WINTER OUTLOOK REPORT 2016/2017 AND SUMMER REVIEW 2016

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European Network of
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entsoe

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1 EXECUTIVE SUMMARY

The analysis performed by ENTSO-E shows that all considered, even if the situation in France will be tense, Europe has sufficient generation to meet normal and severe demand conditions in the winter of 2016/2017.

FRANCE'S SYSTEM ADEQUACY

France's situation this winter will be deteriorated compared to the last due to the lowest nuclear power availability in ten years. Indeed, the latest decisions of the French Nuclear Safety Authority will lead to additional nuclear units being stopped for several weeks this winter, in addition to the ones already planned for maintenance, in order to conduct safety tests. This could lead to a tense situation for France's electricity system in the event of a severe cold wave in early December up to early February.

The availability of the French nuclear units has been deteriorating late October and early November. Some units under scrutiny by the French Nuclear Safety Agency have seen their return to operation delayed until the end of 2016. This means that France will be faced with the lowest nuclear power availability in the last ten years. Subsequently, margins in France will decrease significantly in the first three weeks of December and the country will be depending on imports during these weeks. A risk to French adequacy appears in the second week of January. Adequacy in France is very much dependent on temperatures. Therefore, adequacy risks depend on whether or not there are cold waves during the above-mentioned weeks. Risk can occur in the event of cold waves at least 3°C below normal temperatures in December and 5°C below normal temperatures in January.

In France, measures have been put in place, including contracted emergency load reduction measures and potentially load shedding in order to mitigate the potential adequacy risks for the coming winter. TSO coordination through Regional Security Coordinators will monitor the evolution of the adequacy and address additional countermeasures at regional level that might be required to ensure a secure operation of the power system.

SITUATION IN GREAT BRITAIN

Great Britain's adequacy might also be impacted by the French situation. The Winter Outlook analysis shows the UK will need high imports from all neighbouring countries. However, under extreme circumstances, Great Britain has additional capacity from Open Cycle Gas Turbines, pump-storage plants which are not considered in the Winter Outlook severe scenario but are expected by National Grid – the British TSO – to be available to cover any deficit after imports. National Grid also expects there will be excess volumes of Short Term Operational Reserve (STOR) which can also be used.

INFLUENCE OF GAS SUPPLY

The joint analysis with ENTSOG has shown the robustness of the European electricity system, even in the event of a high demand situation with a simultaneous interruption of gas transit through Ukraine.

EVOLUTION OF THE GENERATION CAPACITY

The total generating capacity has increased by about 11 GW compared to last year's Winter Outlook. This increase is largely due to an expansion of the renewable energy sources (mainly wind and solar) whereas the conventional generation stayed almost stable (decommissioned oil and coal capacity being compensated by mainly gas and hydro).

▲ 12.8 GW WIND AND SOLAR

▲ 6.6 GW HYDRO & OTHER RES

▼ 8.2 GW THERMAL

Figure 1:
Evolution of the total generating capacity from Winter Outlook 2015/2016 to Winter Outlook 2016/2017

2 INTRODUCTION

ENTSO-E and its member TSOs analyse potential risks to system adequacy for the whole ENTSO-E area, which covers 35 countries including Turkey[1]. The report also covers Kosovo[2], Albania, Malta and the 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 security of supply. The ENTSO-E system adequacy forecasts not only present the views of the TSOs on risks to security of supply but also the countermeasures they plan, either individually or by cooperation.

These analyses are done ahead of each critical season – that is, 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 system adequacy for the next ten years. The MAF is put to public consultation in June and published before December.

Each outlook is accompanied by a review of what happened during the previous season. 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 actually took place with regards to system adequacy.

[1] TEIAS, the Turkish transmission system operator is an ENTSO-E Observer member.

[2] The designation Kosovo is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo Declaration of Independence.

The outlooks are done on the basis of data collected from TSOs and using a common methodology based on high and internationally recognised standards in such exercises. For maximum accuracy, ENTSO-E uses in its assessment the Pan-European Climate Database (PECD) to determine the levels of solar and wind generation at a specific date and time.

ENTSO-E analyses the impact on system adequacy of climate conditions, planned outages, evolution of demand, demand management, evolution of generation capacities and system stability issues.

In addition, an assessment of 'downward regulation'[3] issues is performed. Downward regulation is a technical term used when analysing the influence on the security of a power system when there is an excess in generation which cannot be reduced, typically when the wind is blowing at night when demand is really 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 country level, then at 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 winter outlook calculations were done for each week between 30 November 2016 and 2 April 2017. The summer review examines the system adequacy issues registered between 1 June and 2 October 2016.

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

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 which may be in difficulty. Also, all TSOs share with one another the remedial actions they intend to take within their control areas. This information sharing contributes to increasing 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 hopefully 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 impact on the system adequacy, ENTSO-E will publish on its website Winter Outlook addenda. However, ENTSO-E cannot redo the whole modelling exercise and publish a full updated version of the Outlook. These addenda provide regular updates of the adequacy situation when the conditions for the week ahead are worse than expected by the Winter Outlook. These updates are typically provided via the network of Coordinated System Operation Sub Group (CSO SG) members and selected representatives from Baltic, Nordic, GB/Ireland.

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

3 A CONTINUOUSLY IMPROVING METHODOLOGY BASED ON TSO EXPERTISE

The integration of large amounts 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 methodology with a special emphasis on harmonised inputs, system flexibility and interconnection assessments.

The Stakeholders' feedback on seasonal reports is crucial and contributes to developing the methodology further. The ENTSO-E published Target Methodology for adequacy assessment,[4)] agreed with Stakeholders, is kept as a target. Compared to the previous Seasonal Outlooks reports, the present Winter Outlook approach was further improved to increase data quality and Pan-European consistency. In particular:

- The Pan-European Climate Database was recently enhanced to 34 years (PECD 2.0, years from 1982 to 2015), compared to 14 years before;
- All wind and photovoltaic load factors for each reference point in time were all computed based on the PECD 2.0 and used as input for Pan-European calculations;
- The consumption sensitivity to temperature in each country was also updated using this same PECD 2.0; and
- The consistency of fuel type with ENTSO-E Transparency Platform was improved, especially using Transparency Platform data to prefill the Net Generating Capacity per country.

The coordination team that develops the Seasonal Outlook reports is composed of experienced experts from various TSOs all over Europe. The analysis is based on data submitted by each TSO. For the present Seasonal Outlook, both qualitative and quantitative data were submitted in September 2016 via a questionnaire. The report presents the TSOs' views on national and regional matters regarding the security of supply and/or inflexible generation surplus for the coming summer, including the possibility of neighbouring countries contributing to the generation/demand balance of each country in critical situations. The regional analysis is based on coordinated data which are submitted for several synchronous points in time.

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

3.1 GENERAL APPROACH

3.1.1 UPWARD ADEQUACY DEFINITION

The upward adequacy methodology consists of identifying the ability of generation to meet the demand by calculating the 'remaining capacity' under two scenarios:

'normal conditions' correspond to normal demand on the system (i.e. normal weather conditions resulting in normal wind production or hydro output and an average outage level);

'severe conditions' correspond to extreme weather conditions in terms of demand (higher than in normal conditions) and in terms of reduced generation output (i.e severe conditions resulting in lower wind or restrictions on classical generation power plants).

The methodology is the same under normal or severe conditions and is schematically depicted in figure 2.[5)]

5) See Glossary for definitions in Appendix 4

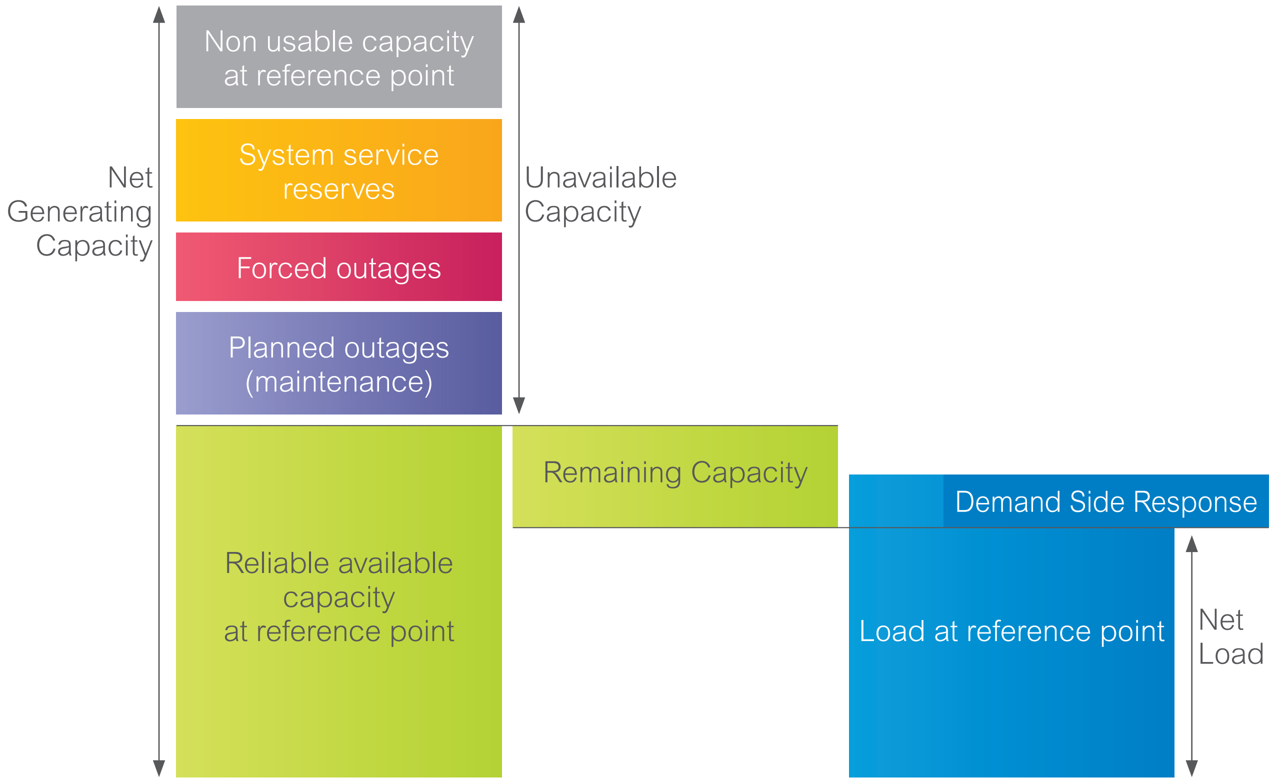

Figure 2: Upward adequacy methodology

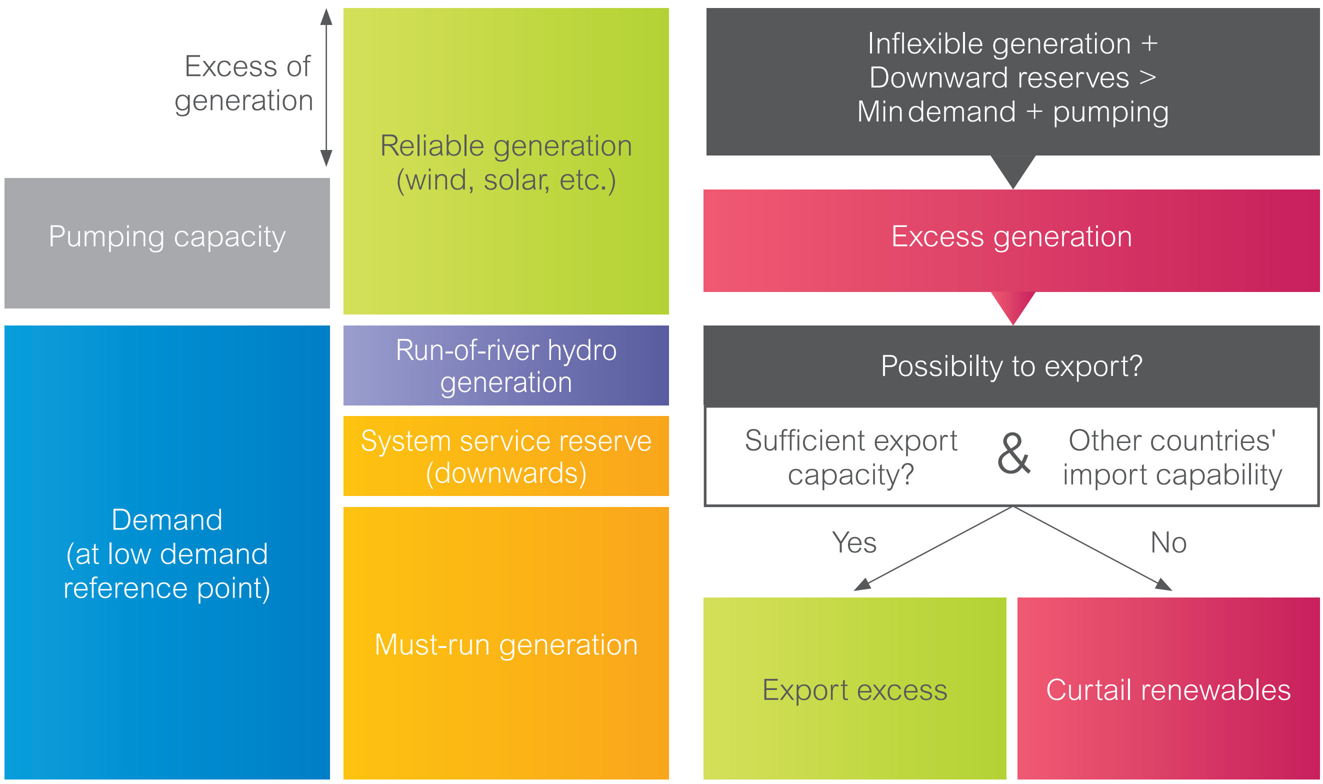

Figure 3: Downward adequacy methodology

The TSO input data input comprise 'Net Generating Capacity', 'Net Load', 'Load reduction' (Demand Side Response) and all data to calculate non available capacity. The 'Reliably Available Capacity' and 'Remaining Capacity' are then calculated for normal and severe conditions.

3.1.2 DOWNWARD ADEQUACY DEFINITION

Under minimum demand conditions, countries could potentially have an excess of inflexible generation running. Some countries can have a level of 'must-run' generation, as for instance Combined Heat and Power (CHP) units or generators that are required to run to maintain dynamic voltage support, etc. In addition, renewable generation such as run-of-river hydro generation, solar and wind power, is, by nature, variable and inflexible. In case of high renewable infeed during low demand, generation could exceed demand at country level, even while pumping for hydro storage. In that case, the 'excess' generation needs to be exported to a neighbouring region and could be even curtailed after all available export capacity has been used. The methodology is schematically depicted in figure 3.

The downward regional 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.

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

3.2 REGIONAL ADEQUACY DETAILED METHODOLOGY

The methodology is described beneath using an upward analysis as example. But the downward regional analysis is performed using the same approach.

The goal is to detect if 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 from. In case a potential shortage is detected in one or more countries, the potential curtailment will be equally shared. In other words, the curtailed energy to initial remaining capacity ratio 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 regional 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 simply added, and when the result is greater than zero, enough capacity is theoretically available in Europe to cover all countries' needs. No problems are expected using this approach, either for normal or severe conditions. As this method does not take into account the limited exchange capacity between countries, it is too optimistic to draw final conclusions based on it.

Next, a **second step** is taken. The regional analysis is based on a constrained linear optimisation problem[6)]. The problem is modelled as a linear optimisation with the following constraints:

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

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

6) Linear optimisation is a method to achieve the best outcome (such as maximum profit or lowest cost) using a mathematical model whose requirements are represented by linear relationships (source: Wikipedia)

For neighbouring systems of the study geographic perimeter that are not modelled in detail, like Morocco, Russia, Belarus and the Ukraine (except the Burshtyn Island, which operates synchronously with Continental Europe), the following values were assumed for the regional 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, **two variants** can be distinguished: a feasibility simulation and a simplified merit-order simulation.

For most simulations in this outlook report, by default, the **feasibility simulation** is used. For this simulation, the input used is the calculated remaining capacity of all countries when using the available generating capacity of all generation types.

Besides the upward feasibility, a **simplified merit order** simulation approach has been also implemented in order to show which countries may be prone to import in a market perspective, even if they do not need import for adequacy reasons.

For the simplified merit-order simulation, the approach is slightly different. In this case, 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
5. Nuclear
6. Coal
7. Gas
8. Other non-renewable sources
9. Hydro pumped storage
10. Demand side management and strategic reserves

It is important to note that the merit order approach is a simplified approach which 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.).

3.3 PROBABILISTIC ANALYSIS FOR REGIONS OR COUNTRIES AT RISK

In case the aforementioned regional 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 photovoltaic 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[7] 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 is used;
- Next, the severe conditions load is replaced by normal conditions, 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 are replaced by those of the concerned record; and
- The normal conditions load is scaled by use of 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 it is determined whether or not the considered region suffers adequacy issues or not.

7) For one point in time record of 6 days before, 6 days after, 1 hour before, 1 hour after

3.4 DATA PROCESSING

3.4.1 SYNCHRONOUS POINTS IN TIME FOR REGIONAL ANALYSIS

Several synchronous points[8] in time are collected for all countries to allow for a meaningful regional analysis when determining the feasibility of cross-border flows:

- Upward adequacy analysis – European synchronous peak load in winter: Wednesday at 19:00 CET (Central Europe Time)
- Downward adequacy analysis – Night-time minimum load with high wind: Sunday at 05:00 CET
- Downward adequacy analysis – Day-time minimum load with high wind/PV: Sunday at 11:00 CET

3.4.2 RENEWABLES INFEED DATA

For the upward adequacy analysis, the renewables infeed is handled through an estimate of non-usable capacity in normal and severe conditions by country. For wind (onshore, offshore) and photovoltaic, the non-usable capacities by default were calculated using a Pan-European Climate Database. This Pan-European Climate Database 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 respectively calculated for normal and severe conditions of 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 worst-case scenario for the different countries and for the different primary energy sources. It should be noted that this approach guarantees a worst-case 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 worst-case) renewable infeed scenario if necessary.

Regarding the downward adequacy analysis, the same approach is used, but using the 90th percentile (value that is exceeded 10 % of the situations)

3.4.3 LOAD SCALING

The submitted per-country load data is 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 Pan-European Climate Database. 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. During data collection, the TSOs were given the possibility to update the ENTSO-E proposed load sensitivity factors with their best estimate. An ENTSO-E dedicated Task Force was recently launched to further improve the load sensitivity factor data at pan-European level. This will increase the consistency of the adequacy studies performed by ENTSO-E.

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 demand (see Appendix 2 for details).

8) The most representative synchronous time points for the different analyses were identified through a study conducted using European historical load data ENTSO-E internal report: 'Pan-European peak and off-peak load study' Peter Olofsson, Svenska Kraftnät (2013)

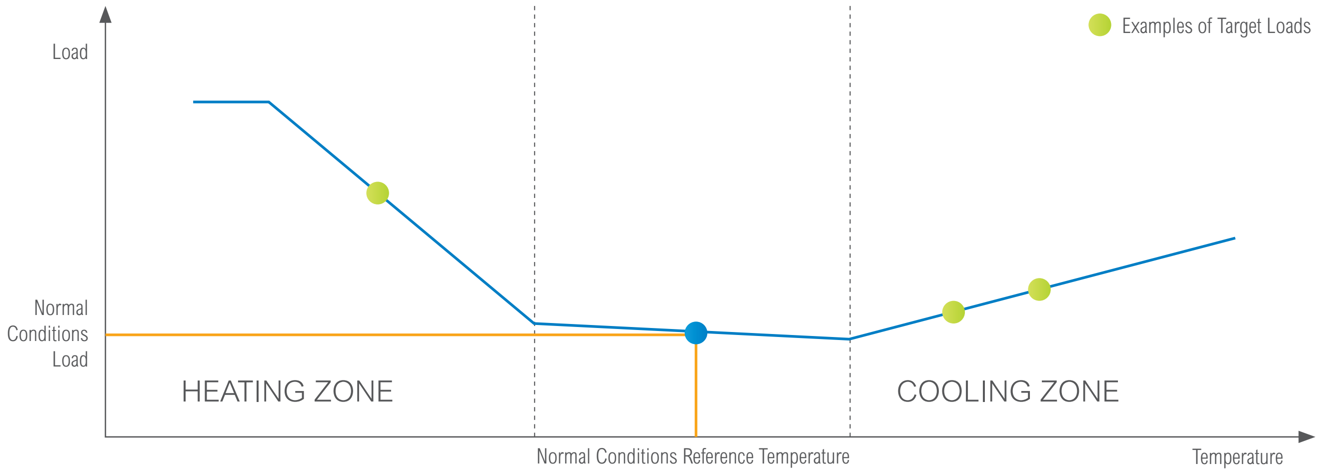

Figure 4: Load temperature sensitivity

3.4.4 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 best estimate of minimum NTC values, being used as the basis for a worst-case analysis. When two neighbouring countries provided different NTC values on the same border, the lowest value was used. Additionally, for the regional analysis, simultaneous importable and exportable limits are considered to limit the global imports or exports of a country. The above approach was used for all regional adequacy simulations.

4 WINTER OUTLOOK 2016/2017 ANALYSIS RESULTS

4.1 A CONTEXT OF DECREASING DISPATCHABLE GENERATION CAPACITY

The analysis for the Winter Outlook 2016/2017 confirms the trend of a decreasing dispatchable generation capacity in Europe. An illustration of the evolution of generation capacity throughout Europe is depicted in figure 5[9)].

In more detail, the installed capacities of conventional power plants like lignite, hard coal and nuclear and other thermal capacities decrease, whereas the installed capacity of renewables increase. The gas capacity also increases, but to a lesser extent. The MW installed capacity of renewable cannot replace the equivalent MW capacity of dispatchable generation one to one: wind or solar produce at a certain period only, not always correlated to the consumption needs. Therefore, the risks of adequacy tensions may appear more often in the future.

It should be noted that the quoted quantities are net generating capacities; outages or the availability are not taken into account in the above graph. In particular, wind/solar availability in hours per year, possibly increased outage rate due to ageing of the conventional fleet, and mothballing of gas plants due to market conditions, are not considered above in Figure 5, but are taken into account in the adequacy assessment.

9) This comparison has been performed on the same perimeter as in the previous Summer Outlook report: Malta and Turkey, which have only been included starting from Winter Outlook 2015/16, are not included in this comparison.

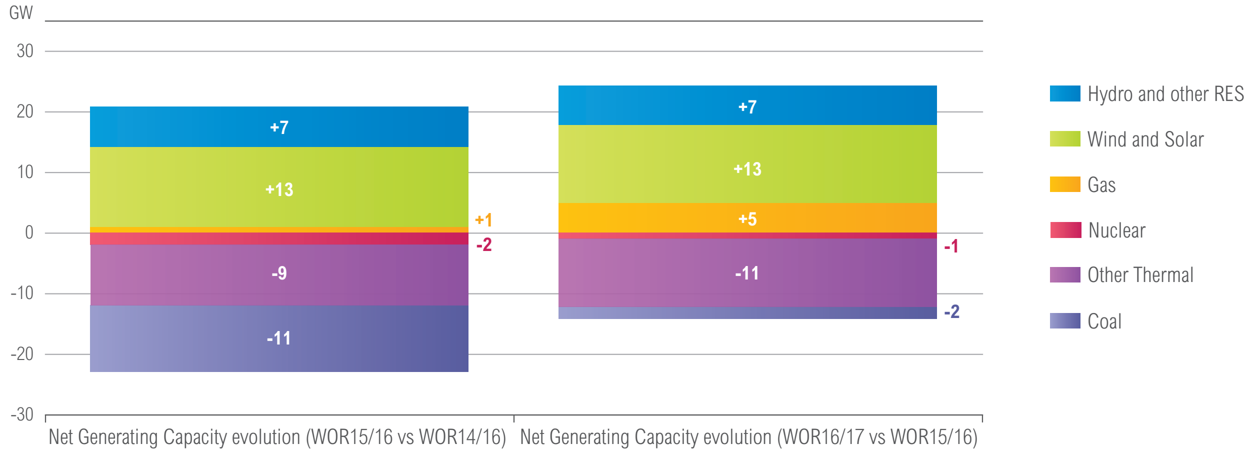

Figure 5: Net Generating Capacity evolution

4.2 UPWARD ADEQUACY ASSESSMENT

A regional assessment of the upward regulation was performed. For the generation adequacy analysis, infeed from wind and solar was calculated from the Pan-European Climate Database (cf. section 3.4.2.) to achieve a consistent scenario of renewable infeed over Europe.

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

4.2.1 UPWARD ADEQUACY UNDER NORMAL CONDITIONS

Based on normal conditions for generation and demand, the majority of countries do not require imports at the synchronous reference time point, as shown pictorially in Table 1. It is also shown in Figure 6. It should be noted that for these simulations, the demand reduction measures and available strategic reserves are taken into account as reported by the TSOs. 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 regional 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.

Simplified merit order approach

While the majority of regions do not require imports for adequacy reasons, the markets will determine the economic energy transfers based on the respective price differentials between regions, so various borders may be transmitting power at their maximum capacity.

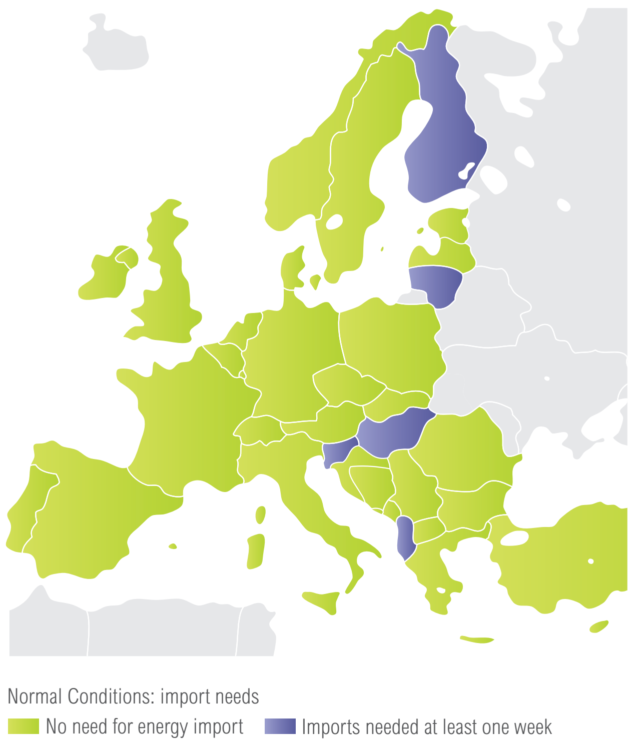

Figure 6: Generation adequacy map under normal conditions

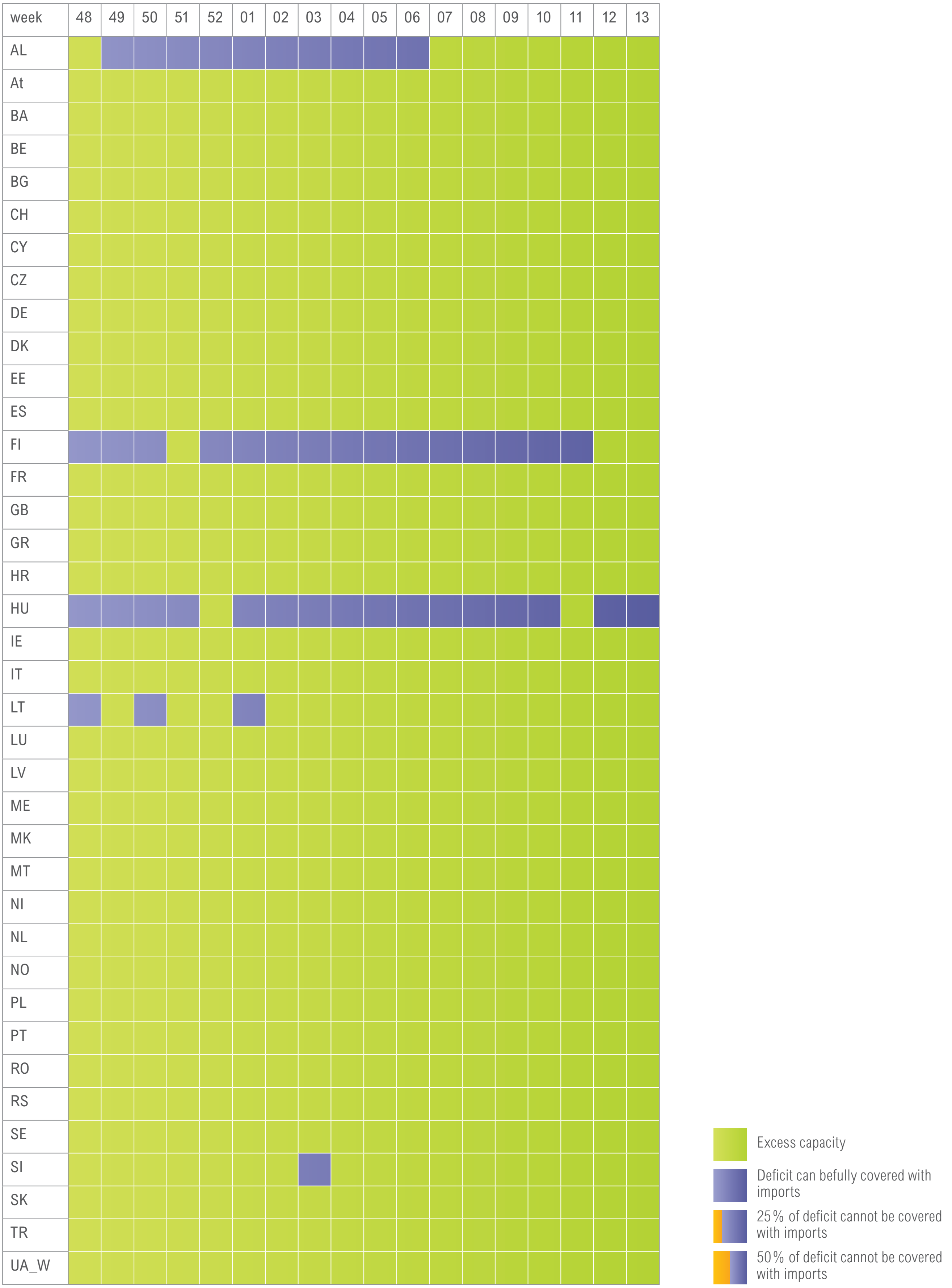

Table 1: Import needs at peak time under normal conditions

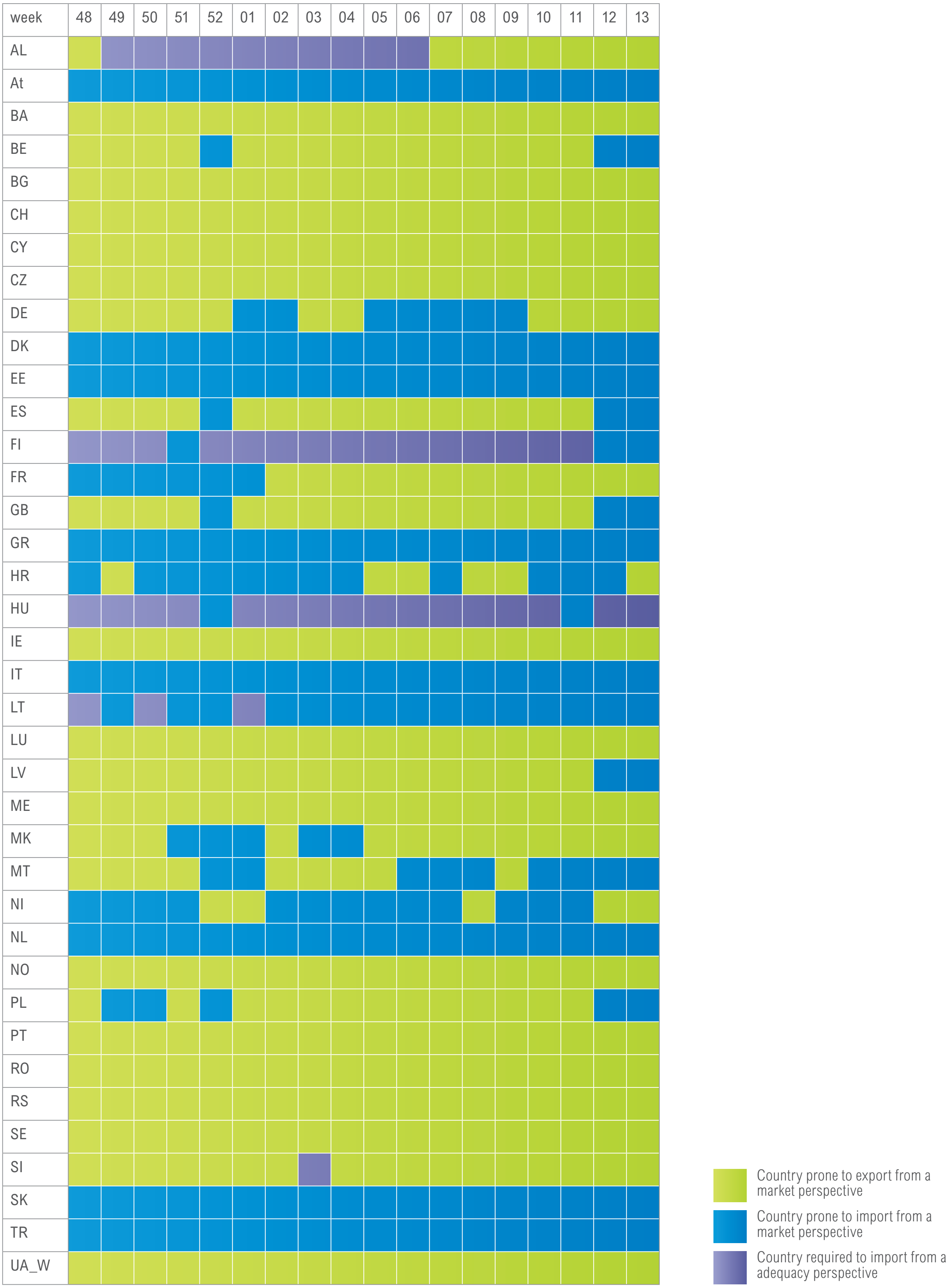

Table 2: Countries prone to market-based imports at peak time under normal conditions

As indicated in the description of the methodology, a simplified merit order analysis was also conducted to provide an indication of the countries which will probably import energy from a market point of view. Different from Table 1 above, which shows the import needs from an adequacy perspective (using a 'feasibility simulation'), Table 2 shows the countries which are prone to import from a market point of view for next season under normal conditions[10].

It is important to note that the merit order approach is an assumption and that Table 2 may not represent the real market situations. In particular, the current hydro power simplified modelling with deterministic capacity-based assessments may not represent the market reality of countries with a high penetration of reservoir hydro with natural feed-in (Norway, France, Switzerland, etc.).

4.2.2 UPWARD ADEQUACY UNDER SEVERE CONDITIONS

Under severe conditions (cf. methodology: this is a worst-case envelope, representing an extreme scenario to detect regions potentially at risk), the picture is somewhat different: the demand of several individual countries increases, whilst generation availability might be lower due to, for instance, unfavourable meteorological conditions. For these simulations, the demand reduction measures and available strategic reserves are taken into account as reported by the TSOs.

The analysis indicated that even under severe conditions, demand can be met and reserves can be maintained across nearly all of Europe, thanks to energy surpluses in most regions and available interconnector capacity to supply the regions depending on imports.

Table 3 depicts the situation under severe conditions. This is not a merit order approach but a feasibility to show when import is needed for the adequacy viewpoint.

The European map in figure 7 provides another view of the data shown in 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. As is evident, the need for importable energy is quite limited and geographically distributed, resulting in a low probability of potential issues regarding generation adequacy for the coming winter period.

Simplified merit order approach

Using the same approach as under normal conditions (cf. chapter 3 for methodology details), an estimation of countries prone to import was performed.

Table 4 shows which countries are prone to import from a market point of view for next winter under severe conditions. The countries and weeks that do not require imports from an adequacy perspective, but are prone to import due to market conditions, are coloured in light blue.

It is important to note that the merit order approach is an assumption and that the following Table 4 may not represent the real market situations. In particular, the current hydro power simplified modelling with deterministic capacity-based assessments may not represent the market reality of countries with a high penetration of reservoir hydro with natural feed-in (Norway, France, Switzerland, etc.).

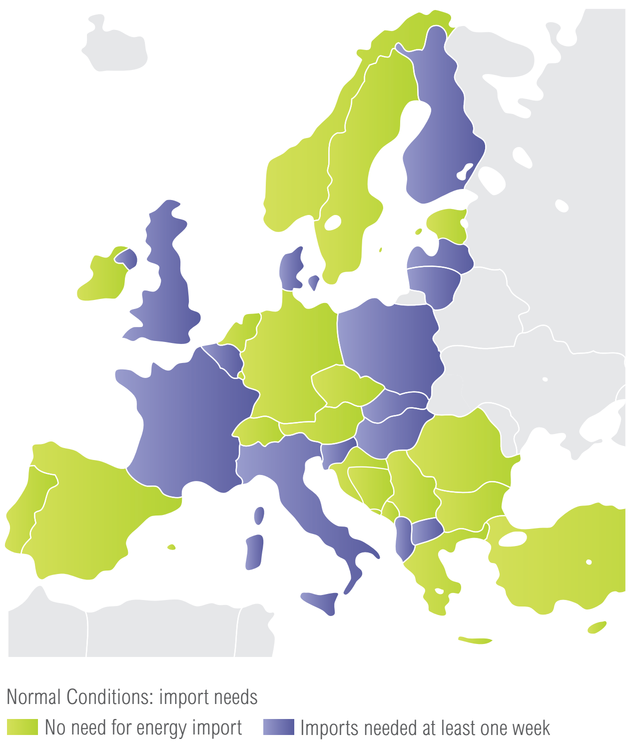

Figure 7: Generation adequacy map at peak time under severe conditions

[10] At weekly synchronous peak time (Wednesdays 11am CET).

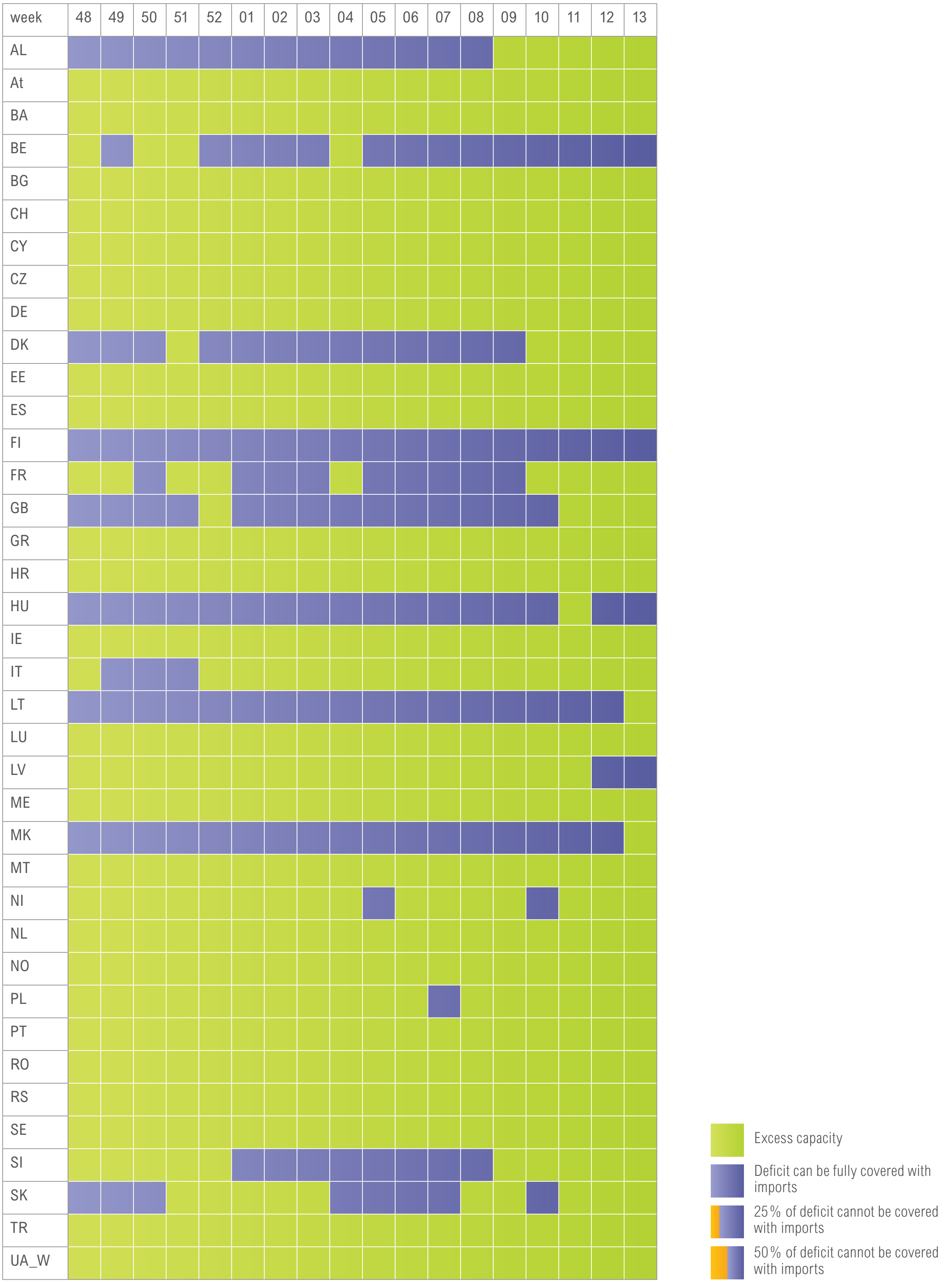

Table 3: Import needs at peak time under severe conditions

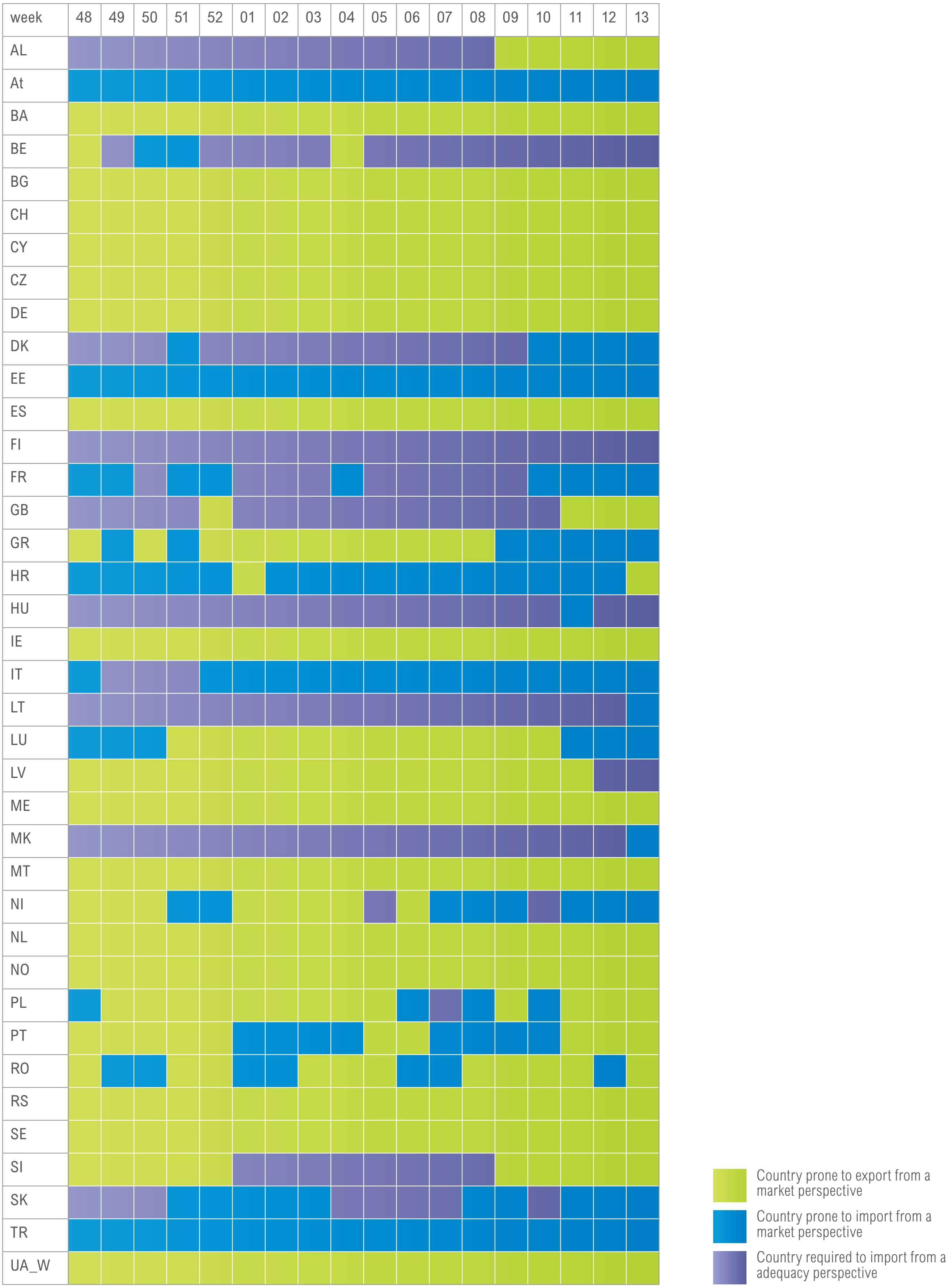

Table 4: Countries prone to market-based imports peak time under severe conditions

4.3 PROBABILISTIC SENSITIVITY ANALYSIS IN GREAT BRITAIN, FRANCE AND BELGIUM

The upward adequacy analysis showed that even under severe conditions, every country would have enough available import capacity to cover its demand. However, during the (most constrained) week 2, Great Britain potentially needs high import from all neighbouring countries whereas France's demand is quite sensitive to temperatures. In order to identify possible critical conditions, a sensitivity analysis was performed using the Pan European Climate Database[11] (wind, solar, temperatures). Indeed, under certain climatic conditions (low wind, cold temperatures) there might be a deficit after import.

Besides France and Great Britain, Belgium was also examined as it also relies on imports and had tense adequacy forecasts in the previous Winter Outlooks. Despite only these 3 countries being scrutinized, the whole of Europe was always considered in this analysis. Indeed, each dot in the following scatter plots represents a full Pan-European calculation.

France's situation this winter will be deteriorated compared to last winter, with the lowest nuclear power availability in 10 years. Indeed, the latest decisions of the French Nuclear Safety Authority have led to additional nuclear units being stopped for several weeks this winter to conduct safety tests.

The analysis shows that the risk on adequacy is low (risk is estimated at 3 % in Week 2) with the current maintenance plan, and linked to very low temperatures. The nuclear maintenance plan used for this analysis is the most up to date at the time this report is written (21 October 2016), but could be changed after the conclusions of the tests that will be conducted during winter on several plants.

French Update, 4 November 2016[12]: The availability of the French nuclear units has been deteriorating late October and early November. Some units under scrutiny by the French Nuclear Safety Agency have seen their return to operation delayed until the end of year 2016. Up-to-date maintenance schedules are available here. Subsequently, margins in France have decreased significantly in the first three weeks of December when France is dependent on imports. The adequacy risk is assessed at 4 % in Weeks 49 to 51 of December compared to 3 % in Week 2 of January. Due to

[11] Due to technical restrictions, 14 climatic years were used in this chapter 4.3 (goal is to enlarge to 34 years in the next report)

[12] For more details see the France Winter Forecast released by RTE: here

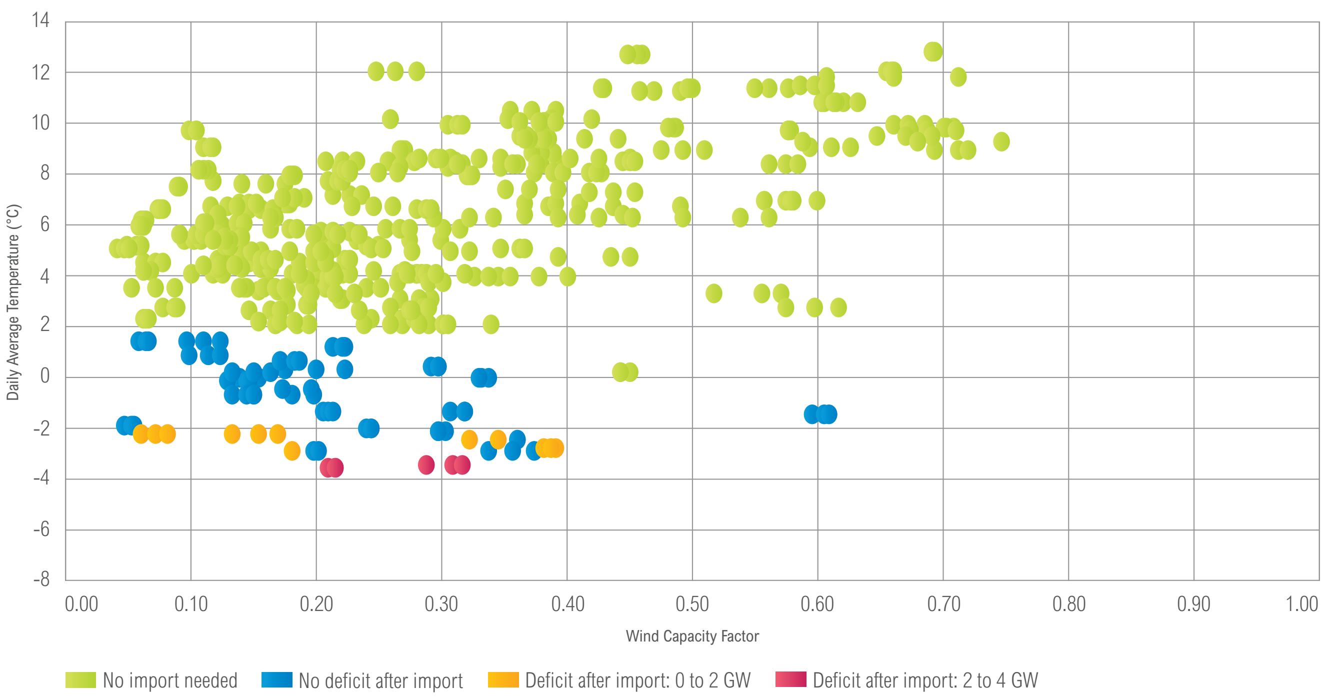

Figure 8: Probabilistic sensitivity analysis for France in Week 2 of 2017

Figure 9: Probabilistic sensitivity analysis for Great Britain in Week 2 of 2017

Figure 10: Probabilistic sensitivity analysis for Belgium in Week 2 of 2017

the high sensitivity of load to temperature in France (up to 2 400 MW/°C), risk can appear during cold waves at least 3°C and 5°C below normal conditions in December and January respectively. In France, measures have been put in place including contracted emergency load reduction measures and potentially load shedding in order to mitigate potential adequacy risks for the coming winter. TSO coordination through Regional Security Coordinators will monitor the evolution of the adequacy and address additional counter-measures at regional level that might be required to ensure a secure operation of the power system.

Great Britain's neighbouring countries France and Belgium also rely on imports under these conditions but have enough import capacity to manage it. Under these circumstances, Great Britain needs to fully import from neighbouring countries and has additional capacity from OCGT units (~0.9GW), Pump-storage plants (~2.9GW) which are not considered in the severe scenario but are expected to be available, to cover the deficit. There may also be excess volumes of Short Term Operational Reserve (STOR) which can also be used.

In Belgium, no adequacy issue was detected, even considering the high import needs of France and Great Britain. Thanks to the return of nuclear power plants Doel 3 & Tihange 2 last year (each ~1000 MW) the balance between generation and consumption should be ensured[13]. The analysis is based on the current planning of the producers, however, a change in the hypothesis will have a direct impact on the margins detected for Belgium. Furthermore, in the analysis the strategic reserves (750MW for the winter 2016/2017) are taken into account. The strategic reserves are contracted to prevent adequacy issues. Without the strategic reserves, the margin detected for Belgium would decrease.

13) A full availability of the nuclear park was expected at the moment of data collection. However, there are some uncertainties concerning this hypothesis, which will have a direct impact on the remaining margin.

4.4 DOWNWARD REGULATION MARGINS

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, high wind) and Sunday daytime with high photovoltaic generation. These margins were calculated making certain assumptions (a one in ten years highest infeed scenario was considered) for renewable feed-in and are no prediction for the reference points.

4.4.1 DAYTIME DOWNWARD REGULATION

The results of the analysis of available downward regulation margins at the daytime reference time point are shown below in Table 5. 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 regional analysis revealed that their excess cannot be fully covered with exports considering the reported NTC values[14]. 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.

On a typical Sunday at 11 am CET, Czech Republic, Ireland, Poland, Romania and Slovenia may need to export an excess of generation for some weeks. After this analysis was completed, the East-West interconnector between Ireland and Great Britain suffered a forced outage and is not expected to return to service prior to 28/02/2017. This may contribute to some wind generation on the Irish system being curtailed.

Germany and Denmark would need to export on each reference point on Sunday in case of high renewable infeed. The cross border capacity should be sufficient to export surplus and thus avoid renewable curtailment in most of the cases.

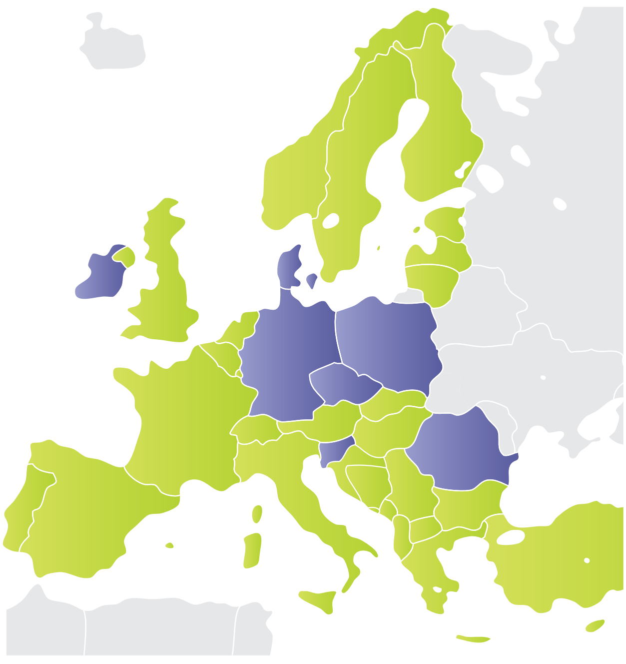

Figure 11: Overview of the export needs for the daytime scenario

14) More details on NTC data collection in chapter 3.4.4

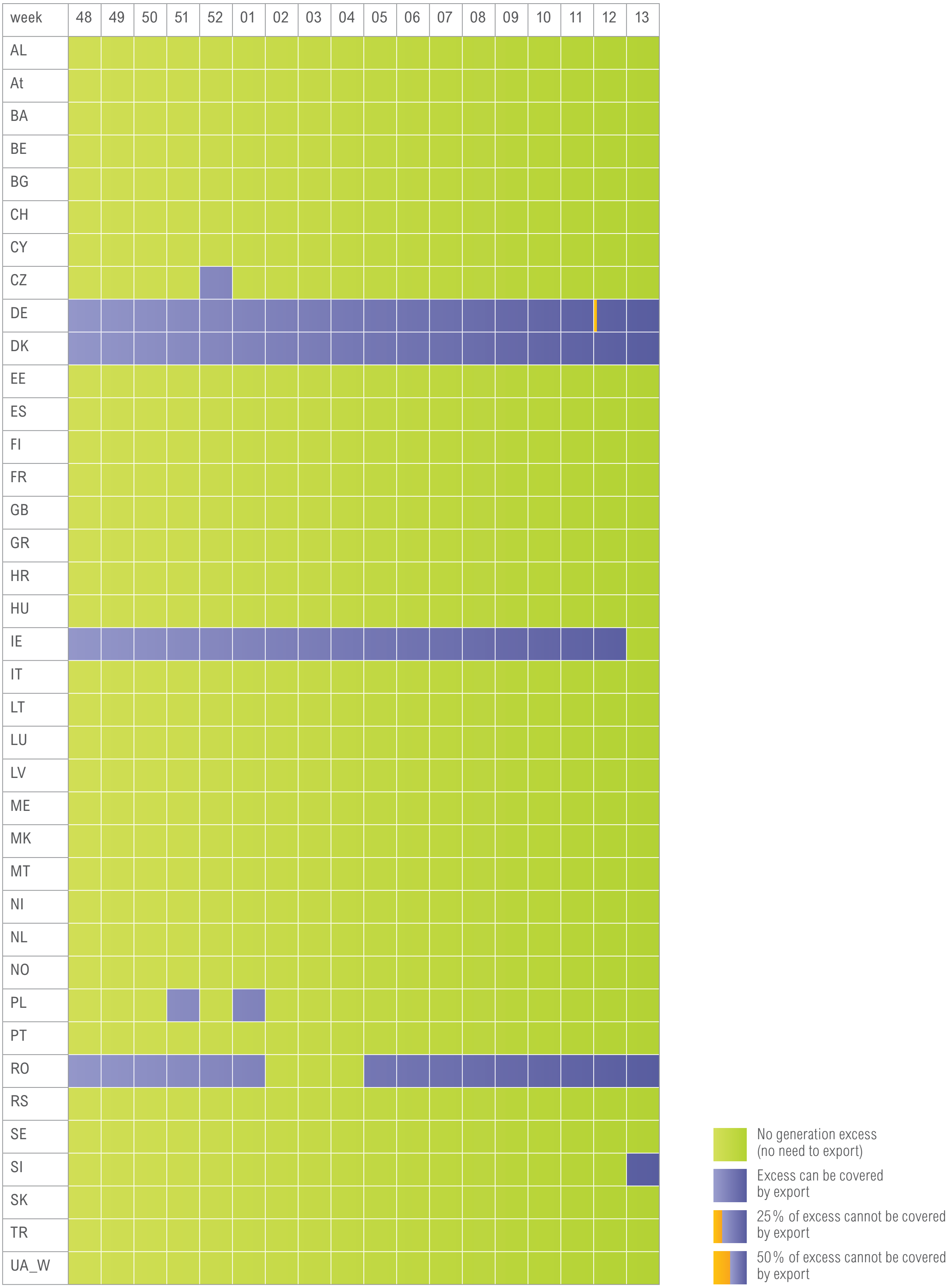

Table 5: Export needs at the daytime minimum (reference points on Sunday 11:00 CET)

However, on Sunday 26 March at 11 am CET in Germany, export capacity might not be sufficient to export surplus of generation. In that case, up to 1 GW renewable might be curtailed in that hour. It should be noted that such a risk of curtailment has a quite moderate probability of occurrence: it concerns, respectively, Wind and PV, a one in ten years highest infeed at that period. In cases of high excess generation specific, German laws and regulations allow the German TSOs to reduce the RES infeed in order to mitigate any negative effects on the network. Therefore, no critical situation is expected.

4.4.2 NIGHT-TIME DOWNWARD REGULATION

The Night-time downward adequacy in winter corresponds to Sunday early morning (5 am CET). At that time, renewable is mostly wind (no sun yet in winter period), but the consumption is lower than on day-time. In case of high wind, nine countries may need to export on some Sunday Night-time reference points.

Cross border transmission capacity should be sufficient to export the generation surplus.

However, Poland and Ireland might have a lack of export capacity:

- In Poland, during the Christmas night (Sunday 25 December 5am), export needs may exceed available export capacity by up to 1.2 GW[15]. For this atypical night, lower load is assessed compared with typical Sunday nights. Therefore, in case of a high windy[16] Christmas night – if available operational procedures are not sufficient – wind might be curtailed as the last countermeasure.
- Ireland may also – between early December and end of February – need to curtail up to 250 MW wind in case of windy Sunday nights. After this analysis was completed, the East-West interconnector between Ireland and Great Britain suffered a forced outage and is not expected to return to service prior to 28/02/2017. This increases the amount of wind which may have to be curtailed.

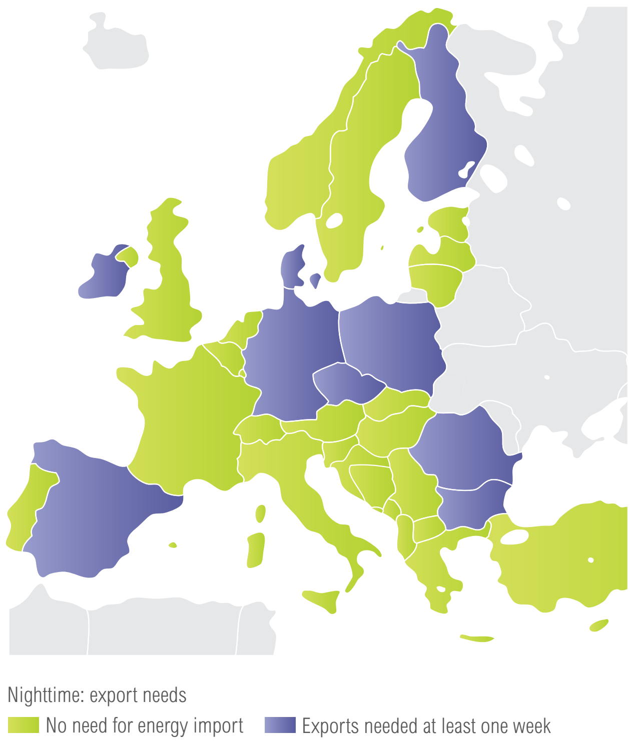

Figure 12: Overview of the export needs for the night-time scenario

15) PSE does not prepare forecasts for downward regulation capabilities in yearly and monthly horizon (only during daily planning), therefore provided data is a kind of estimation only, especially for must run.

16) One in ten years higher infeed at that period

week	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13
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																		

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

Table 6: Export needs at the night-time minimum (reference points on Sunday 5:00 CET)

5 SUMMER REVIEW 2016

The Review report is based on qualitative information submitted by TSOs in September 2016 to present the most important events that occurred during the past summer period and compare them to the forecasts and risks reported in the previous Seasonal Outlook. Important or unusual events or conditions on power system as well as the remedial actions taken by the TSOs are also mentioned. Each country detail review can be found in the appendix 1.

5.1 GENERAL COMMENTS ON PAST SUMMER CLIMATE

Summer 2016 had mainly average climate conditions with monthly temperatures close to normal temperature values[17]. Demand was around or a bit higher than the seasonal average in most European countries, with, however, a few exceptions such as Croatia, Hungary, Italy and the Netherlands where cooler temperatures and less peak load were reached compared to the same period of 2015. Some countries such as Austria, Latvia and Switzerland also experienced wet weather conditions through the summer – where higher precipitations caused more outputs from their hydro power plants.

17) Source: summer review comments by ENTSO-E member TSOs.

5.2 SPECIFIC EVENTS AND UNEXPECTED SITUATIONS DURING THE PAST SUMMER

Several isolated issues regarding the transmission network should be mentioned:

- At the beginning of June, floods in many French regions occurred, including Paris, with severe consequences leading the French Government to declare a state of natural emergency. For RTE, no incident was caused by this natural disaster: only some preventive measures were taken, especially in the Paris area.
- On week 32, multiple fires started in the South East of France, leading to the tripping or de-energising of 11 lines (8 lines 225 kV, 3 lines 63 kV) and one industrial customer long cut (35 MW during 4:20). The Crisis Cell of Marseille was set up to manage the issue.
- Belgium encountered very high temperatures (+30°C) for a few days during September – therefore a "super summer" criterion was applied to reduce the nominal rating power of transmission lines. Spain also suffered extreme temperatures when the summer peak demand was reached on 6 September.
- There were a couple of localised downward margin issues in Great Britain in July and August which were due to local constraints and high wind conditions in the North West corner of Scotland.
- During summer 2016, Hungary had to apply internal redispatch in order to maintain the security of supply due to unexpected power plant outage.
- High voltages were a bigger problem than usual during the summer in Sweden, especially in the area of Stockholm. The normal methods of handling high voltages – disconnection of parallel lines and reactive power control of nuclear power - was not enough. Disconnection of cables in the regional grid and redistribution of power to Finland was carried out.

5.3 TOPOLOGICAL CHANGE ON POLISH WESTERN BORDER

As announced in the Summer Outlook 2016 report, PSE, the Polish TSO, in cooperation with 50Hertz, one of the German TSOs, implemented on 22 June 2016 a special, temporary measure. The measure consisted of commissioning Phase Shifters (PSTs) on one among two cross border lines and disconnection of the second line. This additional measure was necessary for maintaining the secure operation of both transmission grids in case of high unscheduled flows through Poland from the west towards the southern border. The above mentioned measure are remedial actions only, the sustainable solution concerning unscheduled flows is structural market improvement (i.e flow based mechanism for adequate coordination of capacity calculation in relevant region with properly configured bidding zones). However, this solution will not be implemented before 2018. Read more in the Polish subchapter "Specific events and unexpected situations that occurred during the last summer".

In the Summer Outlook 2016, the Polish TSO reported possible balance problems during severe conditions, but the previous summer in Poland can be described as a normal one, with a short heat wave at the turn of June and July.

5.4 MAJOR PLANTS CLOSURE THIS SUMMER IN GREAT BRITAIN AND NETHERLANDS

In Great Britain, 970 MW coal generation closed in the summer of 8 June 2016. In Netherlands, three older coal-fired power plants (~1.6 GW) have shut down from January according to the Dutch Energy Agreement for Sustainable Growth. In the summer, another two coal units (~1.1 GW) were closed. Furthermore, this year there were political discussions whether to also close more coal units to meet the national goals for reduction of CO2 emissions. This summer, at least 5 GW of gas-fired installed capacity has been mothballed due to the weak economic position of gas units, relative low demand and the increasing amount of renewables, mainly wind power.

6 GAS DISRUPTION RISK ANALYSIS

In the two previous Winter Outlooks, a gas disruption sensitivity analysis was performed to respond to the risks that could occur because of the Ukraine/Russia crisis. The present one is an update of the approach for the coming winter assumptions.

6.1 METHODOLOGY: A CLOSE COOPERATION WITH ENTSOG

In its recently published 'Winter Supply Outlook 2016/17 & Winter Review 2015/16' ENTSOG performed a gas disruption sensitivity analysis for the following extreme high-demand situations:

» 2-week Cold Spell occurring during the second part of February with a simultaneous interruption of transit through Ukraine

» 1-day Design Case (peak demand) occurring on the 31 January with a simultaneous interruption of transit through Ukraine

ENTSOG used a European network modelling approach of gas supply, demand and infrastructures. Under high-demand situations and disruptions, the modelling is done on the basis of a cooperative crisis management: in case a country faces a demand curtailment, all the other countries will co-operate to minimize the relative share of disrupted demand, even if they have to face a demand curtailment themselves.

ENTSO-E performed a qualitative sensitivity analysis based on the ENTSOG gas disruption risk analysis with the following inputs:

- list of countries where gas supply could be put at risk in the case of extreme conditions (high gas demand and transit disruptions of Ukraine)
- range of probable percentages of gas disruption as a function of the country gas demand

For the countries at risk, these ENTSOG results were translated by ENTSO-E into the qualitative impact on the electric system, especially:

- the risk of reduction of gas-fired power units (e.g. CCGT, GT, CHP, etc.), being aware that power generation represents only a limited part of the country's gas demand; and
- the risk of an increase in electricity demand[18] from households, industry and district heating as a consequence of the gas disruption. Typically, each country follows a 'protected consumers' distribution procedure when spreading the gas disruption among the different sectors. The residential sector - as well as facilities like hospitals - is typically the most protected and the last to be affected by any gas disruption in each country. Gas power plants can also be protected consumers, depending on the national situations and regulations.

The aforementioned impacts of gas on electricity were based on the TSO qualitative estimation per country.

18) The increase is limited to the gas demand that can be satisfied with electricity and does not include the total final gas demand.

6.2 RESULTS: POTENTIAL GAS SUPPLY RISK FOCUSED ON SOUTH EAST EUROPE

Regarding the gas storage inventory on 1 October 2016, the Underground Gas Storage (UGS) inventory is significantly higher than the previous year (91 % Vs 82 %)[19]. The ENTSOG Winter Supply Outlook states a high EU-28 gas storage inventory level, slightly lower than the 5-year high of 1 October 2014.

The ENTSOG analysis of gas transit disruption through Ukraine provided the following main results[20]:

The named countries in Table 7, where disruption of gas transit through Ukraine during a high demand situation could lead to gas demand curtailment, were analysed further by ENTSO-E in a qualitative way.

Country	Gas demand curtailment risk in peak conditions with disruption through Ukraine	
	1-day Design Case (peak demand)	2-week Cold Spell
Bulgaria	> 25 %	> 25 %
Greece	5 % to 25 %	No gas curtailment
FYRO Macedonia	> 25 %	> 25 %
Romania	5 % to 25 %	No gas curtailment

Table 7: ENTSOG analysis of gas transit disruption through Ukraine

19) Source ENTSOG Winter Supply Outlook 2016/17

20) Gas curtailment less than 5% is considered to have a negligible impact on the electricity system

6.3 QUALITATIVE IMPACT OF GAS CURTAILMENT ON ELECTRICITY SUPPLY

Assuming the case of a high demand situation with a simultaneous interruption of gas transit through Ukraine, an assessment of the impact on the adequacy of the electricity system was performed.

The following country statements are based on ENTSO-E TSO contributions:

Bulgaria

In case of a total interruption of supply to gas-fired combined heat and power plants, with the use of substitute fuel, the effect of decreasing the total electricity power output for Bulgaria is estimated at 83 MWe[21].

Besides, considering the important remaining capacity of electricity under severe conditions (around 2 GW) and the further simultaneous import capacity, no risk of adequacy was identified in Bulgaria, even in the case of a 2-week cold spell with a simultaneous interruption of gas transit through Ukraine. Household gas heating in Bulgaria is fairly insignificant so a possible disruption of gas supply will not lead to a serious spike in electricity demand.

However, industrial gas consumers might have to reduce their consumption in this specific situation.

Greece

The gas supply of the Greek gas system comprises north pipes and an LNG terminal, including tank storage. The ability of this infrastructure to mitigate gas curtailment is already considered as part of the ENTSOG simulation. Furthermore, other fuel (like diesel) can be used as backup to cover 15 % to 20 % of the electricity net generating capacity from gas.

Gas heating in the Greek household sector is moderate, and a possible partial shift to electricity for heating would slightly increase the Greek demand (electricity).

FYR of Macedonia

Gas house heating is limited (about 60 MW[22]) and concentrated in the capital. The 230 MW electricity generation by gas is in one unit which has been out of operation for the last three years because of high market gas prices. Other gas demand (less than 300 MW) concerns the industry sector, and part of this demand can be substituted by heavy oil and a smaller part by electrical energy.

Regarding electricity demand under severe conditions, FYR of Macedonia is already depending on import to satisfy its system adequacy. Even if a total gas disruption would stress the electrical situation a bit more, it would not put the system at risk. However, industrial gas consumers might have to reduce their consumption in the event of a cold spell with a simultaneous interruption of gas transit through Ukraine.

Romania

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

21) MWe stands for Megawatt electricity power, as the plant also produces heat power.

22) ENTSO-E TSO source

6.4 EUROPEAN ELECTRICITY SYSTEM ROBUST TO GAS DISRUPTION IN UKRAINE

In conclusion, the sensitivity analysis showed the robustness of the European Electricity System, even in the event of a high demand situation with a simultaneous interruption of gas transit through Ukraine.

Several Southeast European countries were identified as possibly being affected by partial gas curtailment in such a situation. However, these countries can rely on other fuels for electricity generation and only a limited number of households use gas for heating, so that the electrical system adequacy and security can be maintained.

For the preparation of future Winter Outlook reports, ENTSO-E and ENTSOG strive to further increase their cooperation.

7 APPENDICES

APPENDIX 1: INDIVIDUAL COUNTRY COMMENTS ON THE WINTER OUTLOOK AND SUMMER REVIEW

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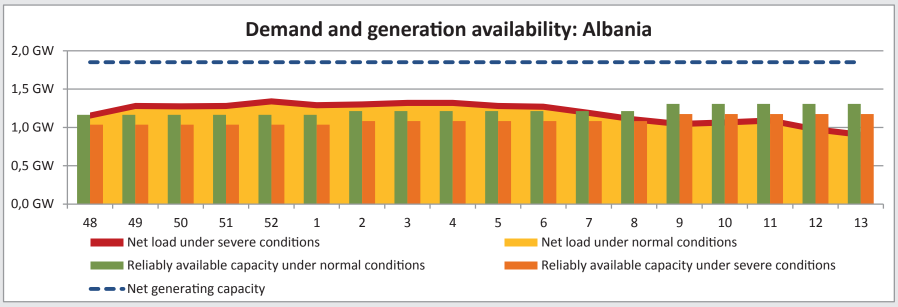
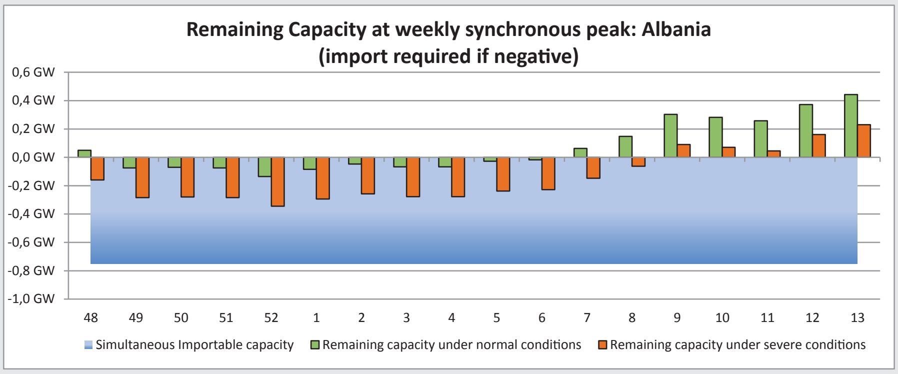
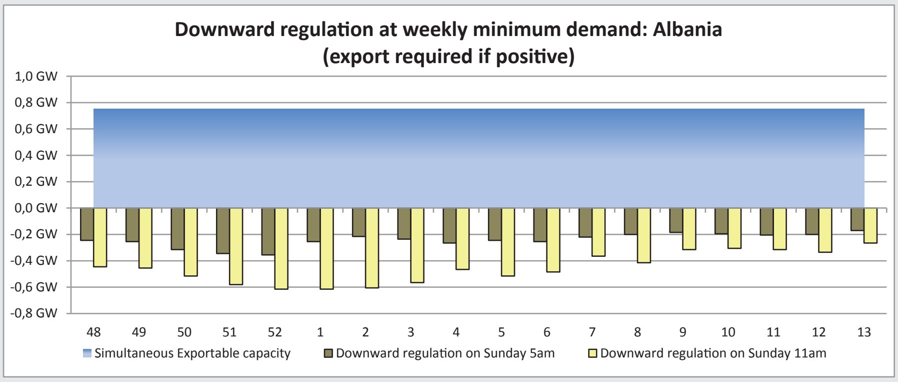
ALBANIA: WINTER OUTLOOK 2016/17

Regarding winter 2016/2017, Albania does not foresee any unexpected event or issue to endanger system adequacy. System adequacy will mainly be fulfilled by hydro generation and the import contracts. In recent years, there has been an increase in the installed capacity and at the same time a decrease in country consumption, consequently Albania's dependency on import is slightly reduced. The maintenance schedule is reduced to a minimum, providing enough capacity for import, or in case of high hydro levels for export.







ALBANIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

This summer is considered to be a normal one (maximum temp 38°C), related with ambient temperatures and with the main energetic parameters of our power system.

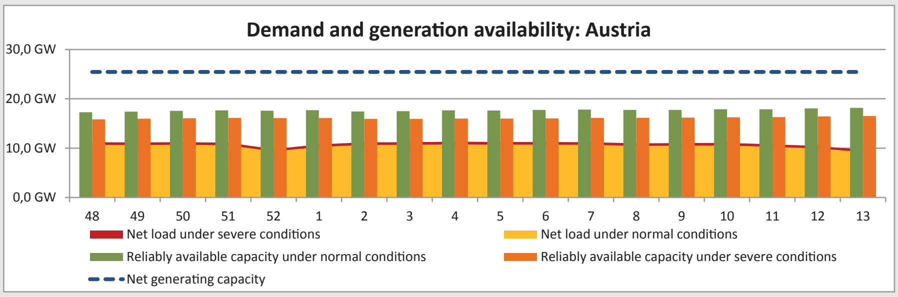
Inflows in the Drin River cascade, which is the main source of the country's generation, were somewhat above the predictions, which helped us maintain relatively high levels in the reservoirs of this cascade, and consequently to maintain a high level of energetic reserve for the country.

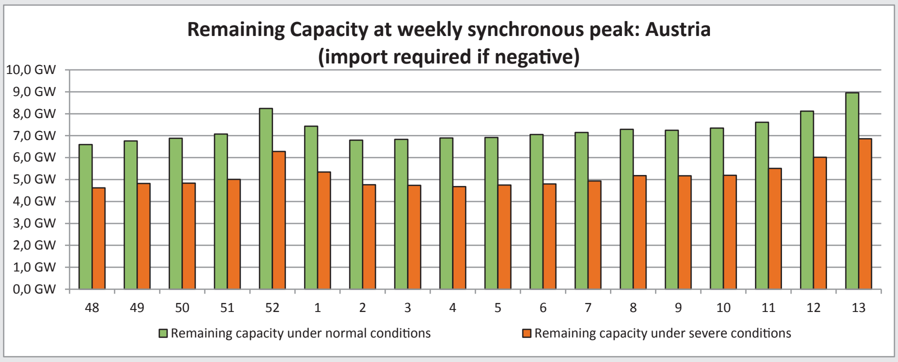
Specific events and unexpected situations that occurred during the last summer

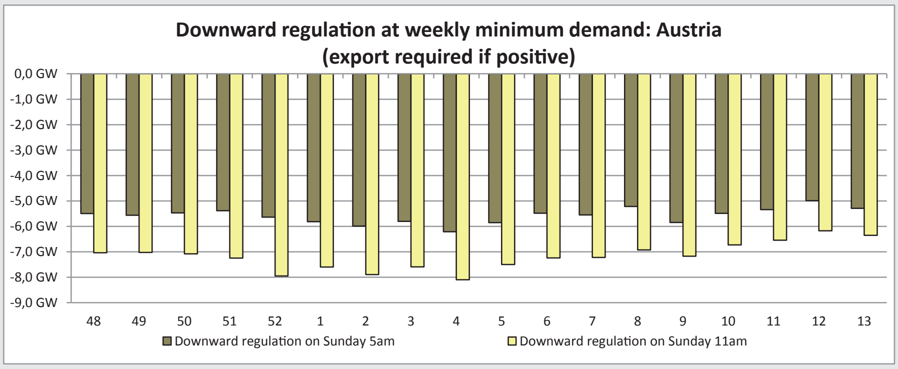
During the summer, we did not face any unexpected situation that placed the power system in a difficult situation. Peak load and electricity consumption was normal for the summer. We did not face any problem with interconnection capacity; the maintenance of interconnectors was accomplished according to the schedule, as well as the main part of the internal lines.

AUSTRIA: WINTER OUTLOOK 2016/17

In Austria this winter there is a high availability of gas power plants due to grid reserve reasons. Thus, we don't expect any generation adequacy problems in this period. Regarding demand, we assume an increased load of +0.56 % compared to winter 2015/2016. Severe conditions are taken into account with an increase of 5 % of the normal load.







AUSTRIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

Summer 2016 was very warm and wet with little lightning. The temperature level was 0.9°C above average with only a few hot periods. Due to the high precipitation (20 % more than normal) hydro production was far above the seasonal average.

BELGIUM: WINTER OUTLOOK 2016/17

The Belgian power system expects no adequacy issues for winter 2016/2017. Thanks to the return of nuclear power plants Doel 3 & Tihange 2 last year (each ~1000 MW) the balance between generation and consumption should be ensured[23]. However, in a severe winter situation, Belgium is still dependent on imports to cover the demand.

The forecasted NTC values are based on the max import calculation of flow-based approach. For winter 2016/17 Belgium still has 750 MW of strategic reserves contracted to be used in case of scarcity situations. The strategic reserves are taken into account in the graphs. Without the strategic reserves, the margins for Belgium would be smaller.

The last major change since winter 2015/16 is the decommissioning of the last coal unit in Belgium Langerlo (470 MW).

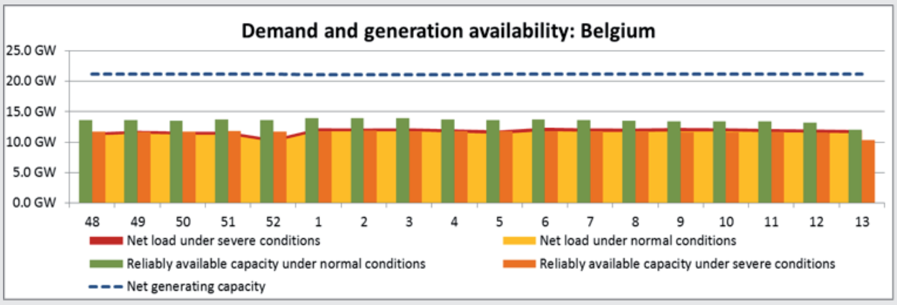
23) A full availability of the nuclear park was expected at the moment of data collection. However, there are some uncertainties concerning this hypothesis, which will have a direct impact on the remaining margin.

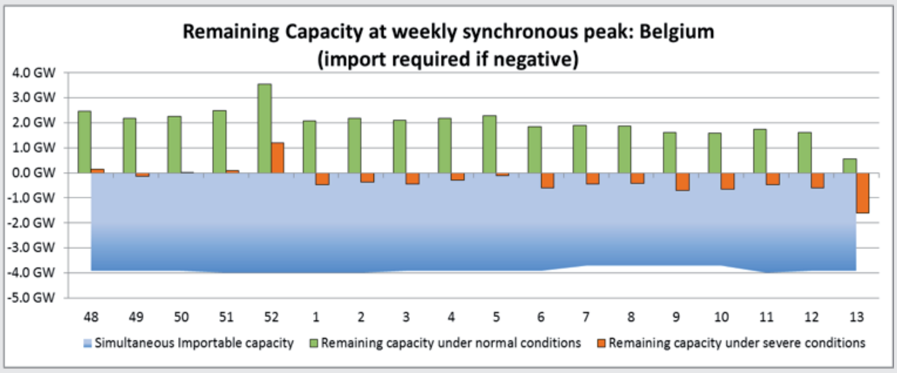
Most critical periods for maintaining adequacy margins and countermeasures

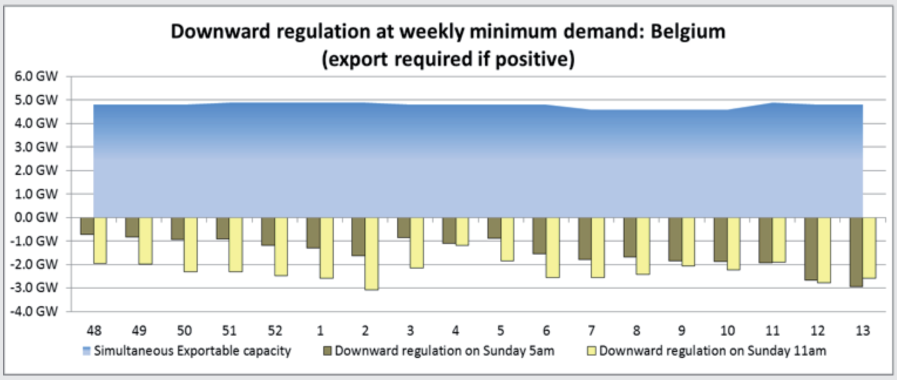
The most critical period concerning maintaining adequacy is during week 13, due to a planned overhaul of Doel 4 (~1 GW). In general, the months December and January are the most stressful due to the high consumption levels. As mentioned in the assumptions section, we still have 750 MW strategic reserves available to secure Belgian adequacy. "Ampacimon modules" (dynamic line rating) are installed on our interconnection lines which, depending on positive weather conditions (wind & temperature), increases the nominal power of the interconnection lines.

Most critical periods for downward regulation and countermeasures

Regarding incompressibility issues, the period around the holidays, in particular Christmas Day, has an increased risk of oversupply.







BELGIUM: SUMMER REVIEW 2016

General comments on 2016 summer conditions

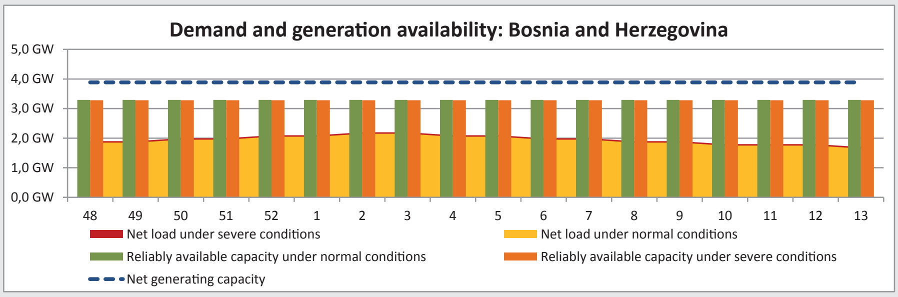
We didn't encounter any problems of incompressibility during the summer of 2016.

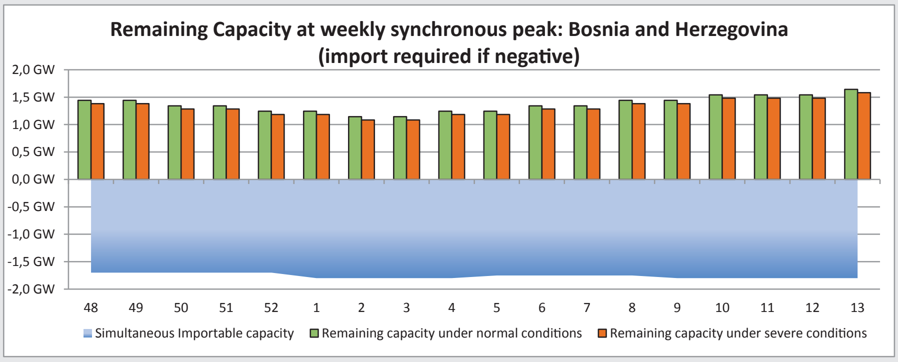
Specific events and unexpected situations that occurred during the last summer

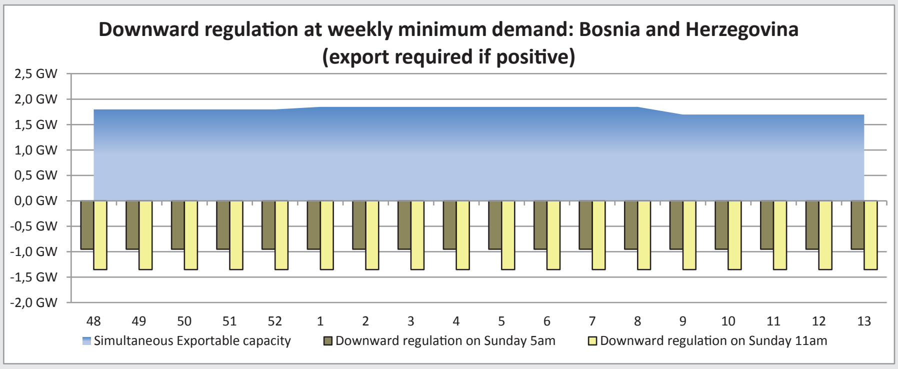
During September, for a few days we encountered very high temperatures (+30°C); therefore a "super summer" criterion was applied to reduce the nominal rating power of our lines.

BOSNIA AND HERZEGOVINA: WINTER OUTLOOK 2016/17

Regarding power system adequacy in Bosnia and Herzegovina for the winter 2016/2017, we do not expect any problems. We predict that in the next winter period our consumption will stay at approximately the same level as last year, and it is expected to be a positive power balance.







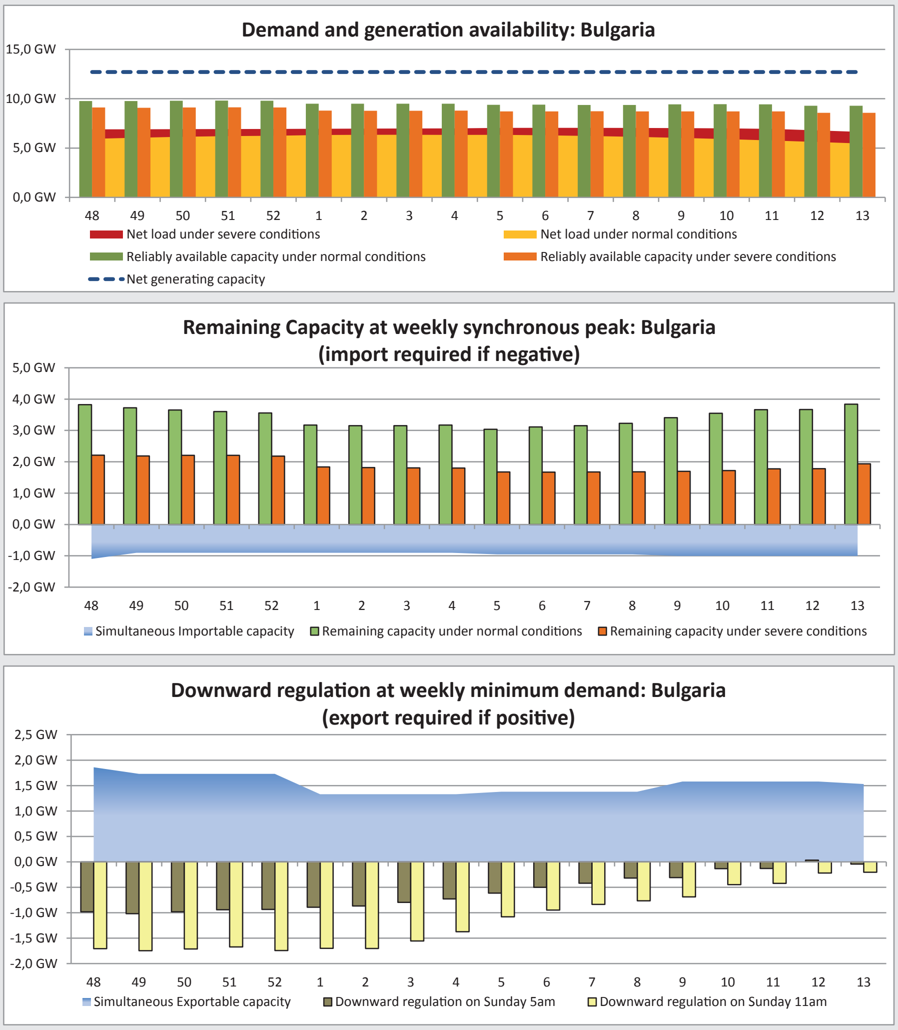
BOSNIA AND HERZEGOVINA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During the summer of 2016, there were no unexpected situations that affected the power system in Bosnia and Herzegovina. The minimum load of 850 MW was registered on June 5, at 6:00, while the maximum load was registered on July 13, at 15:00, and it was 1607 MW. Monthly power balances were positive during this period.

BULGARIA: WINTER OUTLOOK 2016/17

No adequacy issue is expected in the Bulgarian electrical system for the coming winter.



BULGARIA: SUMMER REVIEW 2016

The electricity demand for the summer period June 2016 – August 2016 decreased by 1.77 % compared with the same period in 2015 (comparison based on normal temperature-adjusted monthly consumption). The hottest working day was 1 August (Monday) with temperatures: T_{min} = 19.0°C, $T_{average}$ = 26.8°C, T_{max} = 34.9°C. For this day, the peak load was 4758 MW (observed at 16:00 CET) and the daily consumption was 99757 MWh. No balancing problems were experienced during the studied period and no generation was curtailed. There was no critical outage in the transmission network and interconnection lines. During the whole period, Bulgaria exported electricity to neighbouring countries.

CROATIA: WINTER OUTLOOK 2016/17

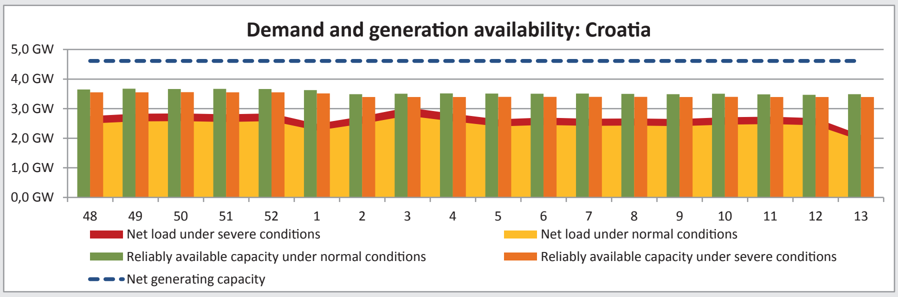
Croatian transmission system operator (HOPS) does not expect any difficulties in power supply during the winter 2016/2017. Due to the dry weather, but also some other economic reasons, import of electricity could be increased. Tie-lines connecting the Croatian power system with other countries have enough capacity both for the supply of domestic consumers and for the transit of electricity. A significant increase of consumption compared to previous years is not expected.

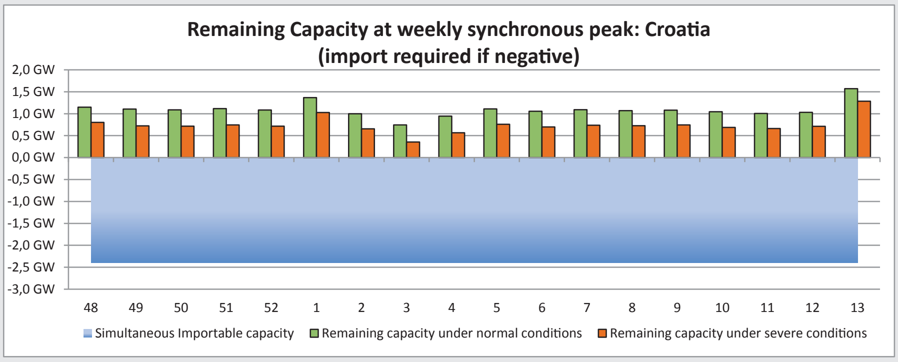
Most critical periods for maintaining adequacy margins and countermeasures

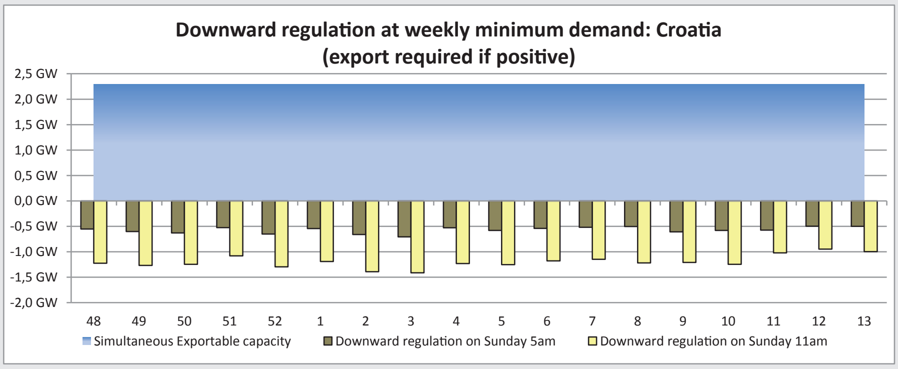
No adequacy risk was identified.

Most critical periods for downward regulation and countermeasures

No adequacy risk was identified.







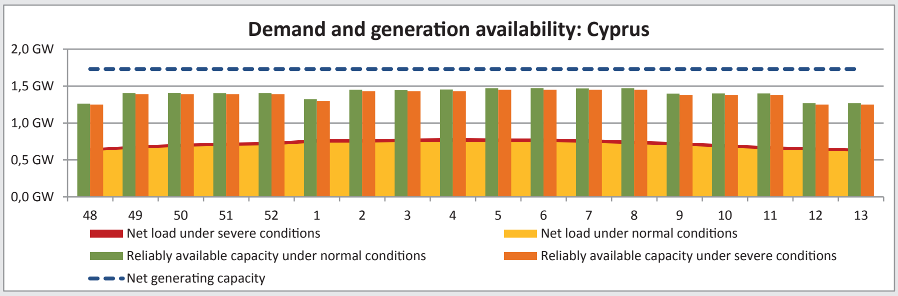
CROATIA: SUMMER REVIEW 2016

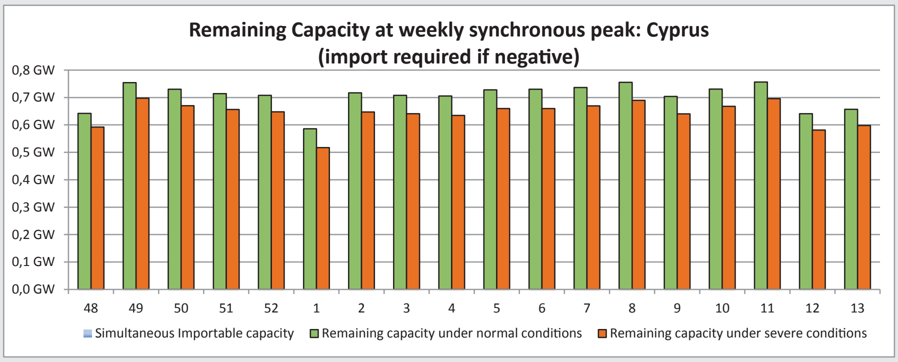
General comments on 2016 summer conditions

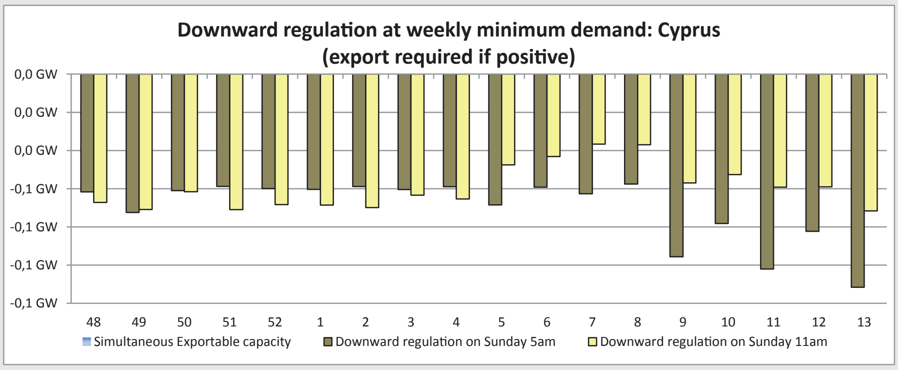
During summer 2016, there were no significant events in the Croatian power system. As the air temperatures were somewhat lower than in 2015, the consumption was slightly decreased. On the other side, domestic production from hydro power plants was increased by 25 % and from wind power plants by 31 %.

CYPRUS: WINTER OUTLOOK 2016/17

No specific period is considered critical during the winter period.







CYPRUS: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During the past summer, no specific period was considered critical.

CZECH REPUBLIC: WINTER OUTLOOK 2016/17

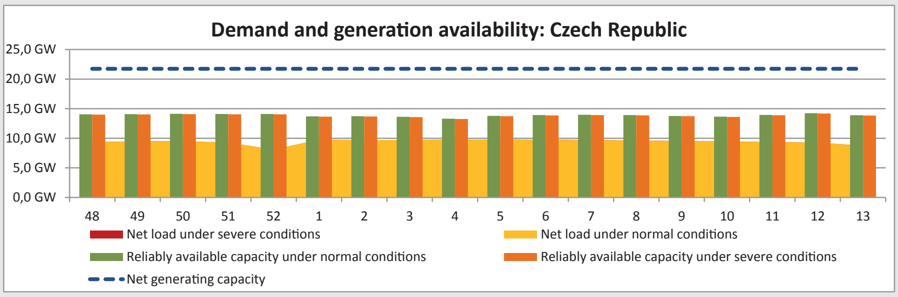
Czech Republic TSO does not expect any adequacy problem, especially related to the gas supply of gas power plants. Due to the effective coordination between generation and transmission, there are no issues associated with utilising interconnection capacity. The forecasted NTC values represent the best estimate values reflecting available information (e.g. maintenance plan) for the time being. These values may be subject to a later update.

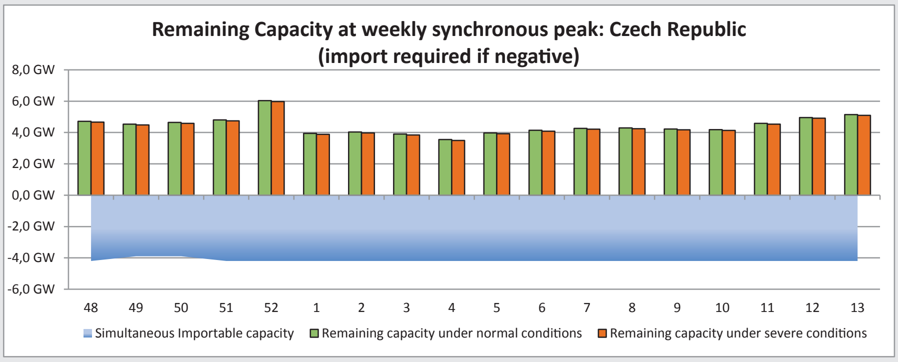
Most critical periods for maintaining adequacy margins and countermeasures

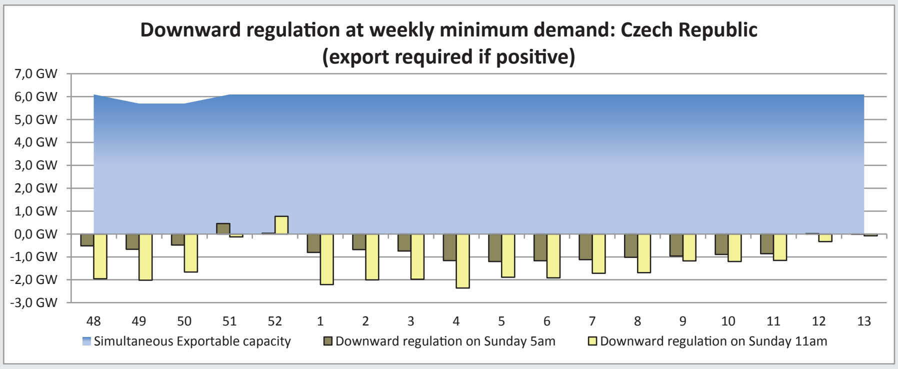
We do not expect problems with the upward adequacy in the winter period.

Most critical periods for downward regulation and countermeasures

The most critical period for downward regulation is predicted between weeks 51–52.
However, we do not expect any problem at this period.







CZECH REPUBLIC: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During the summer, there was generally less available power mainly due to power plant outages and higher levels of planned outages. Unavailable capacities were replaced by the higher output of other power plants or, rarely, by imports.

Specific events and unexpected situations that occurred during the last summer

Nuclear power plants had to deal with longer planned unavailability than expected, mainly because of some x-rays which had to be taken due to regular inspection.

DENMARK: WINTER OUTLOOK 2016/17

Energinet.dk expects a stable winter. The Power situation seems fine and expected Power Plant outages are at a minimum. There are some grid outages that affect the capacity but generally it looks reasonable.

Most critical periods for maintaining adequacy margins and countermeasures

The border between Energinet.dk and 50 Hertz (DK2-DE) will be limited for 2–3 months due to an upgrade of the control system. The capacity will range between 0 and 585/600 MW from November 2016 to 2017. The system will be installed in November 2016.

The border between Energinet.dk and Svenska Kraftnät will be reduced due to work in Sweden. The work reduces the capacity on the border connection. This reduction will affect the power balance in DK2.

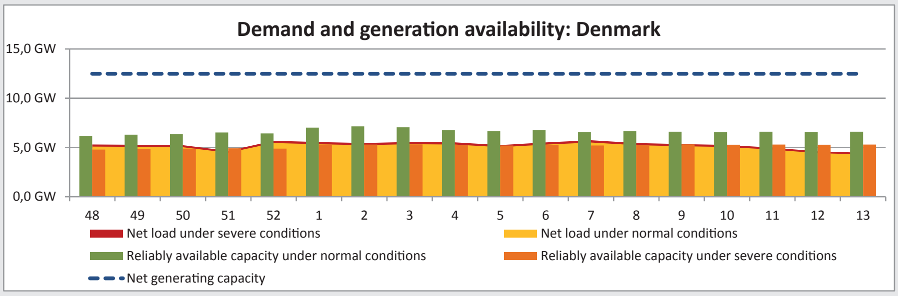
Due to the load flow conditions and wind outputs in the North of Germany, the capacity between Energinet.dk and TenneT can vary between 150 MW and 1500 MW (DE -> DK1) and 0 MW and 1640 MW (DK1 -> DE). It is not possible to predict the capacity for a specific hour at this border and that's why it has been set to the nominal capacity of this line.[24)]

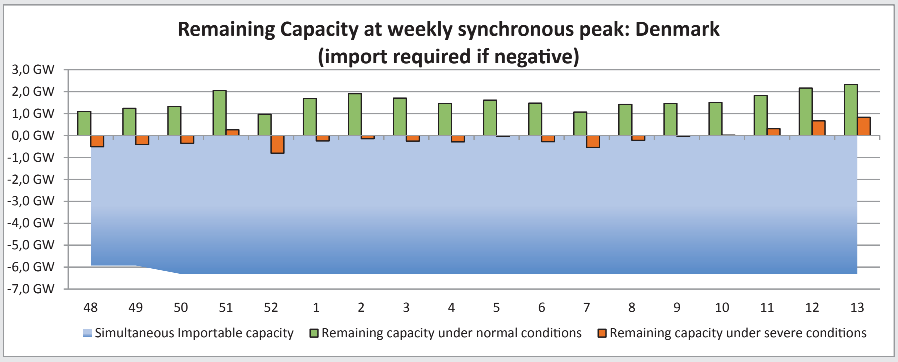
Most critical periods for downward regulation and countermeasures

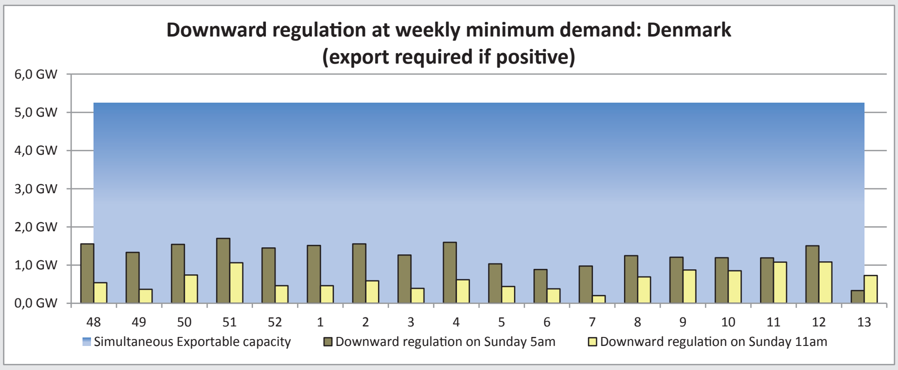
Energinet.dk doesn't expect any problems with downward regulation, but it could be critical in the Christmas period. Wind generation combined with thermal power could cause some downward regulation problems, but these should be resolvable.

In periods with high wind generation, Energinet.dk expects countertrade on the Danish-German border. The reason for that is a high amount of wind capacity in the Northern part of Germany. Energinet.dk will downward regulate the countertrade amount in DK1 and DK2.

24) Indicative NTC tables between DE and DK can be downloaded from Tennets homepage.







DENMARK: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In general, it has been a very still summer. No major disturbance and a satisfactory power situation.

The prices in Denmark have been increasing due to lower wind infeed, especially compared to 2015.

The power balance has been good over the summer, thus there has been recorded high price differences between DK1 and DK2 in the end of June, which was caused by increased consumption in Sweden and the Baltics concurrent with planned outages of Swedish Nuclear plants.

DK1 overhead line from Ferslev to Tjele is proceeding as scheduled. The import capacity in DK1 from SE3 will decrease to 300 MW from mid-September 2016 to early December 2016, due to work in the AC lines in DK1.

DK2 work in 400 kV station Ishøj is proceeding as scheduled. 400 kV station Ishøj is decoupled due to rebuild and maintenance. The work affects the infeed to Copenhagen City and the capacity on Kontek.

The load flow condition and wind infeed in Northern Germany have caused bottlenecks at the border, and great amounts of countertrade between Energinet.dk and TenneT.

Specific events and unexpected situations that occurred during the last summer

There were no specific events or unexpected situations last summer.

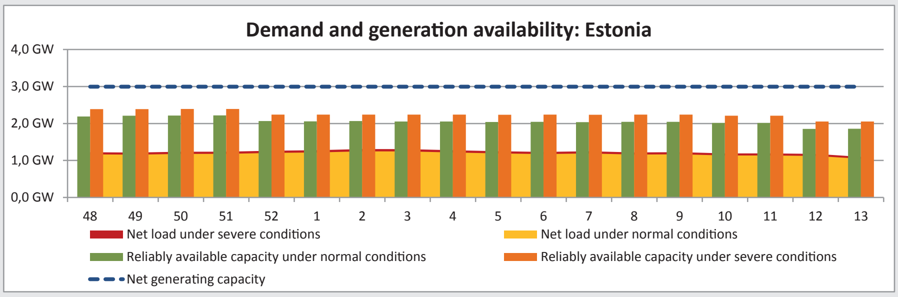
ESTONIA: WINTER OUTLOOK 2016/17

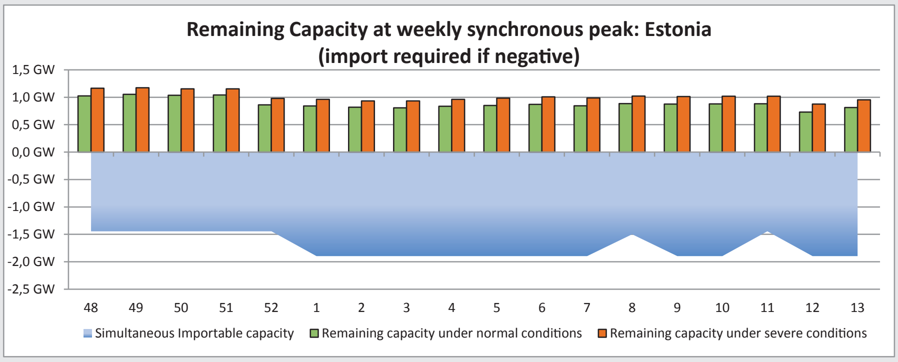
The coming winter 2016/2017 is expected to be normal with no extraordinary circumstances. Generation capacity in Estonia is considered sufficient to cover peak loads during the winter season and the power balance is expected to be slightly positive. The highest peak load is commonly expected in the second half of January or in the first half of February.

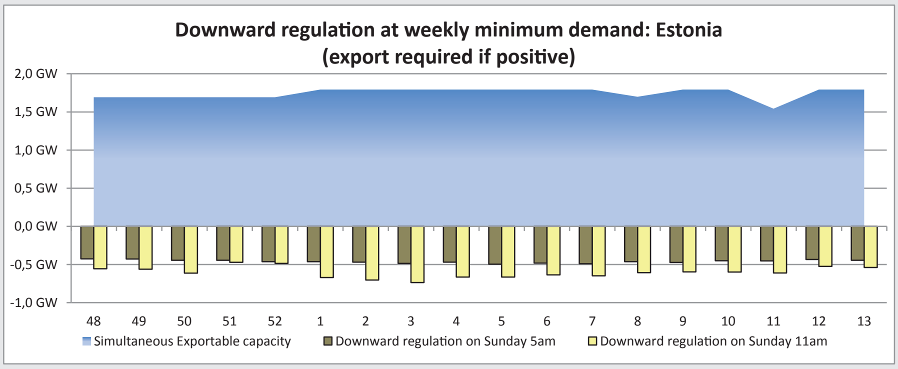
Most critical periods for maintaining adequacy margins and countermeasures

Transmission capacity between Estonia and neighbouring systems will be smallest on week 11, when maintenance work in the Estonian network is planned and thus transmission capacity between Estonia and Latvia will be limited. The exchange capacity between Estonia and Finland will be maximum. The capacities may be reduced for some periods due to some maintenance works in the Estonian grid.

Most critical periods for downward regulation and countermeasures No critical periods are expected.







ESTONIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The average temperatures of the summer months were very similar to the average temperature over many years (around 16°C). The highest measured temperature this summer was 29,2°C in July and the lowest temperature was -0,5°C in June. However, the amount of precipitation was higher than usual.

Specific events and unexpected situations that occurred during the last summer

There were no significant events concerning generation, demand or transmission.

FINLAND: WINTER OUTLOOK 2016/17

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

Compared to the previous winter, the situation has remained the same. The peak load estimate in severe weather conditions is slightly increased to 15.1 GW based on the new peak load record that took place in winter 2015/2016. Available generation capacity is expected to be the same, 11.6 GW, as in the previous winter. Changes in installed capacity are mainly due to 0.5 GW new wind power plants but that only has a minor influence on the estimated available generation. The 3.5 GW deficits are expected to be met with import from neighboring areas. However, in case of a major power plant or interconnection failure in a cold period, there is a risk of power shortage.

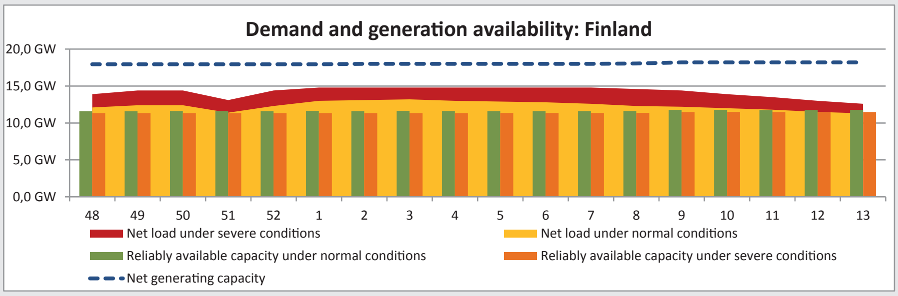
Most critical periods for maintaining adequacy margins and countermeasures

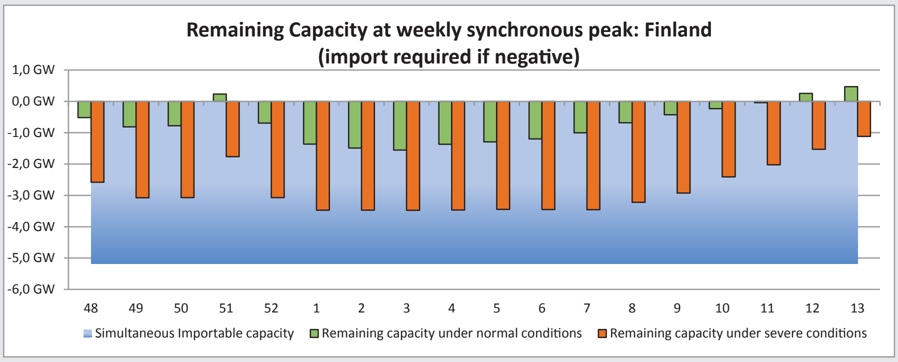
Import is needed to cover the demand during peak periods. The maximum deficit in severe conditions is 3.5 GW from week one to seven. The import capacity on interconnections, 5.1 GW, is sufficient to meet the deficit.

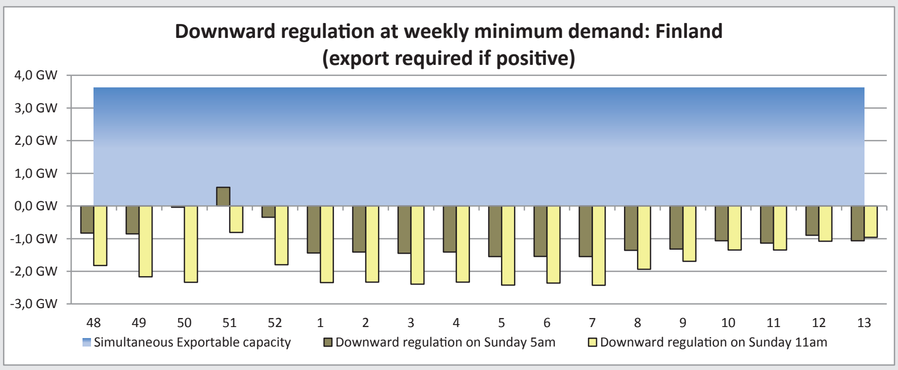
The required amount of import is expected to be available from neighboring areas also in severe weather conditions. However, it should be noted that there are uncertainties with Russian import due to the impact of capacity payments on the Russian electricity markets.

Most critical periods for downward regulation and countermeasures

No specific problem should occur in the minimum demand hours because the installed wind and solar power capacity is still relatively low in Finland.







FINLAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

There were neither adequacy problems nor deviations from expectations during summer 2016.

Specific events and unexpected situations that occurred during the last summer

Several overhauls of both production units and transmission lines were carried out in the summer as predicted. All incidents were managed with normal system operation procedures.

FRANCE: WINTER OUTLOOK 2016/17

France expects this winter to have the lowest nuclear power availability in 10 years, which represents -5 GW compared to the previous winter. This evaluation encompasses the latest request from the French Nuclear Safety Authority, leading to the temporary shutdown of several nuclear plants this winter to conduct safety tests.

Together with the latest maintenance plan available, France expects rising but not critical risk on margins this winter. Any further delays in the recommissioning of the units under test or maintenance will indeed have a direct impact on margins.

Most critical periods for maintaining adequacy margins and countermeasures

French adequacy is very dependent on weather conditions, as a drop in national temperature by -1°C leads to an increase of the load by 2.4 GW. Considering the maintenance plan dated October 21 2016 and severe conditions (20-year cold wave), the most critical periods for adequacy should be early January (week 1 to 3), with a high need of imports in case of a cold wave.

French Update[25], 4 November 2016:

The availability of the French nuclear units has been deteriorating late October and early November. Some units under scrutiny by the French Nuclear Safety Agency have seen their return to operation delayed until the end of 2016. Up-to-date maintenance schedules are available here. Subsequently, margins in France have decreased significantly in the first three weeks of December when France is dependent on imports. Adequacy risk is assessed at 4 % in the Weeks 49 to 51 of December compared to 3 % in Week 2 of January. Due to the high sensitivity of load to temperature in France (up to 2 400 MW/°C), risk can appear during cold waves at least 3°C and 5°C below normal conditions in December and January respectively.

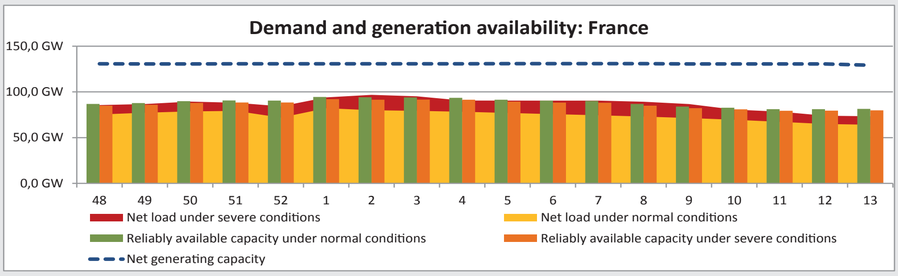
In case of adequacy issue, RTE can use exceptional and emergency Demand Side Management, not assessed in this study. Moreover, RTE can drop the voltage for several hours by -5 % to lower the load and to maintain adequacy. Eventually, in the worst and unlikely case, RTE could curtail load locally in a preventive way to secure the system.

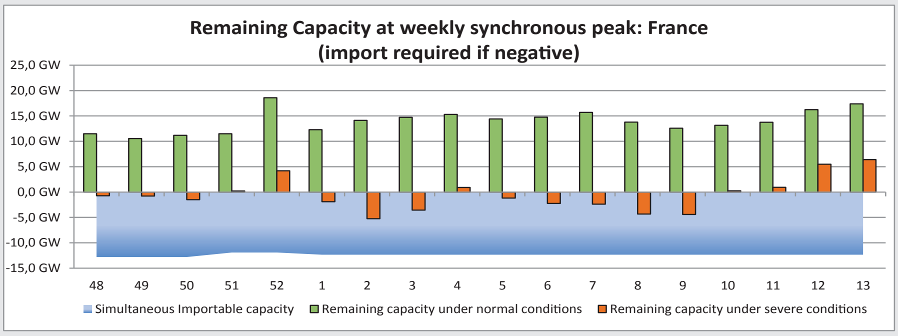
Most critical periods for downward regulation and countermeasures

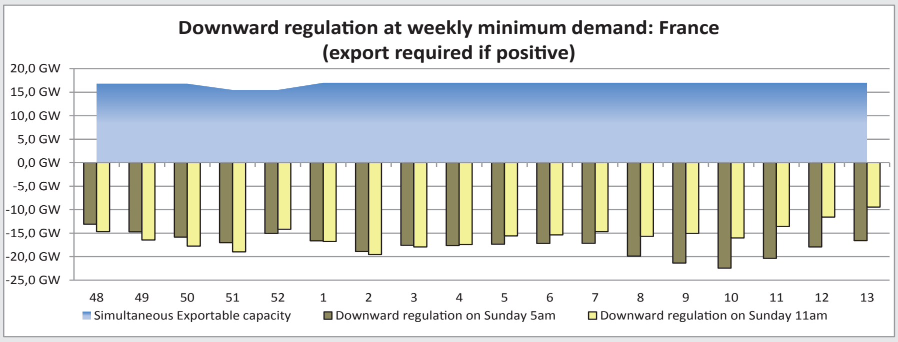
No critical period is expected for downward adequacy.

Additional details on analyses performed by RTE on an hourly and pan European basis are available in the France's Winter Forecast here.

25) For more details see the France Winter Forecast released by RTE: here







FRANCE: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The weather conditions in June led to lower temperatures (-1°C in comparison with normal seasonal temperatures) and to an increase of consumption. This month, fossil fuel power generation production doubled in comparison with June 2015 because of needs at peak of consumption. For July and August, the peak temperature is reached in week 34 with a mean temperature at +4°C from normal seasonal temperatures. Consumption increased by 1.8 % from August 2015. As in previous months, fossil fuel production increased from 2015. Solar power generation, due to high hours of sunshine, increased in August by 27 % in comparison with last year: during July and August more than 1 TWh had been produced each month, a threshold that has never been reached before. Wind power from June to August, because of unfavourable wind conditions, did not produce high levels of electricity. In this period, nuclear power energy production levels were lower than summer last year.

Specific events and unexpected situations that occurred during the last summer

Three major events occurred this summer:

At the beginning of June, floods in many regions occurred, including Paris, with severe consequences leading the French Government to declare a state of natural emergency. For RTE, no incident was caused by this natural disaster: only some preventive measures were taken, especially in the Paris area.

On the 18th and 19th of July, local Crisis Cells were set up to solve an issue regarding some measuring transformers: because of the heat and some structural weaknesses, 15 measuring transformers were rapidly deteriorated (including 2 customer transformers) with 64 MW of power cut on the 18 July and 68 MW on the 19 July.

On week 32, multiple fires started in the South East of France, leading to the tripping or de-energising of 11 lines (8 lines 225 kV, 3 lines 63 kV) and one industrial customer long cut (35 MW during 4:20). The Crisis Cell of Marseille has been set up to manage the issue.

GERMANY: WINTER OUTLOOK 2016/17

The balance between generation and demand is generally expected to be maintained during the winter period in case of normal and severe conditions.

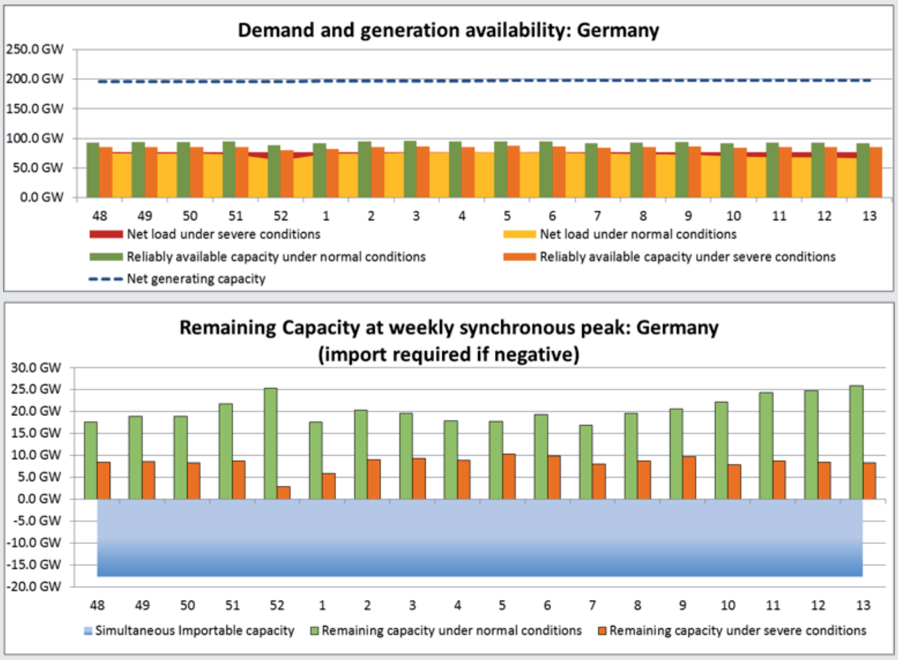
Most critical periods for maintaining adequacy margins and countermeasures

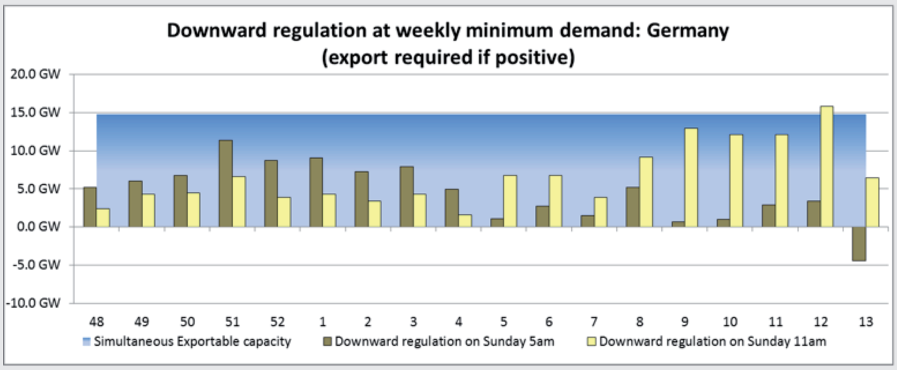
From the experience of past winters, the period around Christmas could be critical due to a massive oversupply of the German control area. This could result in strong negative prices for electricity and could contribute to a high upward frequency deviation. In such an event, the German demand for negative control reserve might not be covered by the usually procured reserves. Therefore, a higher amount of reserves is going to be procured in this period. Additionally, there will be extended possibilities to reduce wind power feed-in in such situations. In situations of high RES feed-in in the north and high load in the south of Germany, the need of remedial actions is expected to maintain (n-1) security on internal lines and on interconnectors. High amounts of non-availabilities (maintenance and overhauls) for nuclear power plants are foreseen at the end of the year/beginning of next year. Possible reasons might be changes in the legal framework for nuclear power plants.

Most critical periods for downward regulation and countermeasures

The interconnectors are expected to play an important role for the export of excess generation during demand minimum periods. According to the quantitative analysis of the downward regulation capabilities, especially on 11am on Sunday, a great amount of excess generation is expected[26]. In cases of high excess generation, specific laws and regulations allow the German TSOs to reduce the RES feed-in in order to mitigate any negative effects on the network. Therefore, no critical situations are expected.

26) In case of high wind on Sunday 26 March at 11 am (week 12), simultaneous export capacity of Germany (14.78 GW) might be too low to export all renewable (cf. following graph)





GERMANY: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In the past summer there were no significant events concerning the system adequacy. According to the German weather forecast service ("Deutscher Wetterdienst", DWD), the average mean temperature in July was 18.6°C, which is 0.6°C more than the average of the years 1981 to 2010. The highest temperature was 36.4°C, and the lowest temperature was 3.0°C. Generally, temperatures in the south tended to be higher than in the north.

Specific events and unexpected situations that occurred during the last summer

The installed capacity of PV plants has moderately increased from 38.1 GW in the summer 2015 to a value of 38.4 GW in this year's July.

After the excessive need for remedial actions to ensure (n-1) security last summer, this summer was rather quiet.

GREAT BRITAIN: WINTER OUTLOOK 2016/17

We expect the winter to be tight but manageable and we have the tools we need to balance the system.

NORMAL condition used 30 years average demand. The SEVERE condition used is a 1 in 10 figure. Customer Demand Management (CDM) is expected during SEVERE condition.

Generation includes 3.5 GW of Supplemental Balancing Reserve (SBR) which is a standard balancing service.

Most critical periods for maintaining adequacy margins and countermeasures

For Normal condition, Week 50 has the lowest remaining capacity (1.49 GW). Imports from interconnectors will improve the margin further.

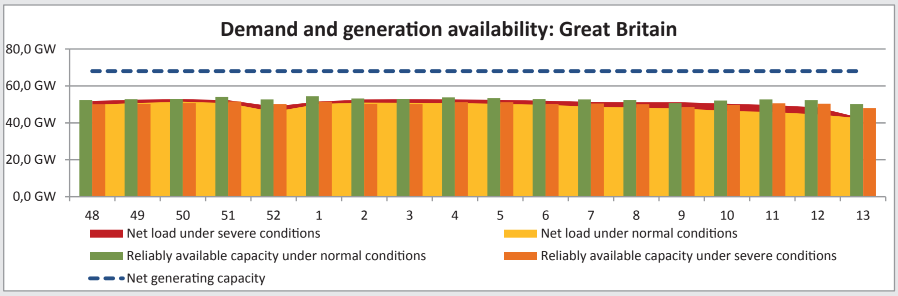
For Severe condition, Week 3 has the lowest remaining capacity (-2.60 GW). This can be managed by imports from Interconnectors, Supplemental Balancing Reserve (SBR) and we would expect the market to respond as well.

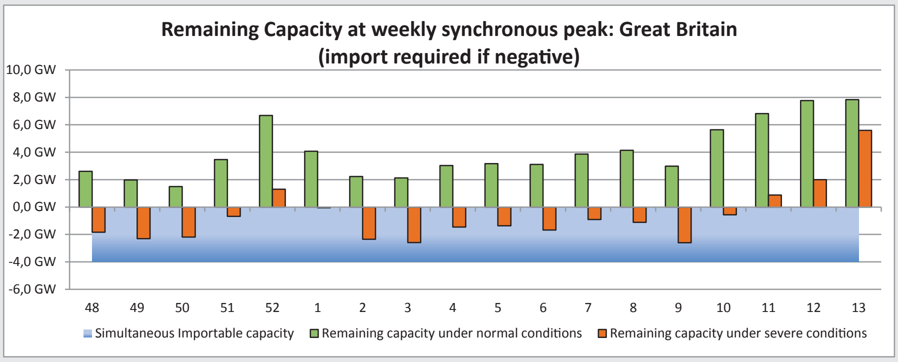
Weeks 48, 49, 50, 2 to 10 are also tight but manageable.

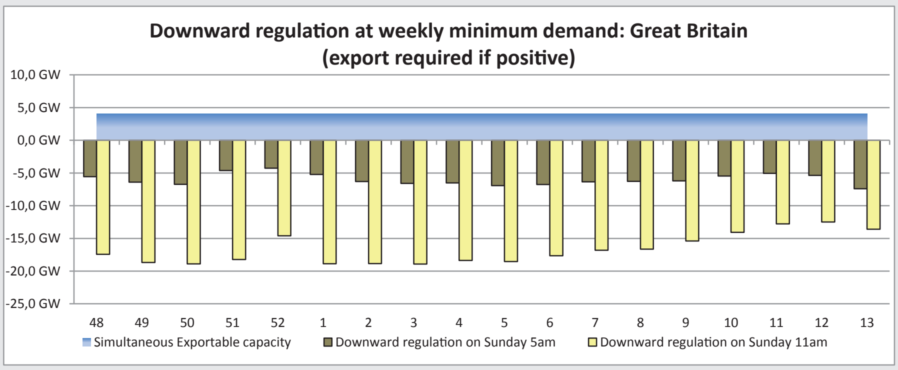
Most critical periods for downward regulation and countermeasures

At night minimum period Week 52 has the lowest downward regulation capabilities (4.27 GW) due to the low load around the Christmas holiday.

At daytime minimum period Week 52 has the lowest downward regulation capabilities (14.60 GW).







GREAT BRITAIN: SUMMER REVIEW 2016

General comments on 2016 summer conditions

Mean temperature was slightly above normal. There was a short hot spell in mid-June.

- Rain was above average.
- Sunshine was below average.

Specific events and unexpected situations that occurred during the last summer

970 MW coal generation closed on 8 June 2016 and one gas unit (840 MW) was commissioned during summer.

The summer went as planned regarding System Margin, there were a couple of localised downward Margin issues in July and August which were due to local constraints and high wind conditions in North West corner of the Scotland.

There were a number of maintenance and fault outages on the French Interconnector.

- Maintenance on 9/6 (Pole), 13/6-18/6 (Pole), 27/6-30/6 (Pole), 13/9-19/9 (Pole) and 19/9-3/10 (Bipole).
- Fault outages occurred on 20/6-23/6 (Bipole), 14/7 (Bipole), 10/8 (Bipole), 16/9 (Bipole).

There was also a maintenance outage on BritNed, 14/9-16/9 (Bipole).

GREECE: WINTER OUTLOOK 2016/17

The Greek system is expected to be balanced in the upcoming winter period (2016/2017). The level of indigenous national generation and the good hydraulic storage of hydropower stations should ensure the adequacy and security of the Greek interconnected System, which is not threatened under normal and severe weather conditions, and there are no plans for a high level of maintenance during this winter.

Most critical periods for maintaining adequacy margins and countermeasures

The most critical period during winter is the second half of December and January. Moderate imports are needed to meet our operating criteria under normal conditions. The role of interconnectors is not currently significant for generation adequacy due to a decrease in demand in previous years.

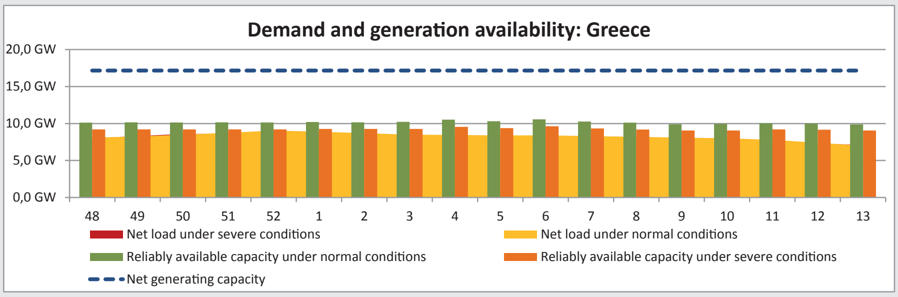
Most critical periods for downward regulation and countermeasures

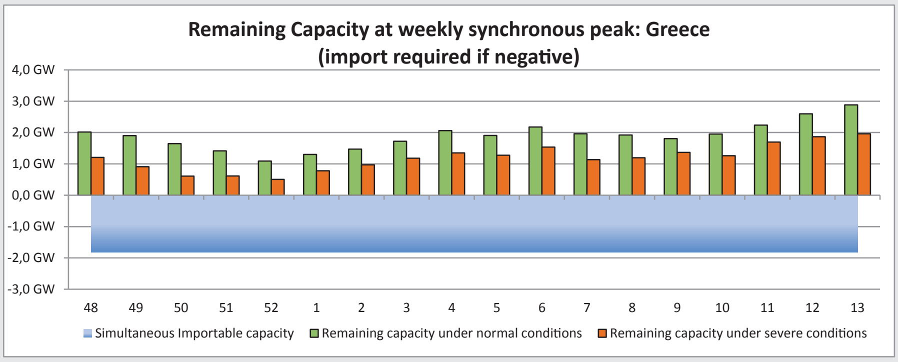
The most critical periods for downward regulating capacity are usually from 00:00 to 06:00 CET, mainly on the weekend.

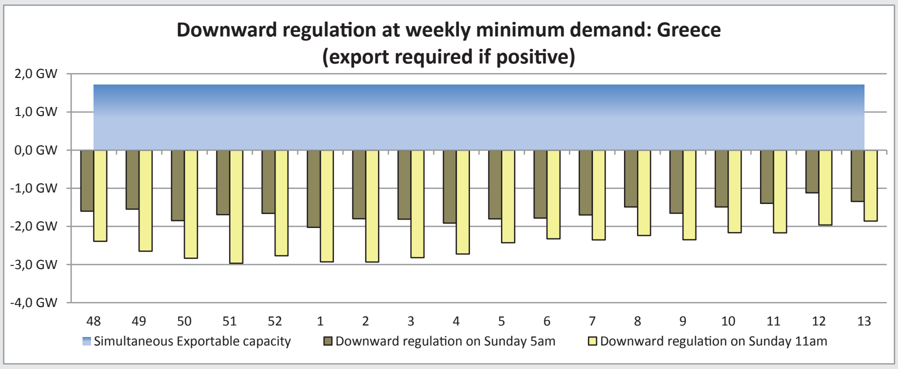
The countermeasures adopted are:

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

The Interconnectors are not used for reserve exchange.







GREECE: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During last summer, there were normal climatic conditions without anything extreme and the temperature range was at the normal level for the season.

There were no high outflows from the reservoirs during the summer, so the general reservoir level is rather high for the coming winter but in the safety level.

Specific events and unexpected situations that occurred during the last summer

During the summer, some fire events occurred that affected the transmission capacity.

HUNGARY: WINTER OUTLOOK 2016/17

In spite of the growing uncertainty on both the generation and demand side, as a result of market development on the one hand, and the promotion of renewable variable generation on the other, the Hungarian power system is expected to be on the safe side during the next winter period.

However, there are a few risks that must be carefully managed by the TSO. These risks are:

- Availability of fuel, first of all that of natural gas. During long-lasting cold winter periods, demand for natural gas becomes very high at households and at power plants at the same time. Therefore, a well-functioning gas market, as well as satisfactory replacement fuel reserves at generators, is essential to keep the lights on. High capacity gas storage was built so that the security of the gas supply could be increased.
- Overall cross-border capacity is satisfactory; however, allocation of cross-border capacity rights on the respective border sections may be an issue.
- The required level of remaining capacity can only be guaranteed by a certain amount of import under normal and severe conditions as well. Cross-border exchange is a matter of economy for market players. Their decision-making can be influenced by contractual conditions, e.g. on reserves.
- As matters stand, the Hungarian electricity system is highly dependent on the gas supply from abroad. In case the gas supply wanes or terminates, then the operation of gas-fired power plants is likely to become unpredictable, which in extreme conditions can cause even 3000 MW capacity outages in contribution with the decrease of electricity import coming from abroad. The unavailability of the needed capacity in this rate for a relatively long period of time cannot be compensated by domestic sources. In case there is no continuous gas supply, it is possible to run out of alternative fuels within 2 weeks.

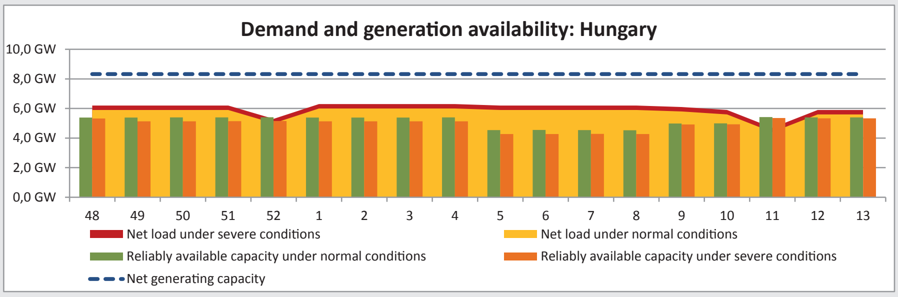
The reference adequacy margin at weekly peak is 0.5 GW, the capacity of the largest generation unit in the power system.

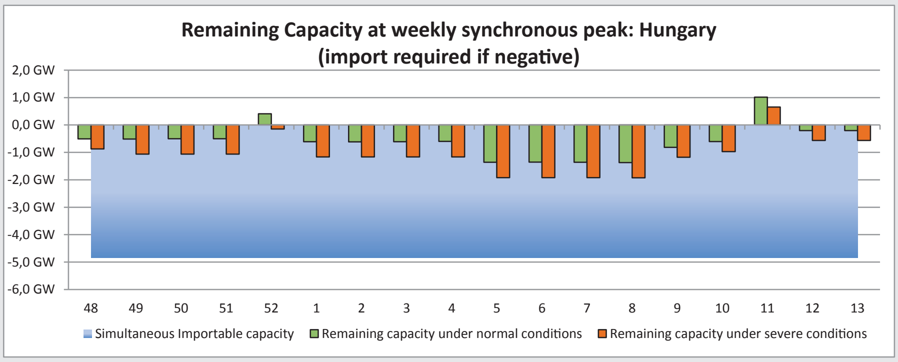
Most critical periods for maintaining adequacy margins and countermeasures

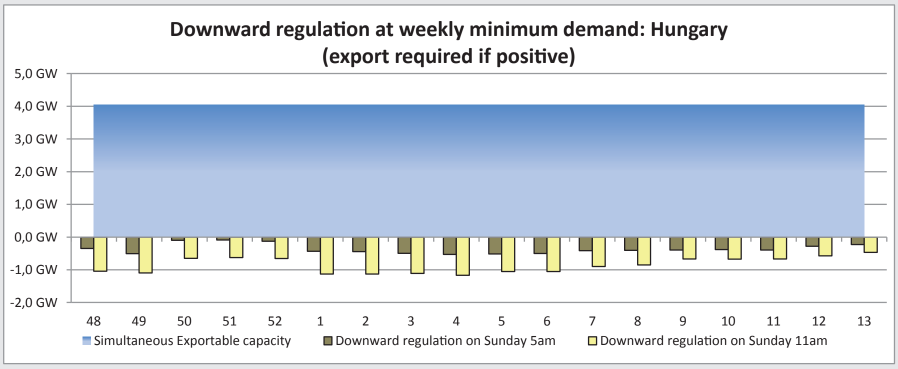
The level of maintenance is zero until 1 February 2017, owing to planning maintenance outside of the high load period of winter. The highest level of maintained capacity is about 900 MW from 1 February to 1 March.

Most critical periods for downward regulation and countermeasures

In the Hungarian electric power system, the required adequacy margin can be guaranteed by a considerable amount of import only. Several years are required to overcome this historical feature, which is a result of missing competitive, highly flexible generation units. Most critical periods for downward regulation would be during the celebration days in December. Incentives for proper scheduling by market players are provided through balancing energy pricing, as well as by market maker contracts between the TSO and the service providers for the necessary regulation capacity.







HUNGARY: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The summer temperature of 2016 was lower than the most recent years so there wasn't any increase of energy demand for the Hungarian power system. Outages of generators were rather low. The grid was reliable and controllable.

Specific events and unexpected situations that occurred during the last summer

During the second half of June, the actual demand was higher than the expected demand, because the temperature was higher than normal in this month.

The peak load in summer (6366 MW) didn't reach the peak load of the last summer (6457 MW).

There weren't any significant outages, they were between 100 MW and 900 MW.

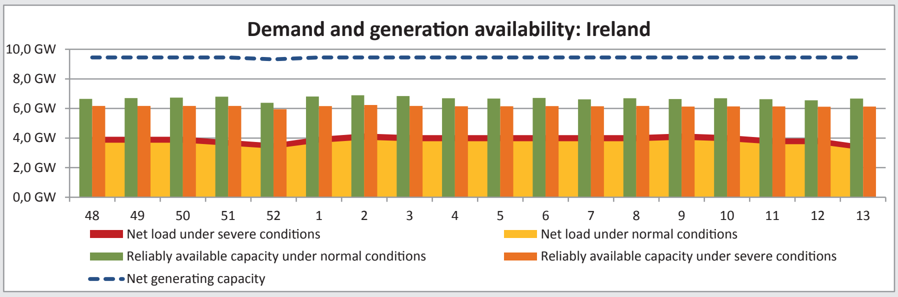
During summer 2016, due to an unexpected power plant outage, internal re-dispatch had to be applied in order to maintain the security of supply.

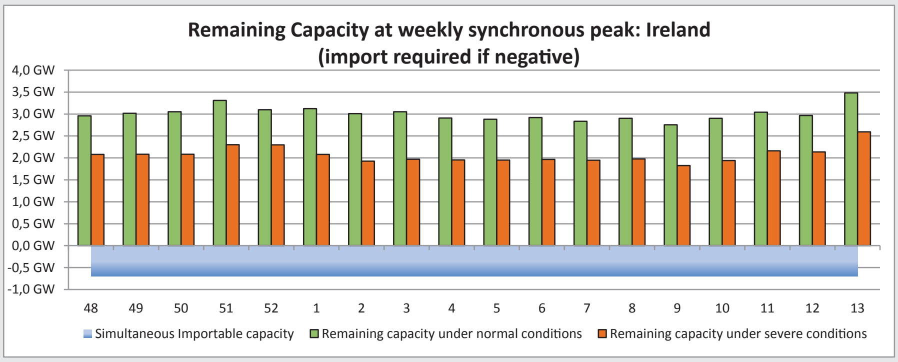
IRELAND: WINTER OUTLOOK 2016/17

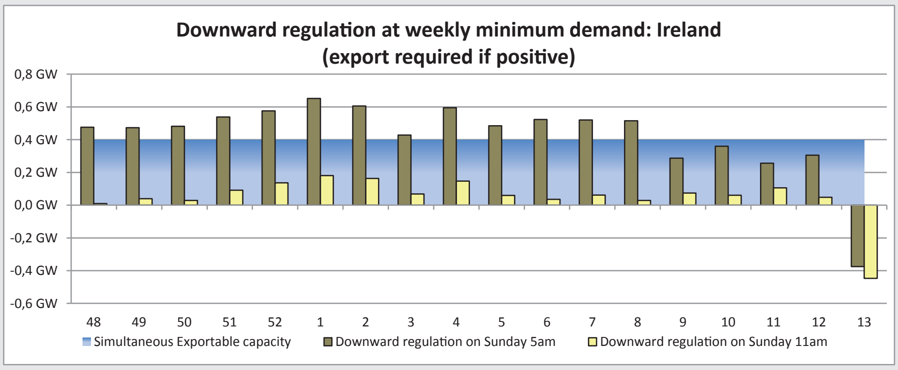
There is expected to be adequate generating capacity for the coming winter period.

Most critical periods for downward regulation and countermeasures

Downward regulation is likely to be affected by the forced outage of the East West Interconnection between Ireland and Great Britain. The interconnector forced out on 08/09/2016 and is not expected to return to service before the end of February 2017.







IRELAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

Adequate and secure generation was available for the entire summer period. Scheduled generator outages, forced outages and constraints in the transmission system in June did, however, limit the usable available generating capacity on the Irish system.

There were no specific events or unexpected situations last summer.

ICELAND: WINTER OUTLOOK 2016/17

There is expected to be adequate generating capacity in Iceland for the coming winter period.

ICELAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

Adequate and secure generation was available for the entire summer period. As usual, this summer there have been some maintenance as well as reinforcements on the system on all voltage levels (from 33 kV up to and including 220 kV). However, the system has been operating accordingly, without any need for curtailment.

Specific events and unexpected situations that occurred during the last summer

There were no specific events or unexpected situations during the summer of 2016.

ITALY: WINTER OUTLOOK 2016/17

The reduction of available capacity, already reported in the past, continued during the first part of the year 2016, with the decommissioning or mothballing of several power plants.

In fact, during the most recent years, the Italian Power System has been faced with the decommissioning of an important share of conventional power capacity; from 2012 to the end of June 2016 about 15 GW were lost. In addition, about 6 GW of conventional power plants are not available due to mothballing or authorization and legal constraints. The growth of variable (e.g. wind; PV) generation at a time of demand fall have put the commercial pressure on traditional generators, causing older power plants to retire or to be mothballed.

This phenomenon is affecting the power system adequacy in Italy and some important warning signals in terms of adequacy scarcity were already registered last year (2015) during the summer period in the peninsula and, particularly, in the two Italian main islands: Sicily and Sardinia.

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

However, in normal conditions, for the next winter, no problem regarding system adequacy is expected in the Italian system, with reliable available capacity expected to be higher than peak load during the entire period.

Under severe conditions (extreme cold), the situation for the winter could lead in the central part of December to the need for a certain amount of import in order to cover the peak load.

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

Concerning the external risk for the security of supply, it should be noted that the Italian generation fleet is heavily dependent on natural gas

Most critical periods for maintaining adequacy margins and countermeasures

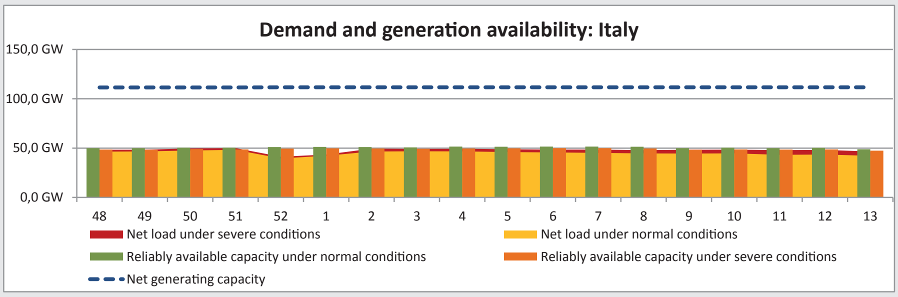
In normal conditions, no problems regarding system adequacy is expected, and the least comfortable period is expected in December.

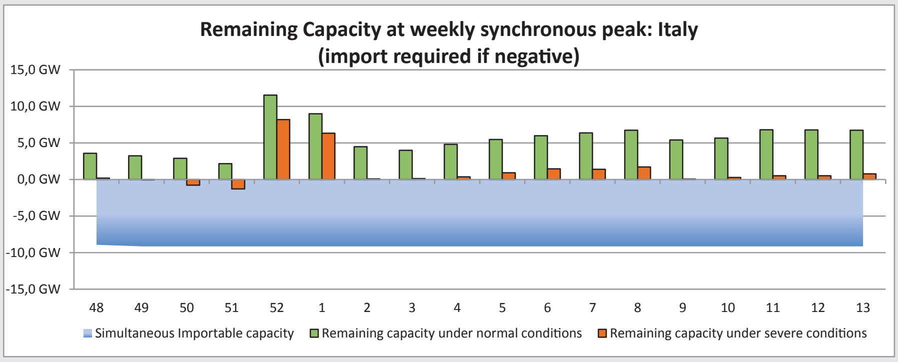
Again in December, under severe conditions, the situation for the winter could lead to the need for imports for 3 weeks.

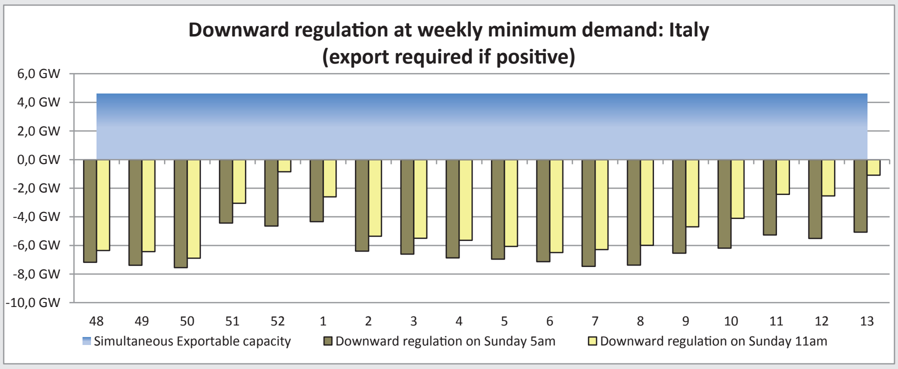
An appropriated coordinated planning of grid and generation elements outages has been performed, but, in case of need, postponement and/or cancellation of planned maintenance could be applied.

Most critical periods for downward regulation and countermeasures

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







ITALY: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During the past summer, there have been no significant events regarding the adequacy of the system.

The electricity demand was less than 5.4 % over the same period of 2015. This is due to a lower temperature (especially in the central weeks of July and in the first 15 days of August) and to a consumption slightly lower than the same period of the previous year.

There were no specific events or unexpected situations last summer.

LATVIA: WINTER OUTLOOK 2016/17

The load forecast is based on the previous winter's actual load. For normal conditions, it is expected that the load could increase up to 1.8 %, but for severe conditions up to 3 %. The actual load depends on weather conditions in Latvia and the actual air temperature on a particular day and hour. The TSO is not expecting load reduction in normal and severe load conditions, therefore load must be covered for the whole winter period. The system service reserve is 100 MW in normal and severe conditions.

The total installed capacity for the Latvian power system is around 2.9 GW for the entire winter. The fossil power plants are around 1.14 GW, the hydro power plants (run of river) are around 1.58 GW and the rest of capacity is from other RES (wind, bio fuel and solar) – 0.22 GW. Throughout almost the entire winter there is no scheduled maintenance and overhauls on gas power plants, therefore the full capacity of fossil fuel will be available throughout, except weeks 12 and 13 when one unit of RigaCHP2 is going on maintenance (reduction of 418 MW). Throughout the entire winter a couple of units from HPPs on Daugava River are in maintenance. It is assumed that during the winter the available capacity of Hydro Power Plants (HPPs) for normal conditions on Daugava river is around 500 MW (average historical production amount during the winter), but in severe conditions the amount is reduced to 400 MW due to lower water inflow level. The full capacity of HPPs of Daugava River will be available from April till June when a flood season is usually in progress.

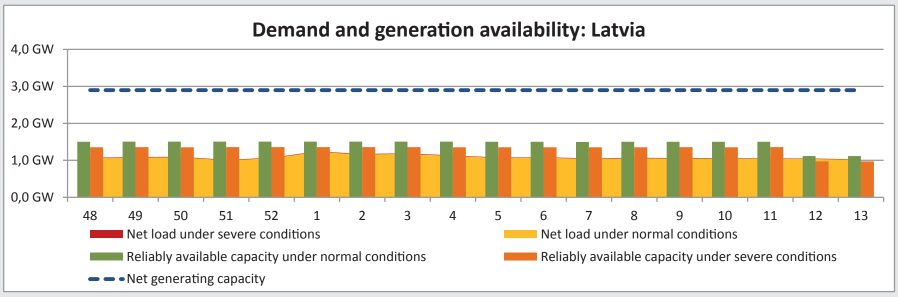
Most critical periods for maintaining adequacy margins and countermeasures

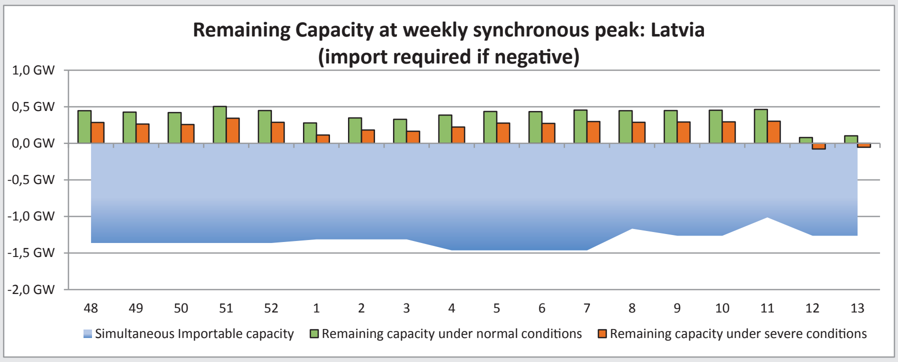
The most critical period for the LV power system could be weeks 12 and 13 when one unit of Rigas CHPP2 is in maintenance (lack of capacity around 418 MW) and generation can't cover a peak load in severe load conditions. The peak load in normal conditions can be covered during the whole observed time period, but in severe load conditions Latvian TSO relies on electricity import from neighbouring countries for weeks 12 and 13 via interconnectors.

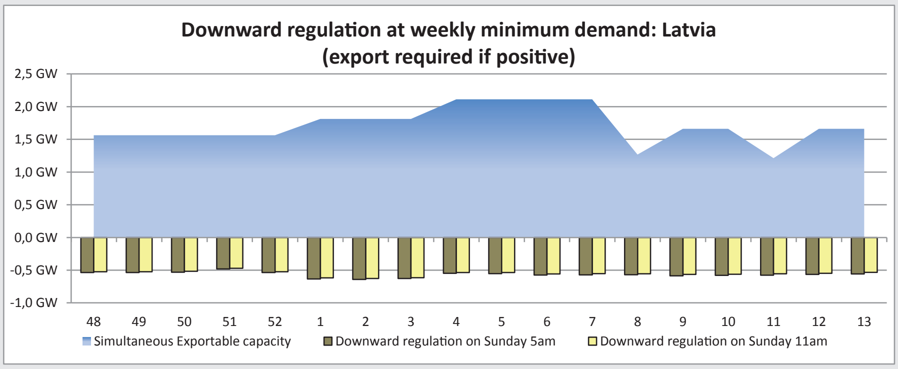
In general, across the entire winter, the Latvian TSO doesn't foresee any problems in covering a peak load in normal and severe load conditions and it doesn't expect reduction of gas imports or any other shortages in power plants in Latvia.

Most critical periods for downward regulation and countermeasures

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







LATVIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The average air temperature in Latvia was higher than normal during the summer. The air temperature was also higher than the previous summer.

The water inflow in Daugava River this summer was higher than expected and production of hydro was much higher - almost two times higher than the previous summer. On average, the other RES has generated the same amount of energy as the previous summer.

The big, significant faults in the interconnectors were not observed. The real import and export capacities from Estonia were higher than planned before. The similar capacity deviation was observed on cross-section Latvia – Lithuania where import capacities were very close to planned import capacities, but the export capacities were higher than planned before. These deviations from the plan don't cause any problems for security of supply in Latvia and the updated capacities were used for power exchange within the Baltic States.

LITHUANIA: WINTER OUTLOOK 2016/17

The load estimation for normal conditions was based on the statistical data of previous years, however the actual load is highly dependent on the actual weather conditions in a particular period. Compared to the previous winter, the increase is expected to be around 3.5 %. During the winter season, the total peak load under normal conditions is forecasted to be up to 1940 MWh (in the beginning of January).

All import volume from neighbouring countries (Russia, Belarus) is based on power flow calculations and the allocations at the Lithuania-Belarus interconnection highly depend on the Estonia-Latvia interconnection capacity. Due to maintenance activities on the Estonia-Latvia interconnection lines and increasing ambient temperature, higher restrictions of the import capacity from neighbouring countries are foreseen from week 12. The import ability of Lithuania PS also depends on available generation in the Kaliningrad region. Lower import capacities from Kaliningrad to Lithuania are foreseen during peak load hours.

In addition to this, transit and loop flows caused by Russian and Belarusian power exchange highly decrease the possibility of importing electricity from neighbouring countries to Lithuania. The influence of these flows is evaluated in the calculations of NTC import values from Belarus to Lithuania.

HVDC interconnections Lithuania – Sweden and Lithuania – Poland are planned to operate throughout all of the upcoming winter season, therefore net import capacity will be higher than in the previous winter.

The volume of system services is planned to be similar to the previous winter and will be equal to 884 MW from 2017.

During the last year, 203 MW of new wind parks were commissioned, while two conventional generation units with a combined installed capacity of 600 MW were closed in January 2016.

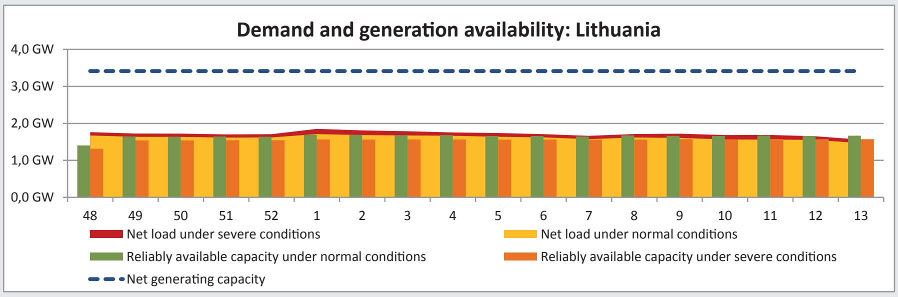
The average adequacy level of Lithuanian power system during the upcoming winter is expected to be positive, however due to a decrease of total net generation capacity and an increase of total load, the deficit adequacy level may be expected during low temperature periods. Nevertheless, the total import capacity will be sufficient to maintain system adequacy.

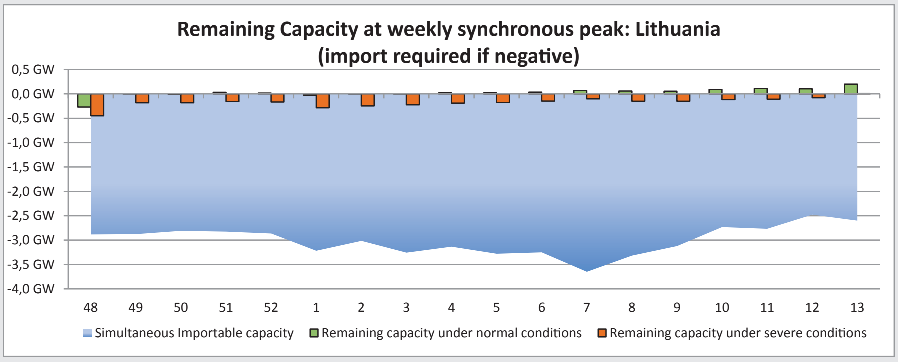
Most critical periods for maintaining adequacy margins and countermeasures

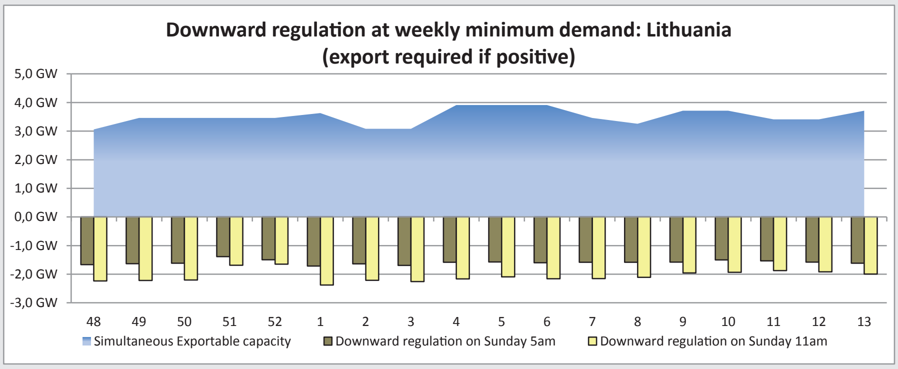
No adequacy risk was identified.

Most critical periods for downward regulation and countermeasures

No adequacy risk was identified.







LITHUANIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In the summer of 2016, the total consumption increased by almost 4 % from the previous summer.

The average temperature in the summer of 2016 was 0.5°C higher than it was in the previous summer. The maximum load was reached in the end of July, with 1576 MW, while the minimum load, as expected, was in the middle of July, totalling 813 MW. The average summer balance portfolio consisted of 29 % local generation and 71 % imports from neighbouring countries. The largest contributor of imported electricity (40 %) was Latvia.

Import capacity from neighbouring countries to Lithuania was restricted during most of the summer because of the reduced capacity of the Estonia-Latvia interconnection. The main reasons for the restrictions were higher ambient temperature and maintenance activities on the interconnection lines. Moreover, in the beginning of the summer, the import volume from Kaliningrad region to Lithuania was reduced due to maintenance of the Kaliningrad Thermal Power Plant.

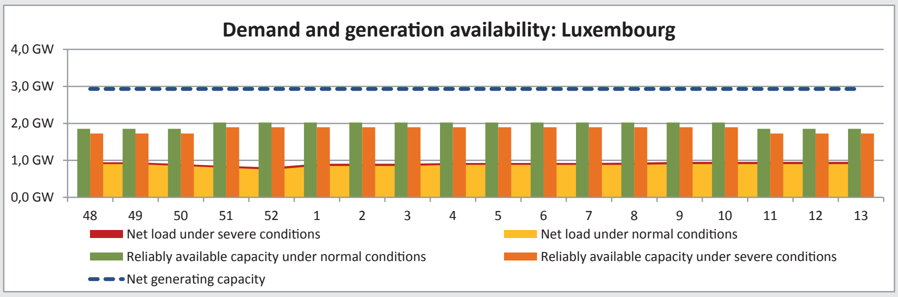
Specific events and unexpected situations that occurred during the last summer

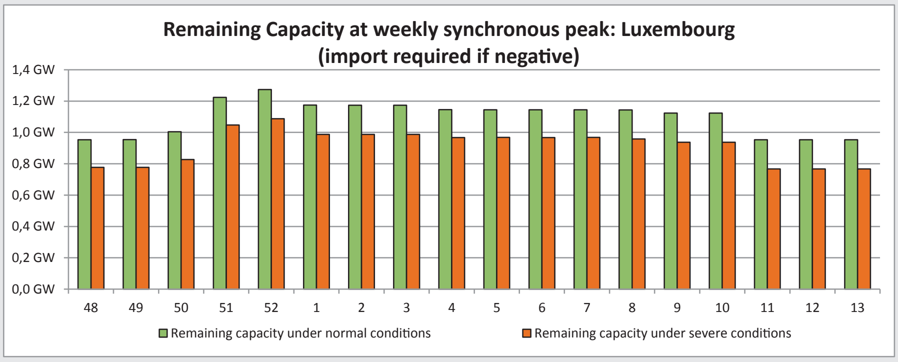
No unexpected situations have occurred during the last summer period.

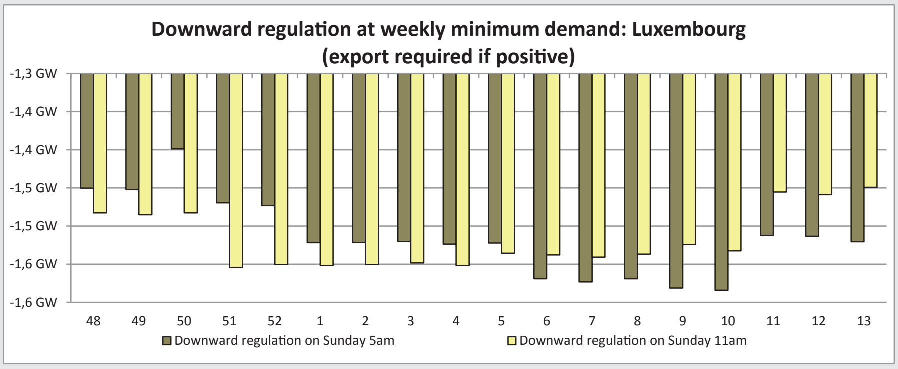
LUXEMBOURG: WINTER OUTLOOK 2016/17

The announced decommissioning of a CCGT at the end of October 2016 will reduce the net generating capacity of Luxembourg by 375 MW. The recent information on CCGT decommissioning made it impossible to incorporate this change in the current Winter Outlook simulations. A new interconnector between Luxembourg and Belgium is expected to go into operation on 30 November 2016 (technical trial phase of one year).

No adequacy issue is expected in Luxembourg for the coming winter.



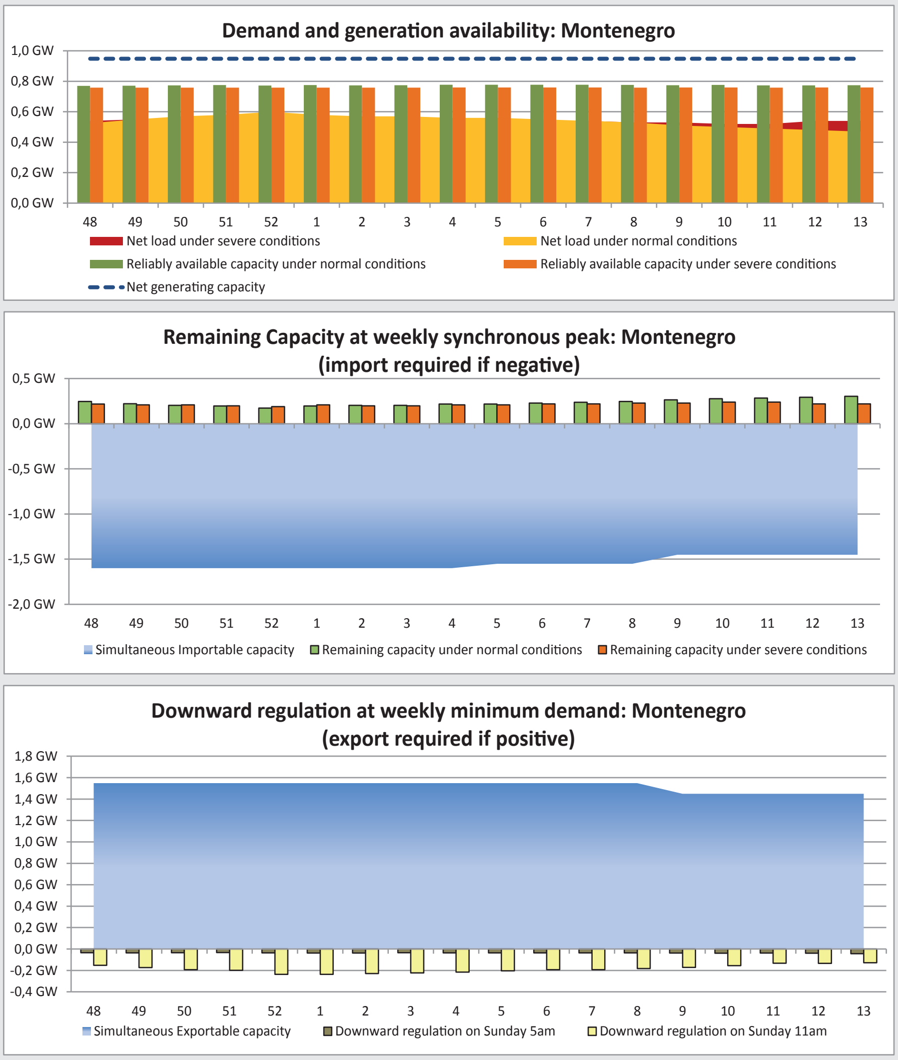




MONTENEGRO: WINTER OUTLOOK 2016/17

The operation of the power system is expected to be secure and reliable across the entire winter period 2016/2017. Generation-load balance problems, under normal conditions, are not expected in Montenegro during winter 2016–17.

During winter, there are no planned high levels of maintenance and hydro levels are expected to be normal. No major variations of the interconnection capacities are expected during winter 2016–17. The most loaded period is during the second part of December and January, depending on weather conditions and temperature.

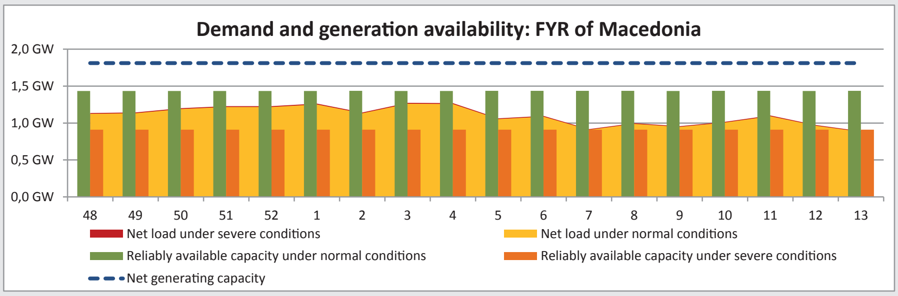


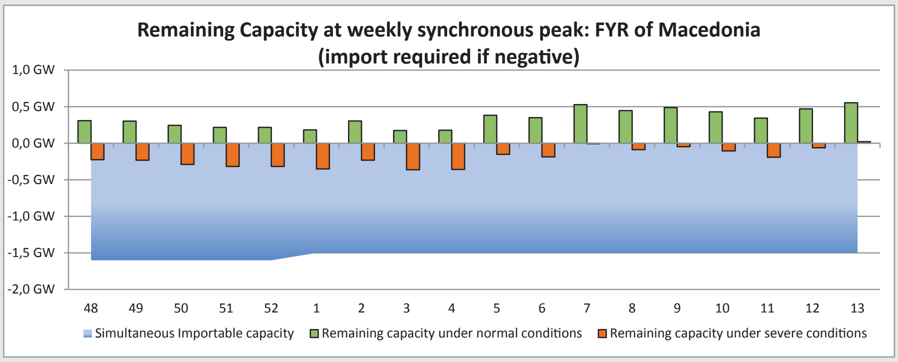
MONTENEGRO: SUMMER REVIEW 2016

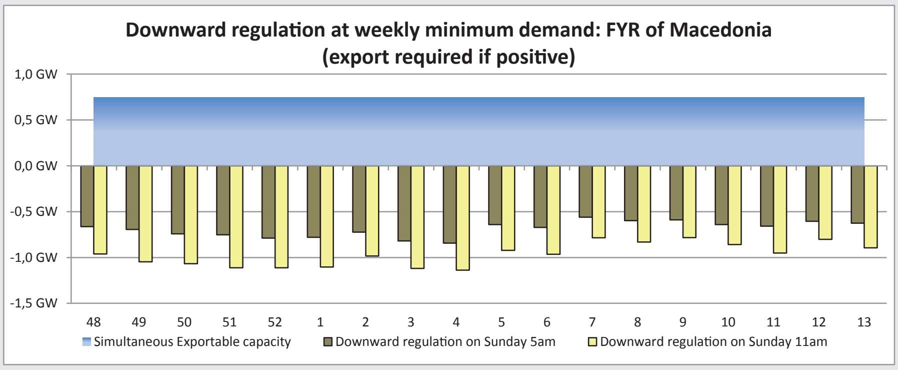
There were no critical outages/events in the Montenegrin transmission network during the past summer. Most of the planned works were completed in accordance to the maintenance schedule for 2016. The availability of interconnectors has been more than adequate and there was no issue with the implementation of the cross border transactions.

FYR OF MACEDONIA: WINTER OUTLOOK 2016/17

For the coming period, the transmission network is fulfilling the adequacy criteria. Our current transmission capacity is sufficient to meet the needs for energy imports and exports. The maintenance schedule of the generation units is set to minimum. No problems in the transmission network are expected because all of the maintenance work has been finished during the summer.





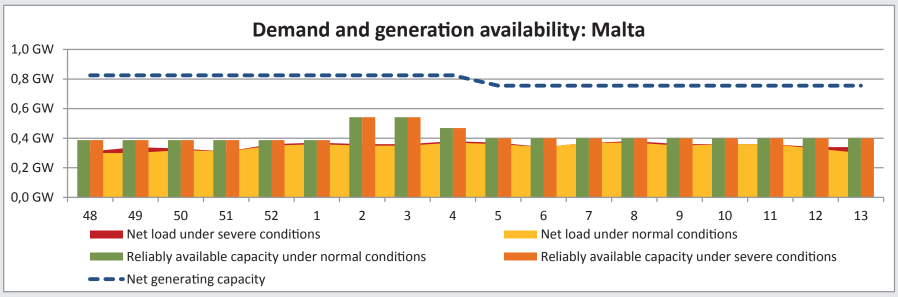


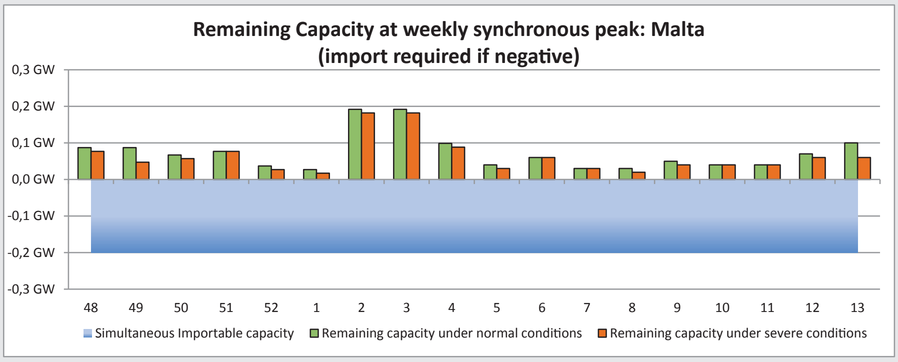
FYR OF MACEDONIA: SUMMER REVIEW 2016

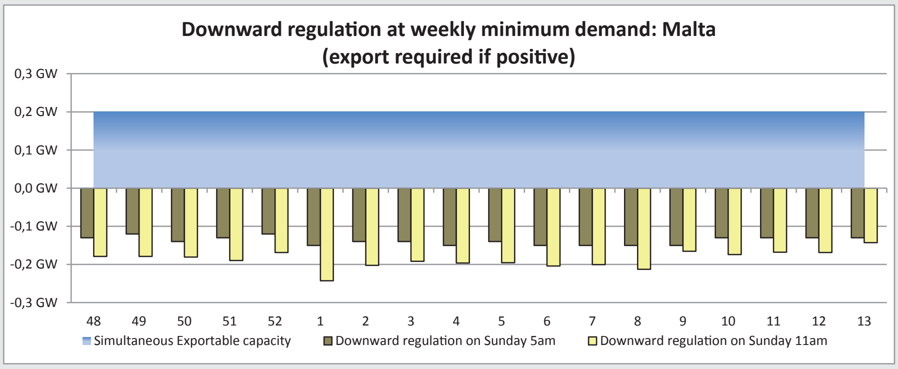
During the past summer in the Macedonian Power System, there were no unexpected events with significant (local and regional) character. All intended maintenance and overhaul works were completed in accordance with the plans. Interconnections were available during the whole period and we did not face any difficulty with regards to NTC quantity, cross-border allocation or relationship with market participants.

MALTA: WINTER OUTLOOK 2016/17

The winters in Malta are very mild. There is no issue with maintaining adequacy margins. There is also no issue with downward regulation.







MALTA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

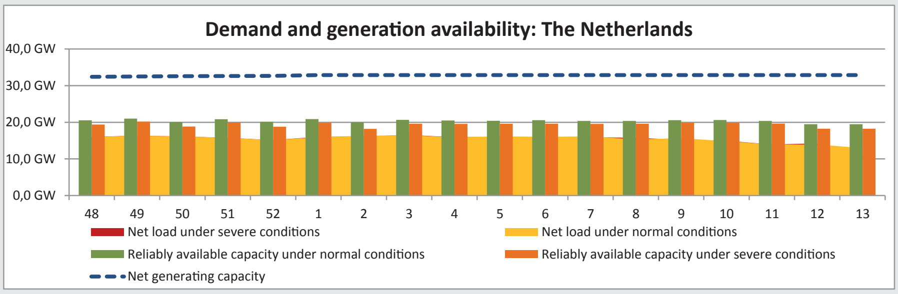
Past summer demand was lower than usual. No issues were met.

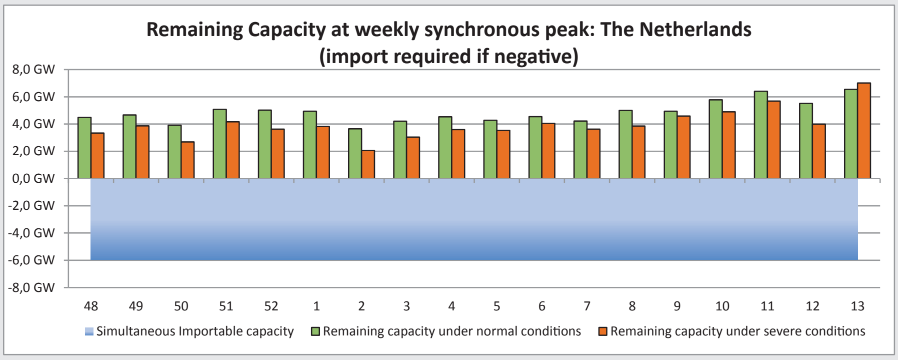
Specific events and unexpected situations that occurred during the last summer

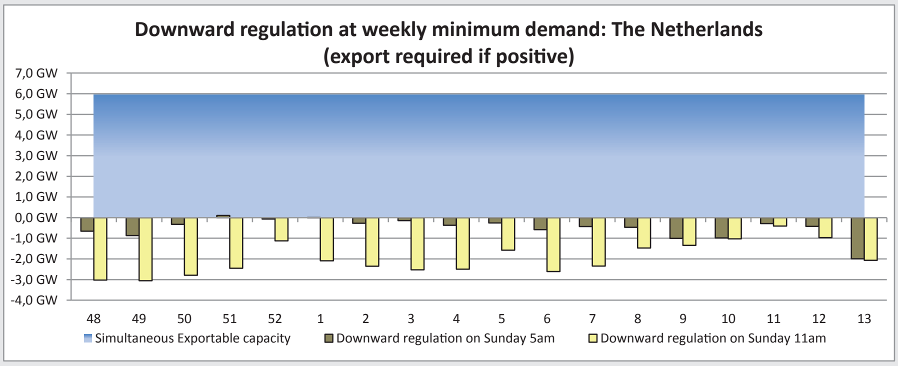
The only serious issue occurred one day in August when the Italian TSO (Terna) advised Malta that they may reduce the interconnector NTC (Sicilia - Malta) during the evening peak due to problems with the Sicilian generation. Malta started an extra plant as a precaution but finally the Italian TSO managed without reducing the NTC.

NETHERLANDS: WINTER OUTLOOK 2016/17

During the coming winter, there are no periods in which TenneT NL expects difficulties with generation and load balance.







NETHERLANDS: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In the past summer, TenneT NL has not suffered any operational difficulties with generation or load balance. Under the occurred conditions the amount of available generation capacity covered the demand peak. In close cooperation with our neighbouring TSOs, an extra amount of capacity has been made available for intraday capacity trading. As of 21 May 2015, Flow Based has been introduced within the CWE region, this has influenced the tradable capacity on the region borders on intraday and day-ahead. The summer of 2016 was a relatively cool summer, with some warmer periods but no long high temperature periods. The peak load this summer occurred on the 23 of August (11:00-12:00 CET) and was 16.1 GW. The lowest load was reached on the 30 of August (6:00 CET) and was 9.0 GW.

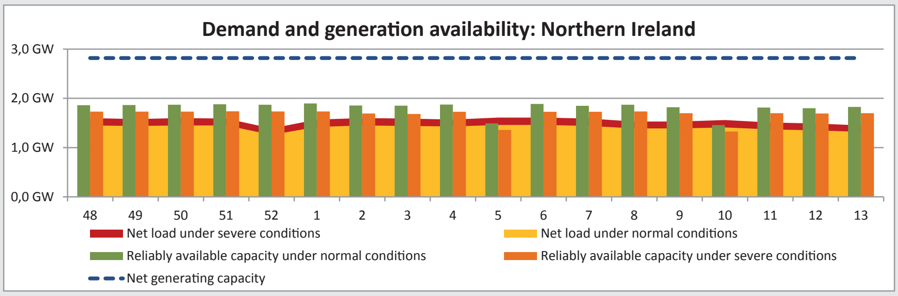
Specific events and unexpected situations that occurred during the last summer

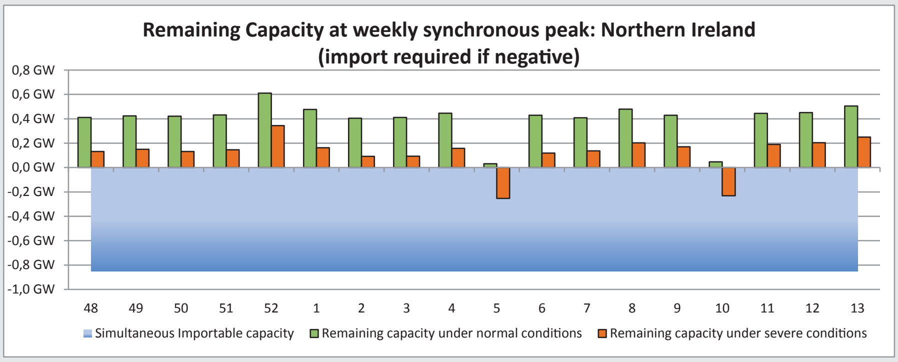
As of 1 January 2016, three older coal fired power plants (1.6 GW) have closed down according to the Dutch Energy Agreement for Sustainable Growth from the SER 2013 (https://www.ser.nl/en/). In the summer of 2016, another two coal units (1.1 GW) have closed. Furthermore, this year there were political discussions whether to also close more coal units to meet the national goals for reduction of CO_2 emissions. This summer, at least 5 GW of gas fired installed capacity has been mothballed due to the weak economic position of gas units, relative low demand and the increasing amount of renewables, mainly wind power.

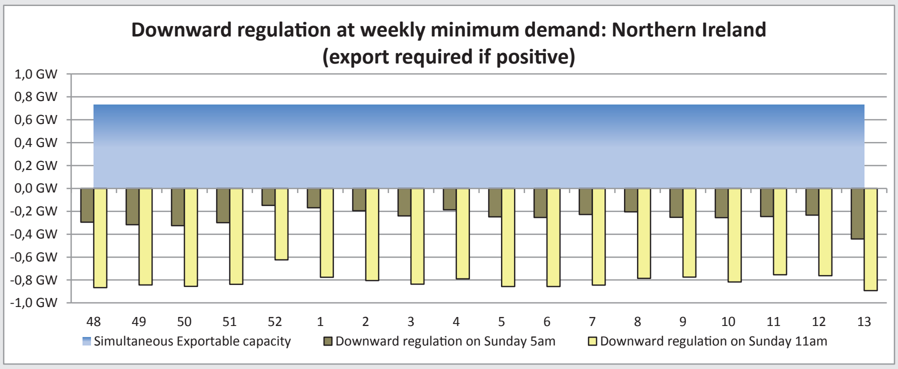
These events, however, did not severely influence the grid security.

NORTHERN IRELAND: WINTER OUTLOOK 2016/17

There is expected to be adequate capacity in Northern Ireland over the winter period. Planned outages have been limited to periods of low demand for the shortest duration possible.







NORTHERN IRELAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

An outage of the Moyle interconnector resulted in zero flows between NI and GB for a considerable part of the summer.

NORWAY: WINTER OUTLOOK 2016/17

A situation with high hydropower surplus, low power prices and high export of power, was earlier this fall expected to continue during the fall and winter. During the autumn, we have had a long-lasting cold and dry weather, resulting in lower reservoirs. The levels are now significantly lower than normal in Norway.

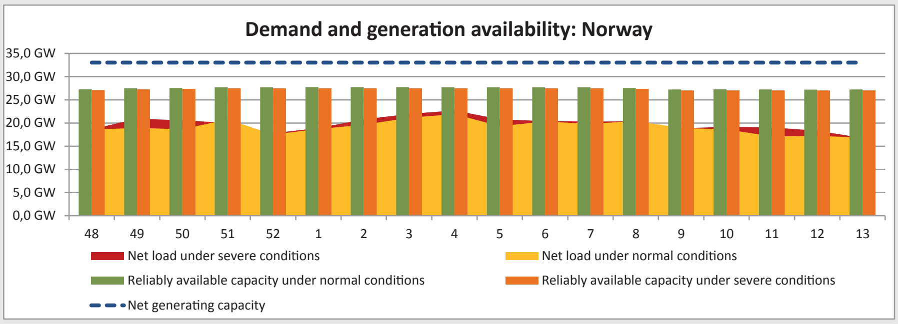
Most critical periods for maintaining adequacy margins and countermeasures

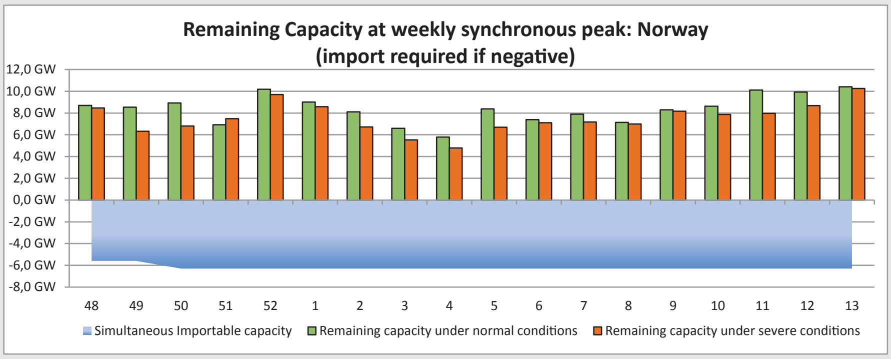
A continued cold and dry weather combined with several severe production outages in Norway or Sweden can result in a difficult situation in late winter and early spring. If the production capacity is maintained as today, we will probably have no problems with the adequacy. Higher prices in Norway will also increase the import of power.

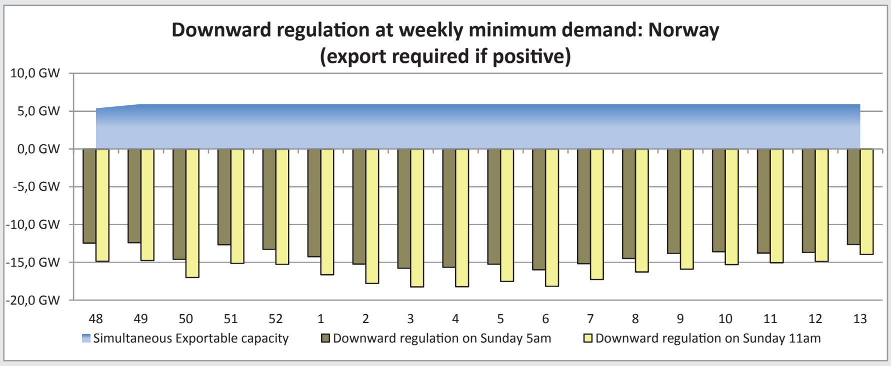
The exchange capacity between Norway and Sweden, NO1-SE3, is to some extent reduced compared to earlier years.

Most critical periods for downward regulation and countermeasures

No critical periods for downward regulating capacity are identified and will probably not be a problem in the winter.







NORWAY: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The power balance in Norway is highly dependent on the hydrological situation in the Nordic countries. From a minimum reservoir level of about 30 % (Norwegian average) in the spring, the level usually increases to about 85 % in the autumn. This summer, the reservoir levels have been on the average level or above, but there have been some geographical differences. The power prices have been low, but not as low as the previous summer because of less inflow (precipitation). We have had to export most of the time. As usual, there has been some maintenance on lines and on hydropower units this summer too.

Specific events and unexpected situations that occurred during the last summer

There was a failure on a cable internally in Norway crossing the Oslo fjord. This has affected the exchange capacity between some of the areas in Norway and the exchange capacity to Sweden, but we have still had to export from Norway most of the time.

POLAND: WINTER OUTLOOK 2016/17

Power Balance forecast

Winter Outlook 2016/2017 power balance results are better compared with previous Winter Outlook ones. The main reason for this fact is the rescheduling of winter maintenance & overhauls – the level of maintenance & overhauls is lower by about 0.8 GW. Negative power balance in some reference points can be covered using import capacity.

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. Read more in the Polish summer review subchapter "Specific events and unexpected situations that occurred during the last summer". PSE forecasts that the new topology on the PL-DE border will enable the offering of some commercial transmission capacities in the direction of Poland. More details referring to unscheduled flows problem can be found in the previous Outlooks reports.

Nevertheless, it is important to underline that this 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).

Most critical periods for maintaining adequacy margins and countermeasures

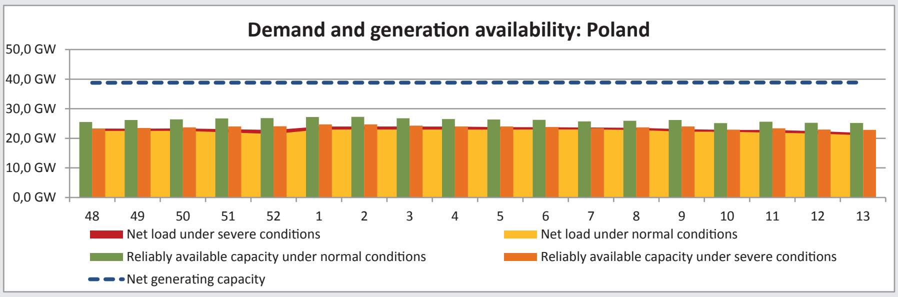
No critical periods forecasted for the forthcoming winter.

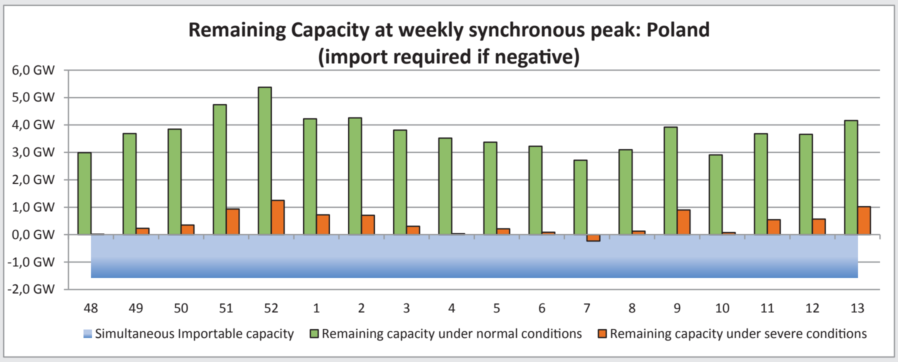
Most critical periods for downward regulation and countermeasures

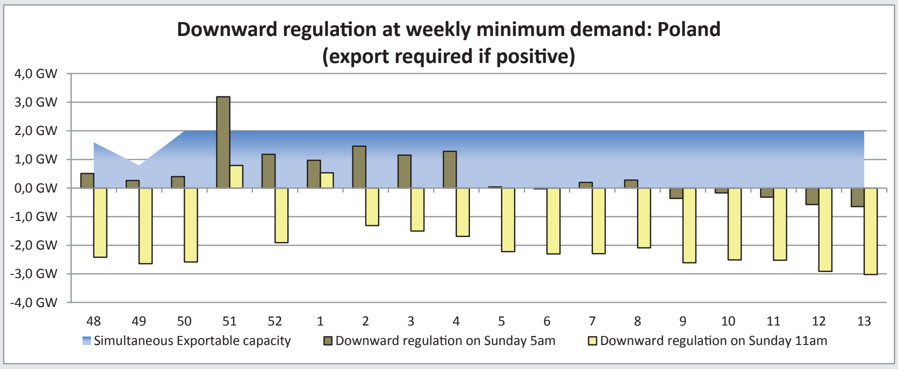
PSE does not prepare a forecast for downward regulation capabilities in a yearly and monthly horizon, so provided data is a kind of estimation only. A detailed specification is done within the operational (daily) planning, when precise forecast of load and wind generation is known. In case of possible problems with balance, the system PSE has operational procedures to keep the system at a safe level, including wind farms switching off as a last countermeasure.

PSE can confirm that there are some stress days during the year (especially during Christmas, Easter and holidays in May), when low demand and simultaneously high wind conditions could cause balance issues in the Polish power system. Owing to the lasting increase of wind NGC in Poland, up to 6 GW, the national downward analysis at 5 a.m. CET shows the possible need for export in some reference points, especially between week 51 and week 4 (2017). The expected renewable load factors are based on 1 in 10 highest historical value (approach explained in chapter 3.4.2). On 25 December 2016 (week 51, Sunday & second Christmas day off) the export needs may exceed the level of exportable capacity.

PSE does not expect problems with balance at 11:00 am on Sundays. Solar generation (which is ca 0.11 GW) is still negligible in the Polish power system.







POLAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

Weather conditions during summer 2016 were much more favourable compared to summer 2015, therefore no balance problems occurred in the Polish power system. The period with the tightest power balance took place in Poland at the end of June to early July. On the one hand, high temperature caused the increase of load. Even though temperatures were not so high and long lasting as during summer 2015, PSE registered a new summer peak load. This peak load took place on 30 June 2016 at 13:15 and amounted to 21.1 GW. For comparison, the 2015 summer peak amounted to 20.8 GW. On the other hand, high temperatures caused the growth of non-usable capacity in some thermal power plans. Power output had to be decreased due to hydrological constrains referred to water used for cooling – water flows into rivers cannot be too warm.

Operational conditions last summer were favourable as well. PSE observed the significant decrease of unscheduled flows from the west towards the southern border. It is believed that the main reason was the changes in the Continental wide trading pattern. The reconfiguration on the PL-DE border dated 22 June 2016 enhanced this decrease. This reconfiguration consisted of the utilization of PSTs in one of two double circuit tie-lines with the simultaneous disconnection of the second double circuit tie-line. Read more in the next subchapter "Specific events and unexpected situations that occurred during the last summer".

With the above-mentioned conditions, utilization of PSTs from 22 June was sufficient to fulfil N-1 criteria. Up to the end of September, there were two situations, when Cross Border Redispatching (CBR) was activated:

1. On 12 and 15 July, PST tapping was replaced (decreased) by bilateral redispatching on 50Hertz request.

2. Between 27 and 30 September, due to the failure of one of four PSTs and the inability to use the full range of angles.

It is worth saying that before summer 2016, CBR was a daily remedial action required to fulfil the N-1 criteria on the PL-DE border. Very often, especially at the turn of summer and spring 2015, CBR was not even enough and there was a need

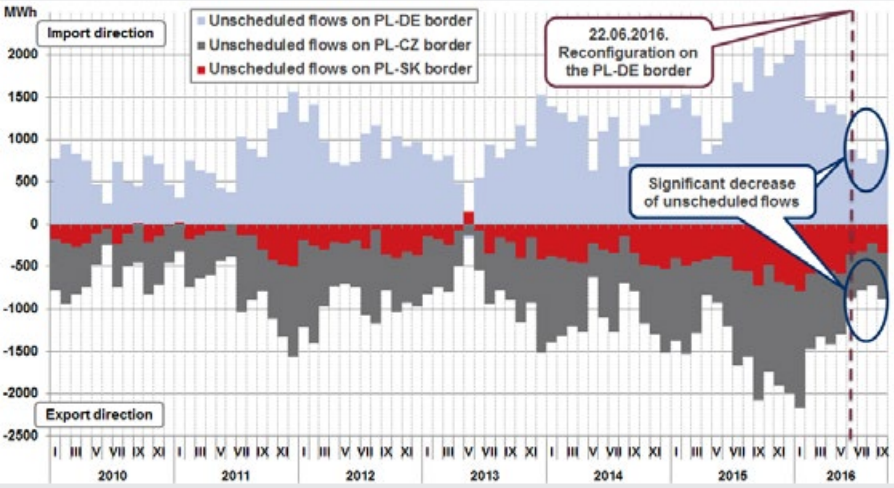


Figure 1: Average monthly unscheduled flows per Polish synchronous border (DE, CZ, SK).

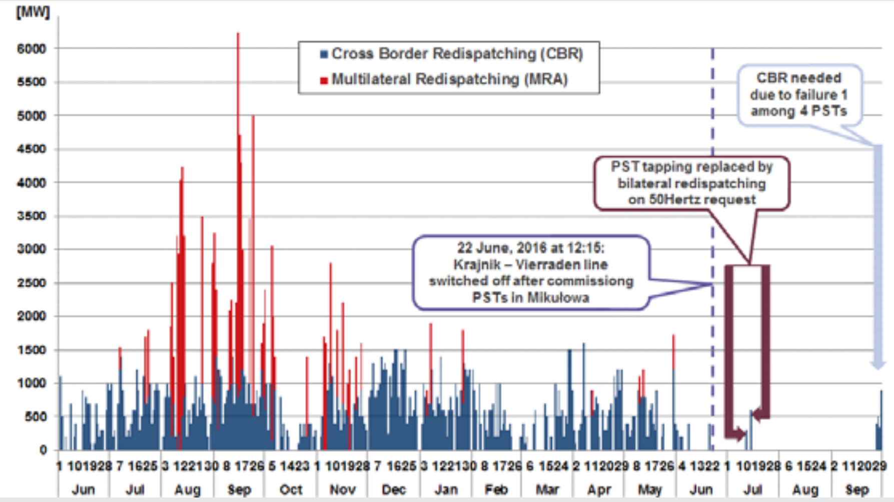


Figure 2: Maximum daily volume of CBR and / or MRA necessary to keep 50Hertz / PSE profile in N-1 secure state.

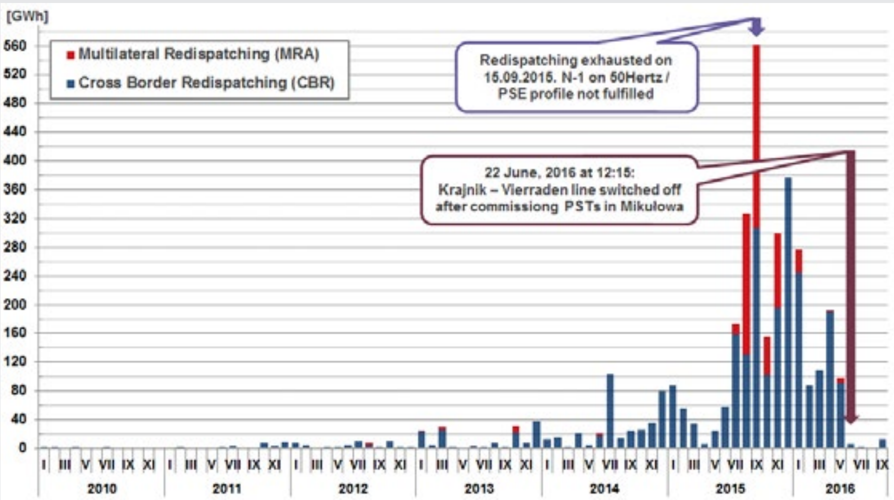


Figure 3: Monthly volumes of CBR and / or MRA necessary to keep 50Hertz / PSE profile in n-1 secure state.

to activate Multilateral Redispatching (MRA). The worst case happened on 15 September 2015, when all available countermeasures were exhausted and N-1 criteria were not being fulfilled for at about 4 hours.

Specific events and unexpected situations that occurred during the last summer

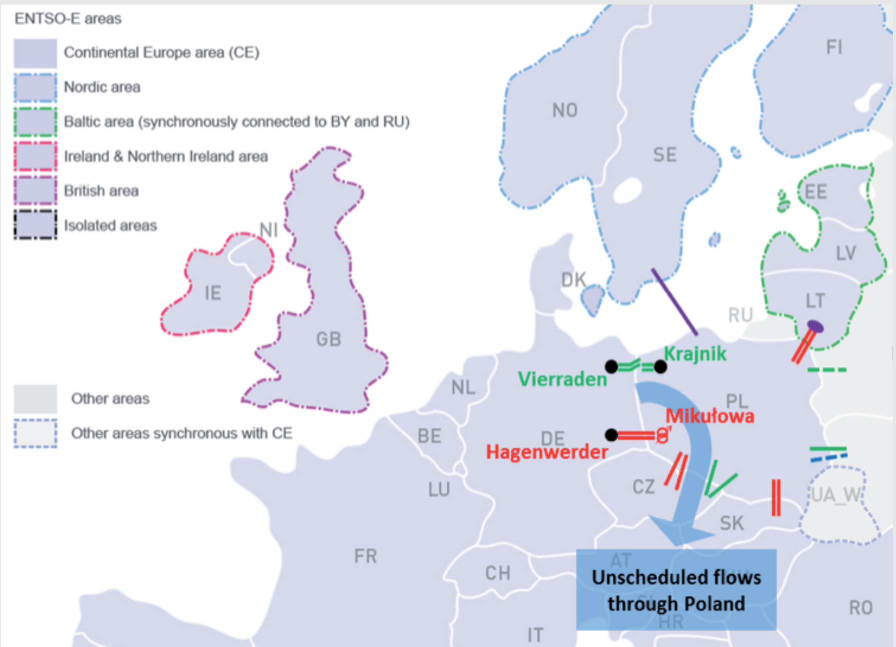
For years, the Polish power system has been affected by unscheduled flows through Poland from the west towards the southern border. The reason for these flows are market transactions concluded outside Poland, which are a result of the development of subsidized (thus attractive from the trading point of view) renewable energy sources in the northern part of Continental Europe (CE).

The sustainable solution concerning unscheduled flows is structural market improvement (i.e. a flow based mechanism for adequate coordination of capacity calculation in the relevant region with properly configured bidding zones). However, this solution will not be implemented before 2018.

Having regards to this fact and the possible generation shortage during severe conditions in summer 2016, PSE and 50Hertz agreed a special, temporary measure for maintaining the secure operation of both transmission grids[27]. The measure consisted of topological change in the grid and referred to both interconnections between Poland and Germany. In the Polish substation Mikułowa, connecting systems via Mikułowa-Hagenwerder double circuit 400 kV line, the PSTs[28] were commissioned. To allow for an effective utilization of the mentioned PSTs in a situation where the PSTs in German substation Vierraden are still not available, a disconnection of the second interconnector, the 220 kV line between Krajnik and Vierraden, was necessary. The topological change was implemented on 22 June 2016.

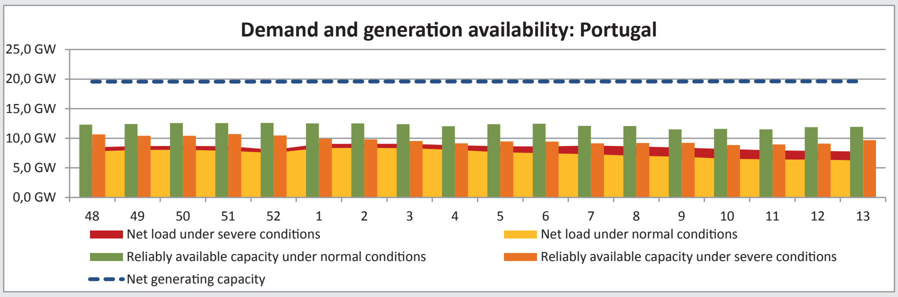
27) This measure was announced in the Summer Outlook 2016 report.

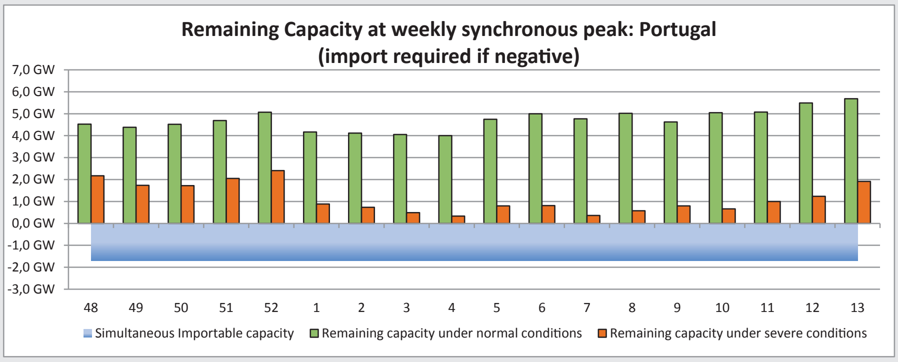
28) In details PSTs in Mikułowa are made up of four PSTs, two operate in series per each circuit of Mikułowa-Hagenwerder double circuit line.

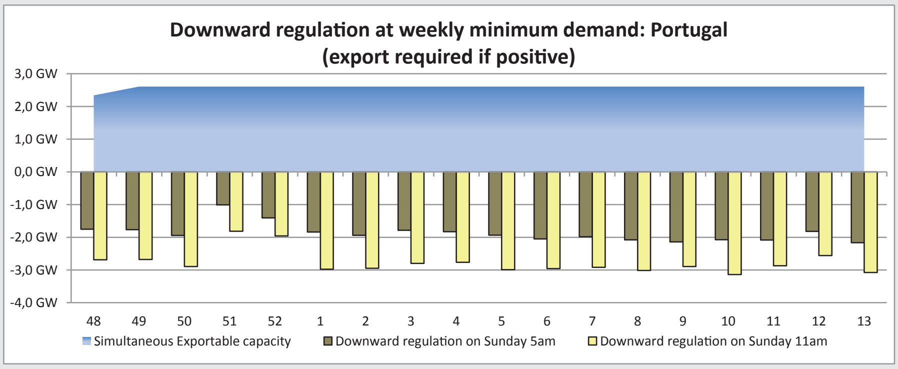


PORTUGAL: WINTER OUTLOOK 2016/17

In the upcoming 2016/17 winter season, the Portuguese system is expected to be balanced. Remaining capacity is sufficient to cover peak loads during the whole period, both in normal and severe conditions and, with the new reversible units in Frades II (2x390 MW), hydro capacity is expected to be even more reliable than in previous years. Regarding system downward regulation capability, our assessment has identified appropriate margins to deal internally with the excess of inflexible generation.







PORTUGAL: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In the 2016 summer season, the electricity demand experienced a strong growth from previous year levels, mainly boosted by the high temperatures. Because of the occurrence of a late heat wave, the summer season peak load, usually registered in July, shifted to September 6 (5032 MW). Hydro inflows in August were relatively high, essentially due to the activity performed on the Spanish reservoirs that feed the Douro River. As result, hydro generation was 2.15 times above the average. Wind generation was in line with the average values. During the season, the system had a highly exporter profile, which justifies the 54 % utilisation of the thermal capacity in August.

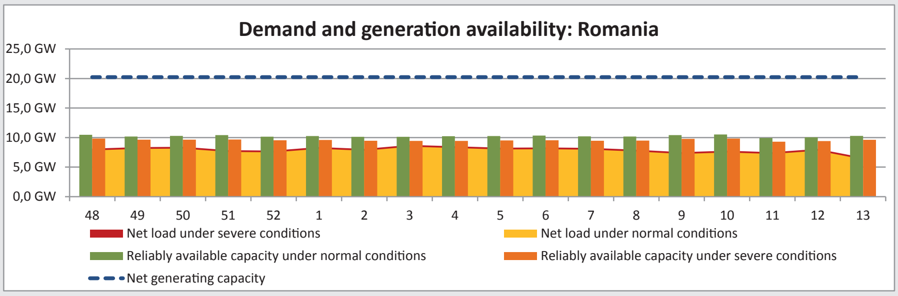
Specific events and unexpected situations that occurred during the last summer

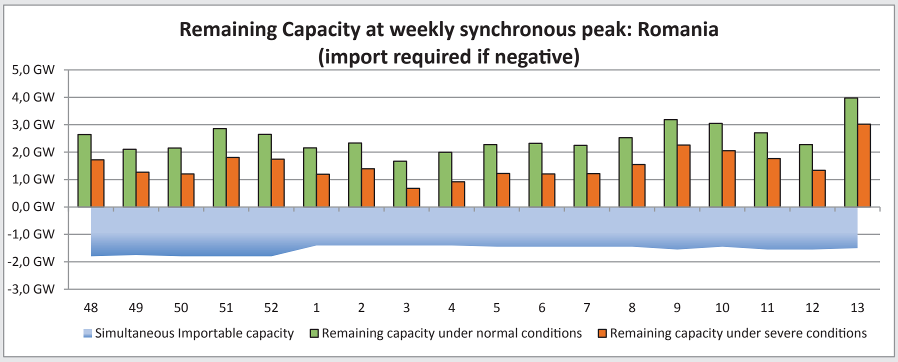
Last summer, Portugal was plagued by fires that posed some difficult challenges to the system operation. However, its impact was small in terms of the energy not supplied.

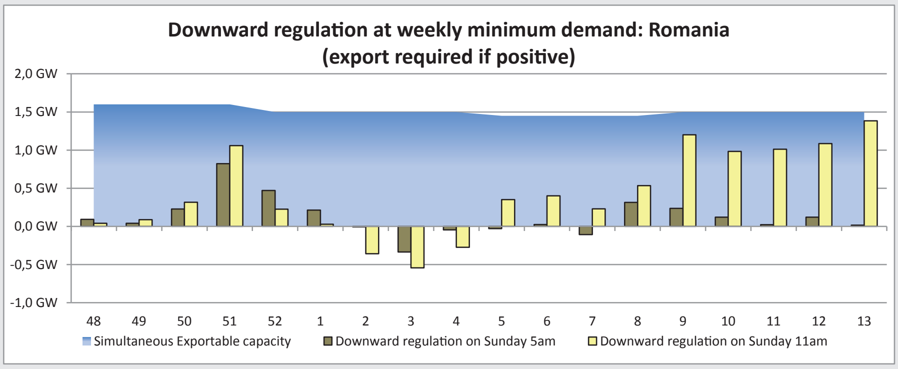
ROMANIA: WINTER OUTLOOK 2016/17

The balance forecast for the coming winter 2016/2017 does not indicate any problem which could affect the Romanian Power System adequacy, for both normal and severe conditions.

In case of positive downward regulation during the minimum demand, the NTC export level will allow the excess of inflexible generation to be exported. However, if the export schedules are significantly lower than the NTC expected value of the present report, then it is possible to apply market rules to reduce the renewable generation (hydro, wind and solar) in order to keep the power balance.







ROMANIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During summer 2016, Romanian Power System did not meet significant or unusual events. The temperature averages were higher than normal values in most part of the country, but the power balance was manageable.

SLOVAKIA: WINTER OUTLOOK 2016/17

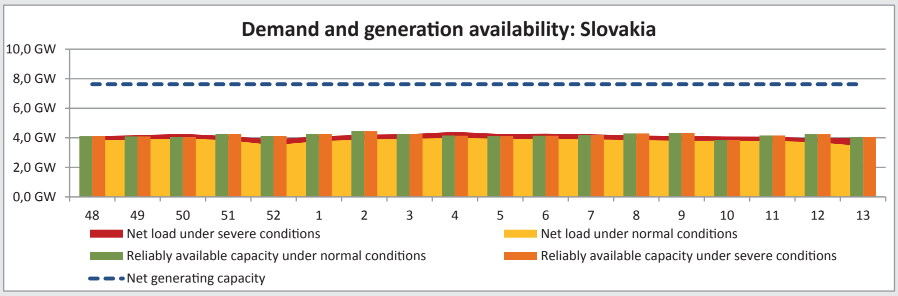
No adequacy risk is identified in the winter outlook 2016/2017 of Slovakia. Expected generation capacity will be sufficient to meet foreseen peak demands this winter and to ensure the appropriate level of security of supply under normal conditions. The real peak load in winter 2015/2016 was 4319 MW that occurred in the 3rd week of 2016. When all influences are considered, it is anticipated that the peak demand for winter 2016/2017 will be approximately 4 250 MW under a normal situation. The maximum weekly peak load in severe conditions is expected to be 4425 MW (as it was in the last winter period forecast, severe conditions). Taking into account the severe conditions scenario, the remaining capacity seems to be insufficient in December, the last week of January and the first two weeks of February. In these cases, the cross-border capacities for electricity import are sufficient. The winter peak demand in normal condition is expected in the 4th week of 2017.

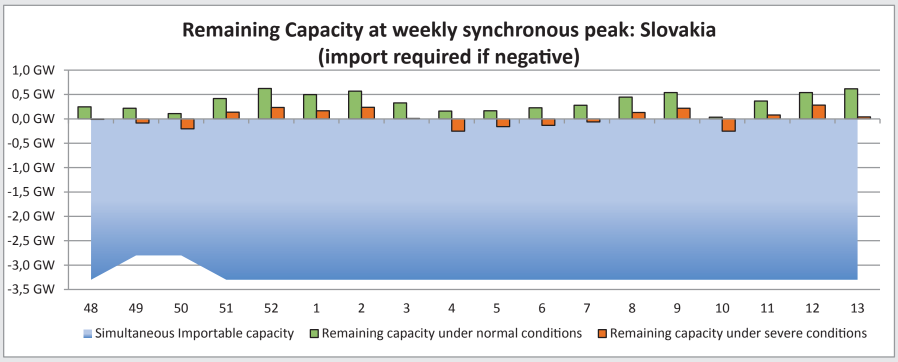
Most critical periods for maintaining adequacy margins and countermeasures

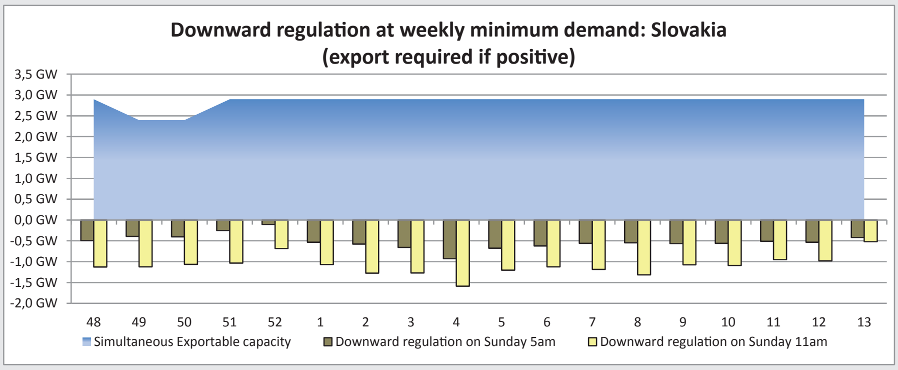
The remaining capacity of production in Slovakia is sufficient in the coming winter 2016/2017 except the beginning of March, due to the foreseen generation of hydro power plants. In the last week of March, the maintenance of a nuclear unit (500 MW) is scheduled. In severe conditions, the results of analyses show that in the half of winter the capacity will be negative. However, the interconnection capacities are high enough for import and export of electricity in such cases.

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 winter 2016/2017.







SLOVAKIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

During the summer, the Slovak Power System did not encounter any unexpected and unusual events or conditions.

The weather conditions of summer 2016 were normal, the weather was colder and changeable compared with summer 2015. June 2016 was slightly warmer than in 2015 (+0.6°C). The average temperatures in July and August 2016 were much lower than in 2015, in July -1.4°C and in August -3.4°C. September 2016 was very warm (+1.0°C). The average temperature during the summer months from June to September was 19.2°C (the previous summer it was 20.0°C).

In the following text, there are only preliminary results of energy balance of summer 2016 (from June to September) compared with summer 2015. There was an increase of production (+7.2 %) of electricity in Slovakia compared with summer 2015. Good hydro conditions made increase of production of hydro power plants, especially in July and August (+15.1 % and +18.6 %). The increase of production was recorded from July to September (in average +11 %), whilst in June there was lower production (-5 %) due to the maintenance of nuclear power plants. The electricity consumption was slightly higher than in the previous summer (+0.7 %). There was an increase of consumption in June (+2.4 %) and September (+1.7 %) and a decrease in July (-1.7 %). In August, the consumption was almost the same as in summer 2015 (+0.6 %). The summer peak load was recorded on Friday, 1 July 2016 at 13:00, 3 753 MW (week 26), in the previous summer it was 3 791 MW (week 30).

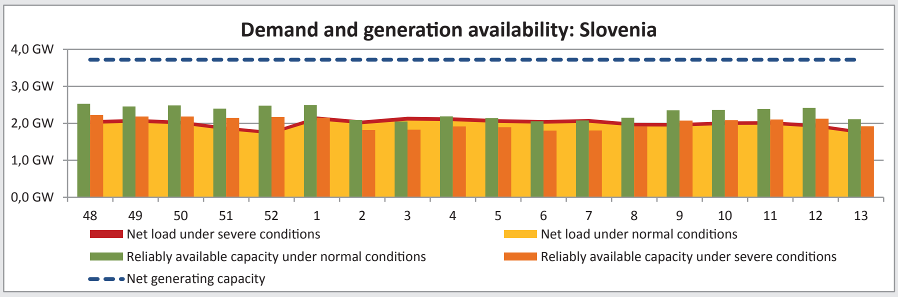
The electricity imported to Slovakia in months June and September contributed to balance generation and consumption. In June especially, the share of import on consumption was 19.9 %. In September it was 6.4 %. The total balance of electricity exchange that was import decreased to half compared with summer 2015.

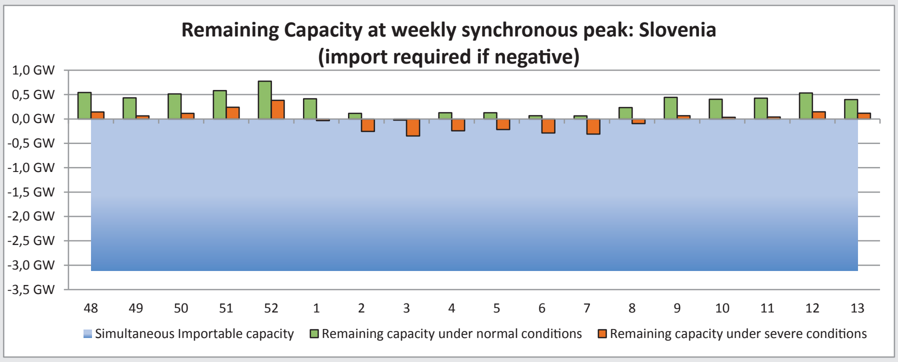
Specific events and unexpected situations that occurred during the last summer

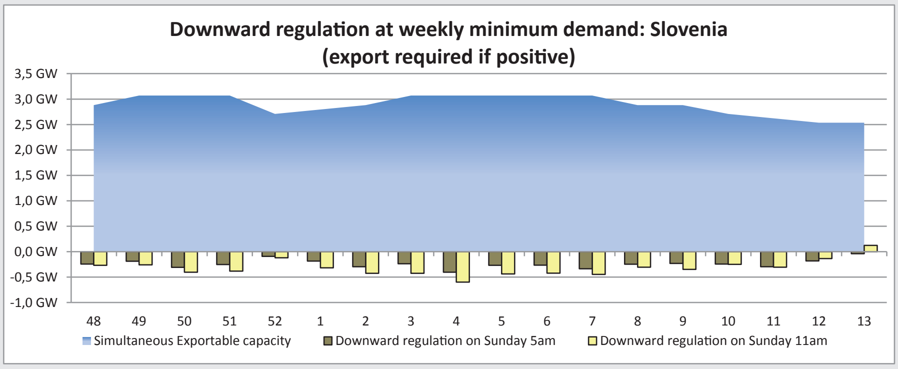
There were no critical outages and situations in the transmission network during the whole period.

SLOVENIA: WINTER OUTLOOK 2016/17

Only in the event of severe conditions, Slovenia might face a negative remaining capacity between the 2nd and the 8th week of 2017. These negative capacities may occur due to the high number of hydro power plants under maintenance and a relatively high load at the same time. However, the expected import capacities are sufficient to cover all energy shortages so no adequacy issues are expected during the upcoming winter.







SLOVENIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

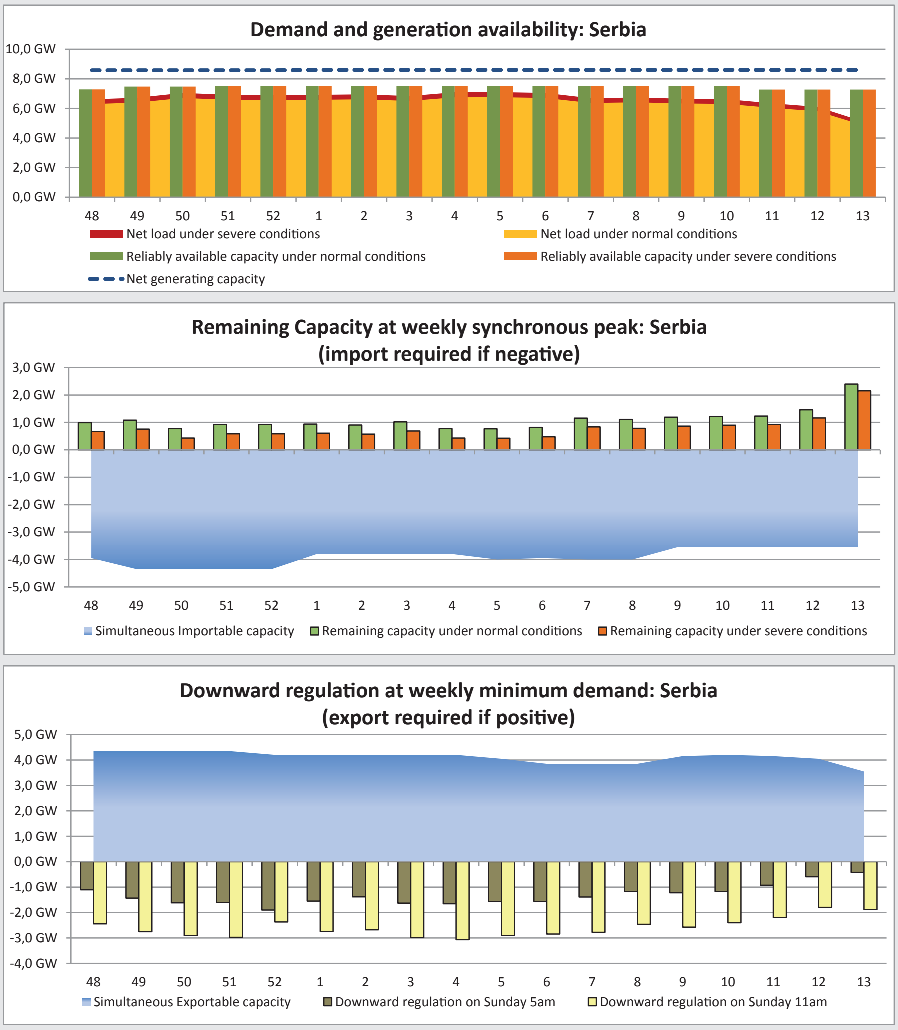
On average, summer temperatures as well as the amount of precipitation in Slovenia were slightly lower than normally. Summer outlook expected lower hydro levels in July and August, but there was no decrease in the hydro generation.

Specific events and unexpected situations that occurred during the last summer

There were no specific events or unexpected situations last summer.

SERBIA: WINTER OUTLOOK 2016/17

For the upcoming winter, the Serbian TSO doesn't expect problems in covering demand. Moreover, a small amount of energy exporting is expected under normal weather conditions. The maintenance of power units and transmission network are planned to be completed before the significant increase of demand. Only the major overhaul of the two hydro generators is planned throughout the winter, but missing power of 200 MW should not affect the adequacy. In case of gas shortage, it is estimated that it may increase electricity consumption by up to 300 MW. A further increase over this margin in winter peak is not possible due to constraints in the distribution system (experience from the gas crisis in 2009). Imports will be required for covering demand only in the event of extremely high peak loads under severe weather conditions. Taking into account the fact that maintenance of interconnectors and significant internal lines are not performed during the winter seasons, there will be enough cross-border capacity to meet domestic and regional demand in any case.



SERBIA: SUMMER REVIEW 2016

General comments on 2016 summer conditions

In general, summer 2016 passed as expected, without major problems. During the whole summer, temperatures were moderate and loads were lower than expected so that significant amounts of energy were exported. The highest levels of maintenance in the first half of June didn't disrupt the generation-load balance. In August and September especially, there was a significant increase in the levels of rivers and hydro storages for this time of year, which resulted in an even greater increase in energy exports.

Specific events and unexpected situations that occurred during the last summer

There were no specific events or unexpected situations last summer.

SPAIN: WINTER OUTLOOK 2016/17

From the point of view of upward adequacy, there is no detected risk situation in the Spanish peninsular system for the upcoming winter. Good generation/demand adequacy can be expected regardless of imports from neighbouring countries. If average conditions are considered, the remaining capacity will be over 13.5 GW. In the case of severe conditions, the assessed remaining capacity is still over 7.4 GW.

The most important risk factors for the next winter in the Spanish system are hydro and wind conditions, sensitivity of load to temperature in extreme weather conditions and gas availability for combined cycle thermal plants during situations of low RES supply.

Assumptions

It is expected that the total demand in 2016 will slightly increase. Nevertheless, the demand peak values expected for winter, with low temperature values, are lower than the ones expected last year, as winter peak values have significantly decreased during the previous years.

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

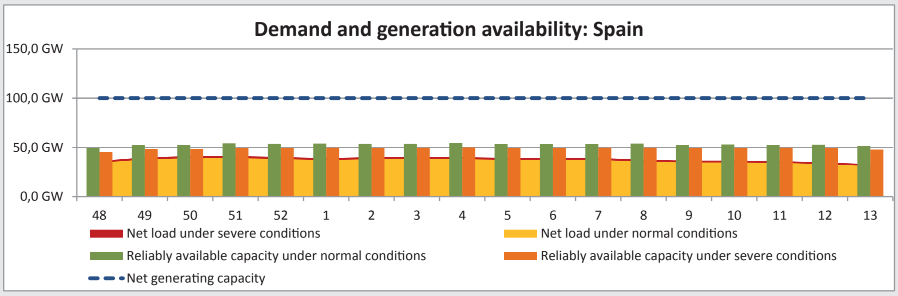
The NTC values are calculated taking into account forecasted scenarios that are shared with neighbouring countries, with different time scopes. Weekly values are calculated taking into account planned outages and overhauls in the system.

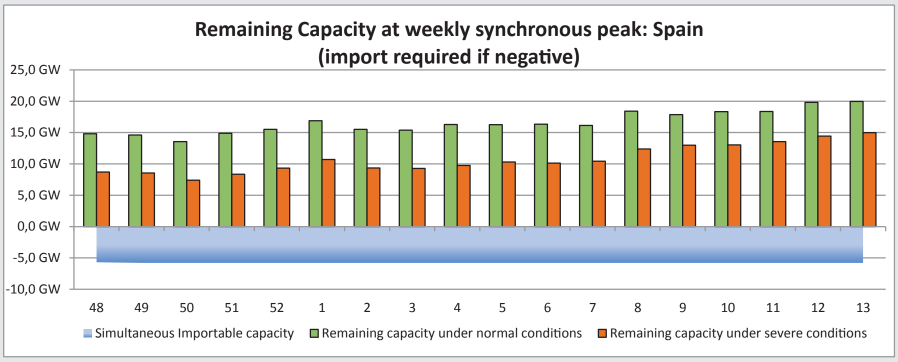
Most critical periods for downward regulation and countermeasures

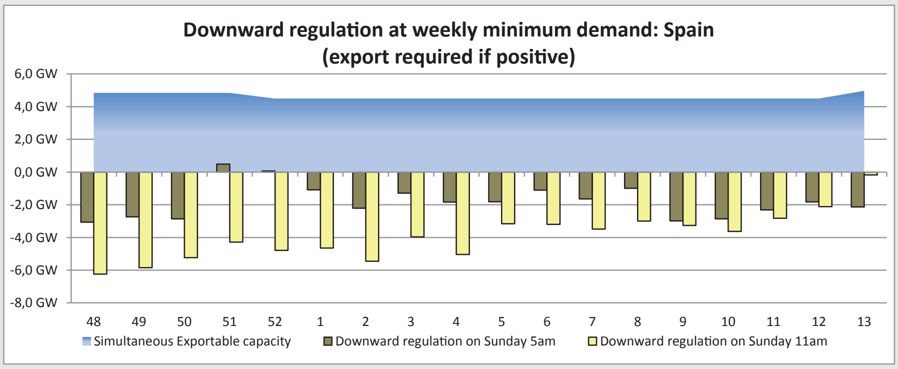
Concerning minimum demand periods with high probability of RES spilling, the Christmas season is the most critical period due to low demands, mainly at 5:00 CET.

The export capacity of interconnectors is a key factor in order to avoid the spilling of renewable energy, mainly wind power. Another point worth mentioning is the importance of energy storage – mainly pump storage plants – in order to properly manage the excess of inflexible power. The installed capacity of hydro pump storage plants in Spain has recently increased, and it is currently around 3300 MW (pure pumped-storage).

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







SPAIN: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The temperatures were higher than the average values during summer, especially during the beginning of September. Last summer was also a drought period, slightly more than usual. No adequacy problems were encountered.

Specific events and unexpected situations that occurred during the last summer

Water inflows were lower than the average during summer. However, given that the hydro reserves were quite high at the beginning of the summer, their evolution was normal and the present level is similar to the historical average value.

Extreme temperature values were reached during September, which is not a typical month for extreme heat and summer peak demands. The demand peak value (which is for the moment the peak value for the whole year) was 40500 MW, reached on 6 September at 13:32 CET. This value is quite similar to the forecasted extreme peak demand for the summer. However, no adequacy problems took place.

SWEDEN: WINTER OUTLOOK 2016/17

The domestic power balance is expected to be positive for the chosen reference point in time. At national weekly peak load, the power balance is more strained but adequacy problems are generally not expected. This is based on the assumption that the Swedish nuclear power is available according to market messages.

The hydro reservoir levels in Sweden are lower than normal in the early autumn.

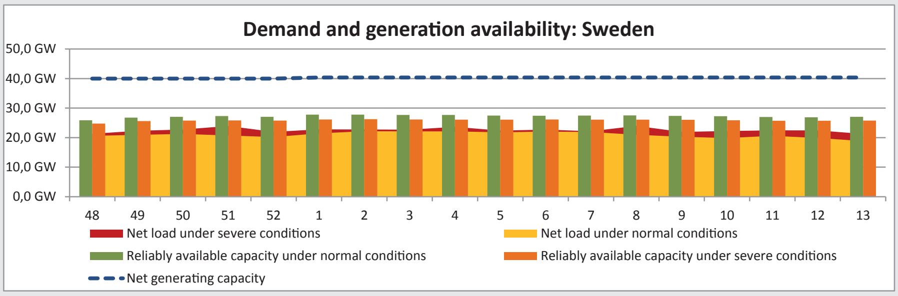
Most critical periods for maintaining adequacy margins and countermeasures

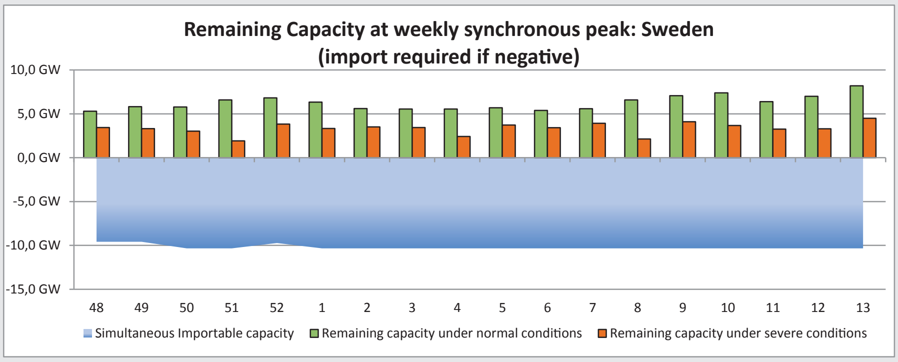
The electricity demand in Sweden is strongly dependent on outside temperatures. Peak load occurs at periods with cold weather, likely in January or February. To secure power adequacy, Svenska kraftnät contracts a Peak Load Reserve during the winter. This winter (2016/2017), the Peak Load Reserve consists of 660 MW generation capacity and 334 MW load reduction.

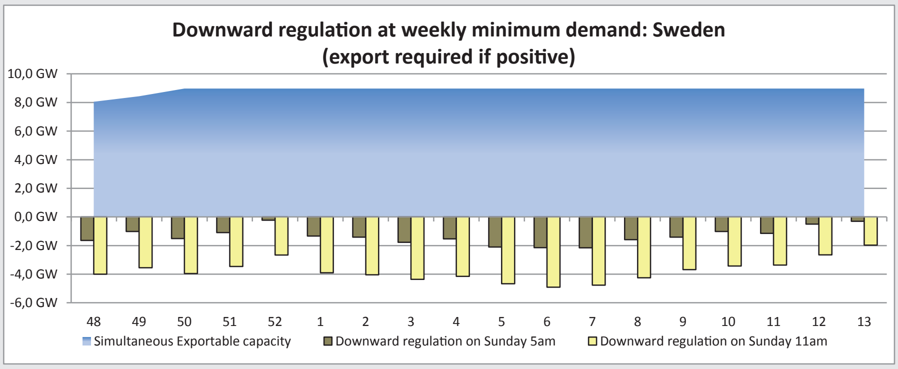
Interconnectors may play a role in maintaining adequacy during some weeks of severe winter conditions.

Most critical periods for downward regulation and countermeasures

Svenska kraftnät is not expecting any down regulation issues during the winter period.







SWEDEN: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The weather conditions in Sweden were normal during the summer and the operation of the power system was generally stable.

Specific events and unexpected situations that occurred during the last summer

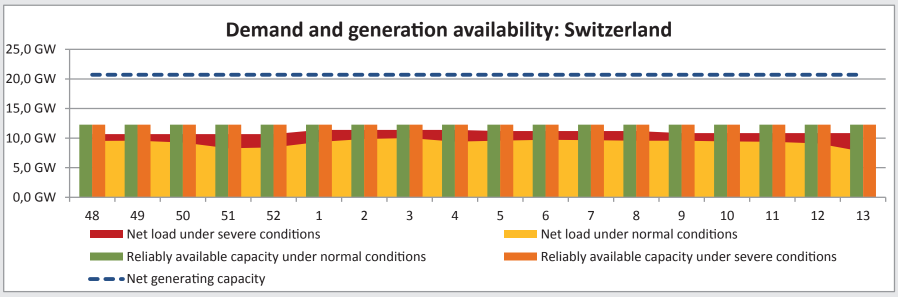
The import/export capacity between Sweden and Norway was known to be considerably reduced due to planned maintenance work during the summer. However, an unexpected cable failure in the area reduced the capacity further. The combination of these events led to price differences between Norway, Sweden and Finland for most of the summer. It also limited the availability of balancing reserves.

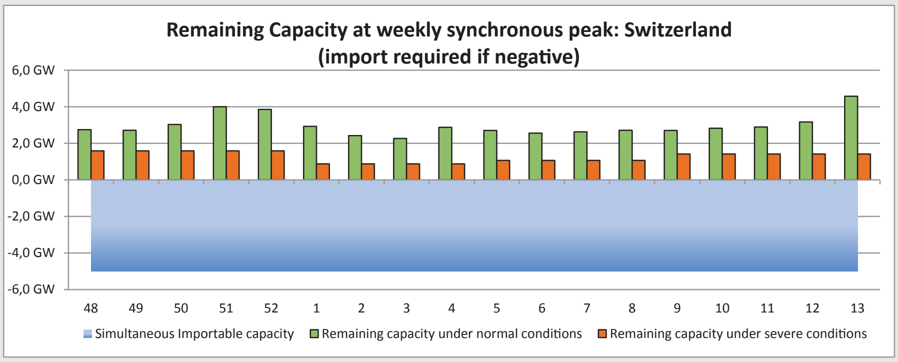
High voltages were a bigger problem than usual during the summer, especially in the Stockholm area. The normal ways of handling high voltages - disconnection of parallel lines and reactive power control of nuclear power - was not enough. Disconnection of cables in the regional grid and redistribution of power to Finland was carried out.

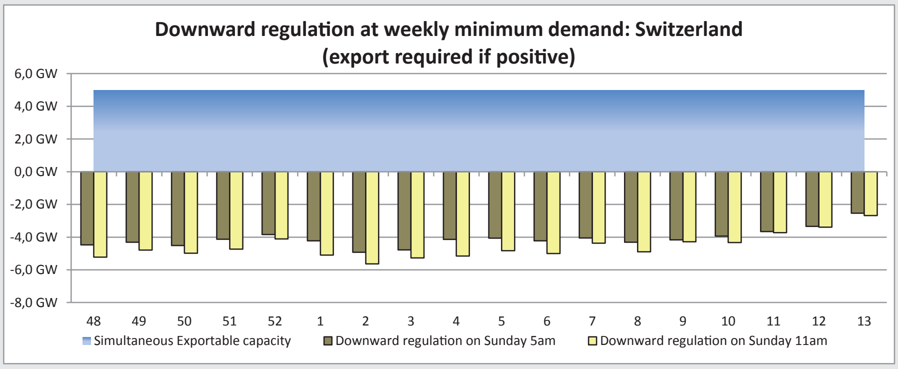
SWITZERLAND: WINTER OUTLOOK 2016/17

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. For Switzerland in particular, 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 words, even if the used methodology concludes that no problems are expected in Switzerland, specific problems might still arise (cf. situation of the last winter).







SWITZERLAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The average temperature was 0.7°C higher than the 1981-2010 norm. Although the precipitations were globally slightly higher than the norm, in canton Valais and in the South of the Alps, they were below average. The sunshine was normal in most parts of the country.

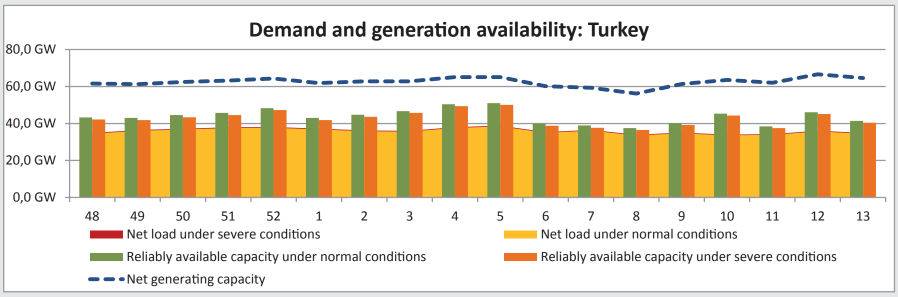
Specific events and unexpected situations that occurred during the last summer

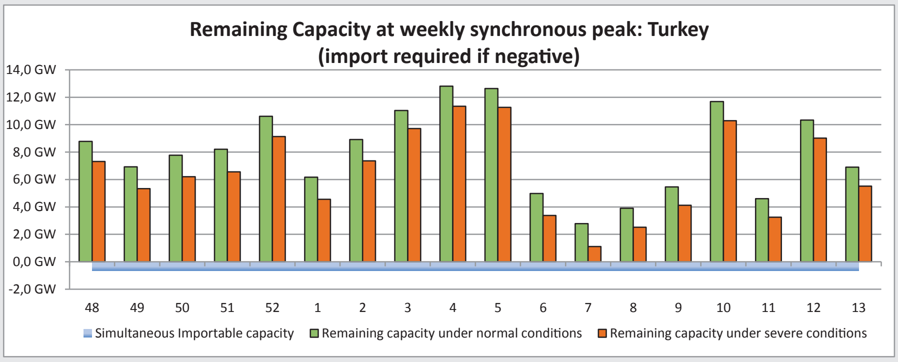
Compounded by high north – south transits and by the planned revision of lines, the high hydro production between June and August led to congestion in the Alpine region.

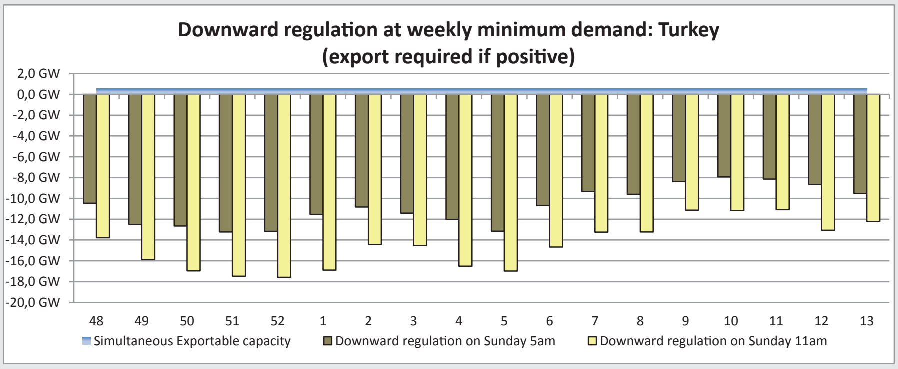
TURKEY: WINTER OUTLOOK 2016/17

No adequacy issue was identified for the coming winter. However, Turkey has very limited gas storage and also a high dependency on Russian and Iranian gas pipelines. Therefore, in case of contingency in these pipelines, a risk of inadequate generation could be observed.

TEIAS, Turkey's TSO, increased the load peak consumption estimation for NORMAL and SEVERE conditions by, respectively, 3.8 % and 5.0 %.







TURKEY: SUMMER REVIEW 2016

General comments on 2016 summer conditions

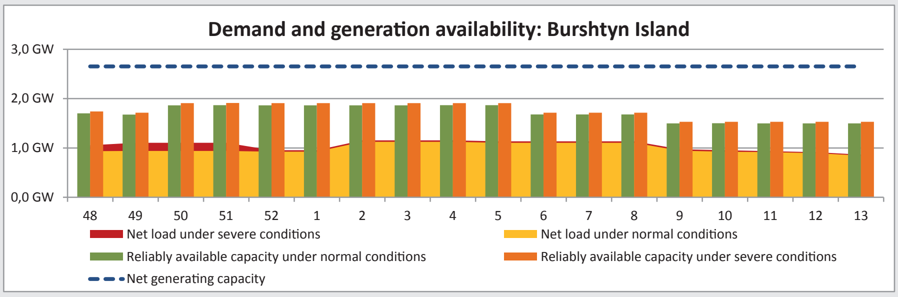
The weather conditions in Turkey were normal during the summer and the operation of the power system was generally stable.

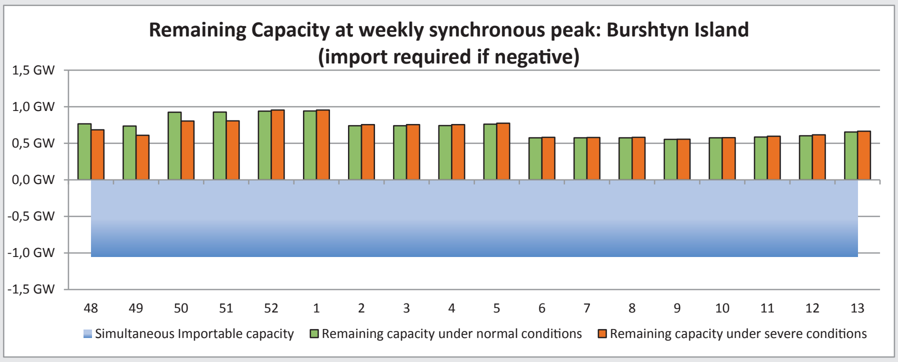
Specific events and unexpected situations that occurred during the last summer

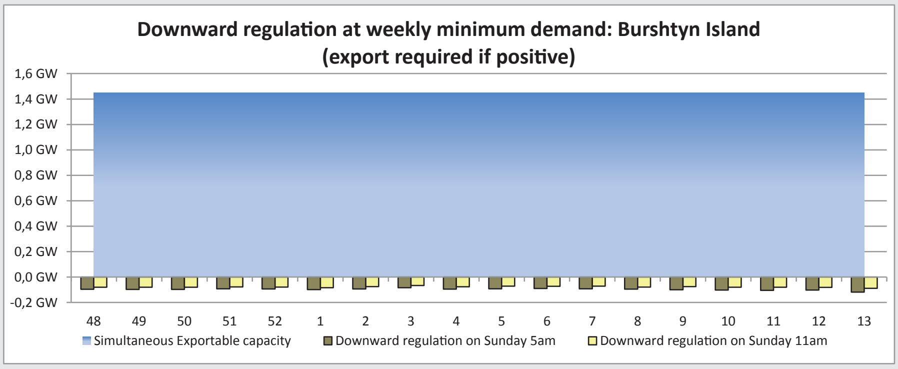
There were no specific events or unexpected situations last summer.

BURSHTYN ISLAND: WINTER OUTLOOK 2016/17

No adequacy issue is expected in the Burshtyn Island electrical system for the coming winter. Even in severe conditions, Burshtyn Island has margins and is able to export to the rest of Continental Europe.







BURSHTYN ISLAND: SUMMER REVIEW 2016

General comments on 2016 summer conditions

The weather conditions were normal and the operation of the power system was generally stable.

Specific events and unexpected situations that occurred during the last summer

There were no specific events or unexpected situations last summer.

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 (**NPcountry**) based on the latest census of each country.[29)]

2. Define the number of cities in each country to be weighted (**NCweighted**). The lower threshold for calculating the weight is set to 3,000,000 inhabitants.
$NCweighted = INT(NPcountry3000000)+1$

3. Take data for the population (**CPi**) of each of the first **NCweighted** biggest cities (cities preliminarily arranged in descending order by number of inhabitants)

4. Define the weighting coefficient (Ki) of each city using the formula: $\boldsymbol{Ki = CPiiCPi}$, i = 1 to **NCweighted**

5. Collect data for the normal monthly average temperatures of the selected cities[30)]:
$\boldsymbol{NMAT}$ij , i = 1 to **NCweighted**, j = 1 to 12
(1 = January, 2 = February, ….)

6. Define the country population weighted normal monthly average temperatures $\boldsymbol{CPWNMATj = Ki} \times \boldsymbol{NMAT}$ij ,
i = 1 to **NCweighted**, 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 $\boldsymbol{CPWNMATij}$
j = 1,2,3,……, NDi month, i = 1 to 12
(1 = January, 2 = February,..)
ND_{imonth}- number of days of month j

1. Assign the population weighted normal monthly average temperatures $\boldsymbol{CPWNMATij = CPWNMATj}$
to the dates corresponding to the middle of each month:

$CPWNDAT_{1\,16}$ = $CPWNDAT_{1}$ 16 January
$CPWNDAT_{2\,14}$ = $CPWNDAT_{2}$ 14 February
$CPWNDAT_{3\,16}$ = $CPWNDAT_{3}$ 16 March
$CPWNDAT_{4\,15}$ = $CPWNDAT_{4}$ 15 April
$CPWNDAT_{5\,16}$ = $CPWNDAT_{5}$ 16 May
$CPWNDAT_{6\,16}$ = $CPWNDAT_{6}$ 15 June
$CPWNDAT_{7\,16}$ = $CPWNDAT_{7}$ 16 July
$CPWNDAT_{8\,16}$ = $CPWNDAT_{8}$ 14 August
$CPWNDAT_{9\,15}$ = $CPWNDAT_{9}$ 15 September
$CPWNDAT_{10\,16}$ = $CPWNDAT_{10}$ 16 October
$CPWNDAT_{11\,15}$ = $CPWNDAT_{11}$ 15 November
$CPWNDAT_{12\,16}$ = $CPWNDAT_{12}$ 16 December

2. Define the population weighted normal daily average temperatures $\boldsymbol{CPWNMATij}$
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:
$AAT_{monthly} = (\sum \boldsymbol{CPWNMATi/12})$, i = 1 to 12
$AAT_{daily} = (\sum\sum \boldsymbol{CPWNMATij/365})$, i = 1 to 12,
j = 1 to ND_{imonth}

4. Calibrate $\boldsymbol{CPWNMATi}$ in order to reach the equality:
$AAT_{daily} = AAT_{monthly}$
by shifting $\boldsymbol{CPWNMATij}$ 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 $\boldsymbol{CPWNMATij}$ (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 TEM_{REF_SET1}

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

30) 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

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 (T_{satur}) – this is the value above which a further increase of the temperature does not cause an increase in the electricity demand (practically all available cooling devices have been switched on). This saturation concerns few countries in Southern Europe.

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

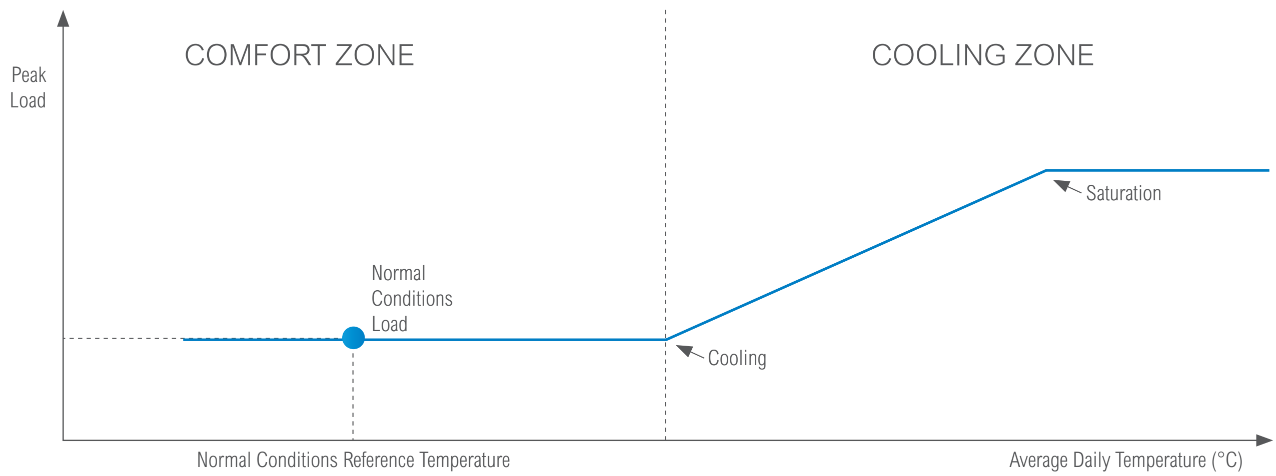
5. Model the relation between the peak load and the daily average temperature in the range T_{start} - T_{satur} by simple linear regression:

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

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

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

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



APPENDIX 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

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

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 that cover 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

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

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

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)

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