

$\boldsymbol{CPWNDAT_{9\ 15}} = \boldsymbol{CPWNDAT_9}$ 15 September

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

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

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

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

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

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

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

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

4. Calibrate $\boldsymbol{CPWNMAT_i}$ in order 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 $\mathbf{TEM_{REF\_SET1}}$

Methodology for load sensitivity calculation

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

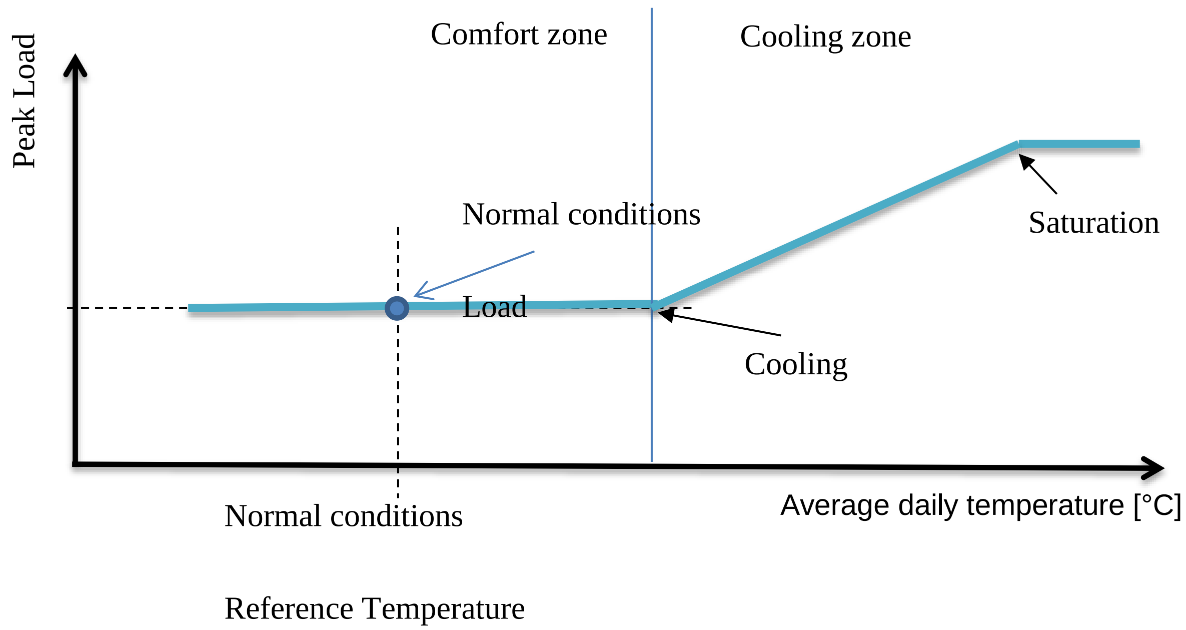
1. Define the peak load for every day of the reference year;
2. Remove values for Saturdays, Sundays and official holidays for the assessed country from the time series of peak loads (P_{peak}) and daily average temperatures (T_{avd}), creating in this way resulting time series only for working days;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

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

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

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

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



Appendix 3: Questionnaires used to gather country comments

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;* *- any event that may affect the adequacy during the period.*
Most critical periods for maintaining adequacy, countermeasures adopted and expected role of interconnectors.
Most critical periods for downward regulating capacity, countermeasures adopted and expected role of interconnectors in managing an excess of inflexible generation.
A short description of the assumptions for input data
Please describe concisely: *1) which assumptions were taken for calculating NORMAL and SEVERE conditions (e.g. if an average daily temperature for normal conditions different from population weighted daily values provided) and how the outage rates have been calculated;* *2) how the values of NTC have been calculated;* *3) Treatment of mothballed plants: under what circumstances (if any) could they be made available?* *4) Issues, if any, associated with utilising interconnection capacity e.g. existence of transmission constraints affecting interconnectors for export or import at time of peak load (such as maintenance or foreseen transit or loop flows)* *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)?*

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 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.* *- **gas shortages;***

Appendix 4: Glossary

Bidding zone: area where market participants are able to 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

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 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

Downward Regulation Margin (also **Downward Regulation Capability):** indicator of the system flexibility to cope with an excess of generation infeed during low demand time

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

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

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

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

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, environmental causes etc.

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

National Generating Capacity (NGC): The Net Generating Capacity 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 National Generating Capacity of a country is the sum of the individual Net Generating Capacity 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, but not limited to: 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, etc.

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. Also, more neighbouring countries of ENTSO-E perimeter were added

Phase Shifter Transformers: a specialised form of transformers for controlling the real time power flows through specific lines in a complex power transmission network

Pumping Storage Capacity: Net Generating Capacity 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 National Generating Capacity 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 which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves and geothermal heat

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

Severe conditions are related to what each TSO would expect under a 1 in 10 year scenario. For example, the demand will be higher than under normal conditions and in certain regions, the output from generating units (e.g. wind) may be very low or there may be restrictions in thermal plants which 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 Regional Security Coordinators

Simultaneous exportable/importable capacity: Transmission capacity for exports/imports to/from countries/areas expected to be available. It is calculated 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: generation of renewable energy sources, mostly wind and photovoltaic, whose output level is dependent on non-controllable parameters (e.g. weather)