8 July 2019

Short-term and Seasonal Adequacy Assessments Methodology –

Explanatory note

(supplements the Methodology document for information and clarification purposes)

Disclaimer
This explanatory document is submitted by ENTSO-E to all Stakeholders for information and clarification purposes only accompanying the “Short-term and Seasonal Adequacy Assessment Methodology Proposal in accordance with Article 8 of the Regulation (EU) 2019/941 of 5 June 2019 on risk-preparedness in the electricity sector.

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Contents

I Introduction

Decarbonization of the electricity sector and massive integration of variable RES leads to increased need for regional cooperation in adequacy assessment and risk preparedness to prevent and manage electricity crisis. Seasonal adequacy assessments support decision making of stakeholders (MSs, NRAs, EC, ACER, Market Operators, etc.) to mitigate risks for coming season and bridges mid-term resource adequacy and short-term adequacy assessment. Short-term adequacy assessments are also gaining importance, especially considering pace of renewable energy expansion.

The risk preparedness regulation (RPR) of the clean energy for all European package stretches goals and framework of short-term and seasonal adequacy assessments. For these assessments, there is a need for a common approach to the way possible adequacy-related problems are detected. This document supplements the Methodology document with details on method to assess adequacy and explanation of concepts used in Methodology.

In this document, if not explicitly mentioned, same descriptions apply for both: seasonal and short-term adequacy assessments.

II Short-term and seasonal adequacy assessments–in general adequacy assessments context

Short-term and seasonal adequacy assessments have a different purpose than medium to long-term European resource adequacy assessment (from year-ahead to several years ahead). The use of medium to long-term resource adequacy assessment common methodology is prescribed in the Electricity Regulation 2019/943. It shall ensure that Member States' decisions as to possible investment needs are made on a transparent and commonly agreed basis. Short-term and seasonal adequacy assessments are used to detect possible adequacy related problems in short timeframes, namely seasonal (six months ahead) and month, week-ahead to at least day-ahead adequacy assessments. These assessments shall first ensure risk awareness for all relevant stakeholders and support system operation by identifying what are the risks and when risks exist. It can also support system operation planning to mitigate those risks (e.g. maintenance planning). Same methodological principles may be applied for short-term and seasonal adequacy assessments, however, latter assessment deals with higher uncertainty compared to short-term adequacy assessment, namely, but not limited, weather conditions.

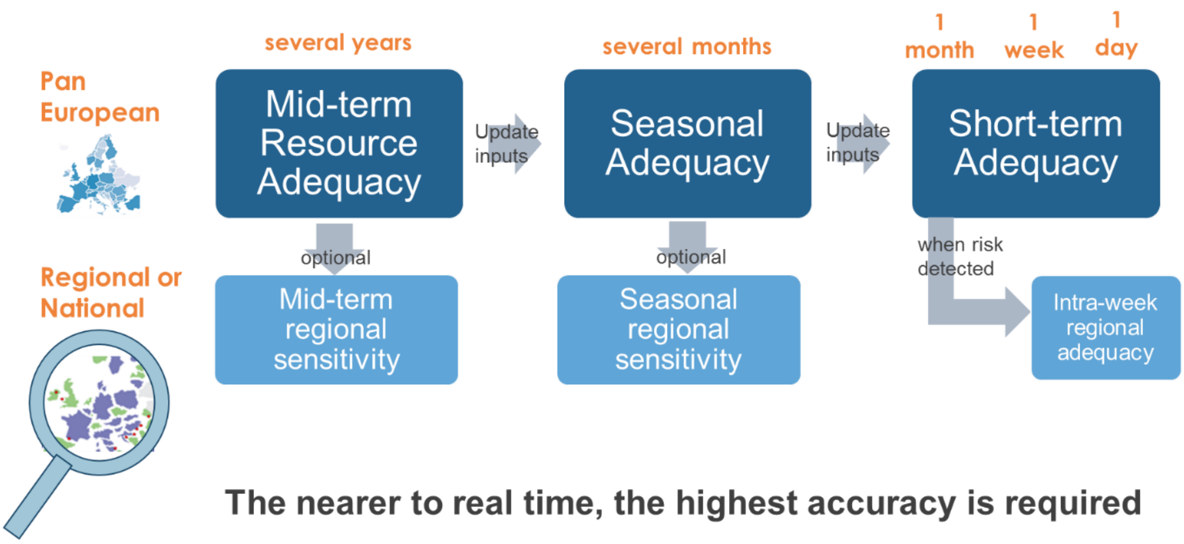

Figure 1. Overview of Pan-European Adequacy Studies

Several years ahead resource adequacy assessments need to use large set of dataset as probabilistic inputs, while in infra-week adequacy assessments some inputs can be forecasted (e.g. wind, temperature) and therefore modelled with lower uncertainty but still with probabilistic approach.

Seasonal adequacy assessments bridge mid-term and short-term adequacy assessments, giving insight on potential periods of adequacy risks using a wide range of climatic scenarios.

Short-term adequacy assessments, namely week-ahead to at least day-ahead, refines the inputs based on forecasts, thus dramatically reducing the incertitude, and can include ad-hoc regional studies with detailed network models to validate risks and evaluate counter-measures to mitigate adequacy problems detected in the pan-European phase of the assessment. This provides insight on the circumstances and contingencies under which risks would be credible. Furthermore, TSOs can trigger regional assessment even if no risk is detected but internal congestions could be anticipated.

Month-ahead adequacy assessment may be performed on TSO request if resource availability changes significantly compared to seasonal assessment. Month-ahead adequacy assessment is classified as short-term adequacy assessment and is in between of seasonal and week-ahead adequacy assessments. Very often in this timeframe information does not change significantly compared with seasonal adequacy assessment . Therefore, latest seasonal adequacy assessment already covers risks of most possible changes. Furthermore, the uncertainty of month–ahead study compared with seasonal adequacy assessment does not decrease as is the case with week-ahead adequacy assessments. On the other hand, in some rare occasions significant change of resource availability might occur. Example of such change could be an extension of planned outage of big generation unit or interconnection which will prevent unit to come back to operations and may have impact on adequacy in time-frame outside the following week-ahead time-frame. Therefore, month-ahead adequacy assessments might be performed if TSO estimate that situation has changed significantly compared to seasonal adequacy assessments.

III Scope of Adequacy Studies

1. Geographical perimeter

Geographical perimeter covers all ENTSO-E members and engages neighbouring regions to participate in adequacy study. The minimum requirements for geographical granularity is the minimum size between country and bidding zones.

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Figure 2 Geographic perimeter of short-term and seasonal adequacy assessments (status January 2019)

Furthermore, ENTSO-E endeavours to establish and foster cooperation with tightly interconnected system's operators. If those regions commit for cooperation on adequacy assessments, they could be modelled in same details as the core analysed systems. Otherwise, contribution to pan-European adequacy of those systems would be considered with the assumption of ENTSO-E's members having interconnections with those systems.

Explanation

Model element	Modelled Zone	Non-explicitly modelled system
Demand	Yes	No
Resources	Yes	No
Outages (forced and planned)	Yes	No
National Balance	Yes – result of resources, outages and demand balance	Yes – neighbouring TSO assumption
Interconnections	Yes	Yes – neighbouring TSO assumption
Impact of weather variability	Yes	No

2. Temporal scope

At least hourly temporal granularity shall be used in all studies covered by this methodology.

Short-term adequacy assessments
Week-ahead adequacy assessment is performed every day and covers 7 following days. This assessment also includes day-ahead timeframe required by regulation.

Seasonal adequacy assessments
Seasonal adequacy assessment covers at least a season as described in Methodology – period between 1 December and 31 March in winter adequacy assessments; and period between 1 June and 31 September in summer adequacy assessments.

The above study periods shall be considered as minimum requirements to be respected all seasons. It corresponds to the experienced risk periods for the security of supply in Europe. ENTSO-E does not exclude specific assessments in earlier or later weeks if there would be a potential risk.

IV Adequacy calculations general approach

Objective of adequacy assessments is monitoring if available supply and transmission capacities are enough to cover demand under various conditions; and if not, what, where and when the risks are.

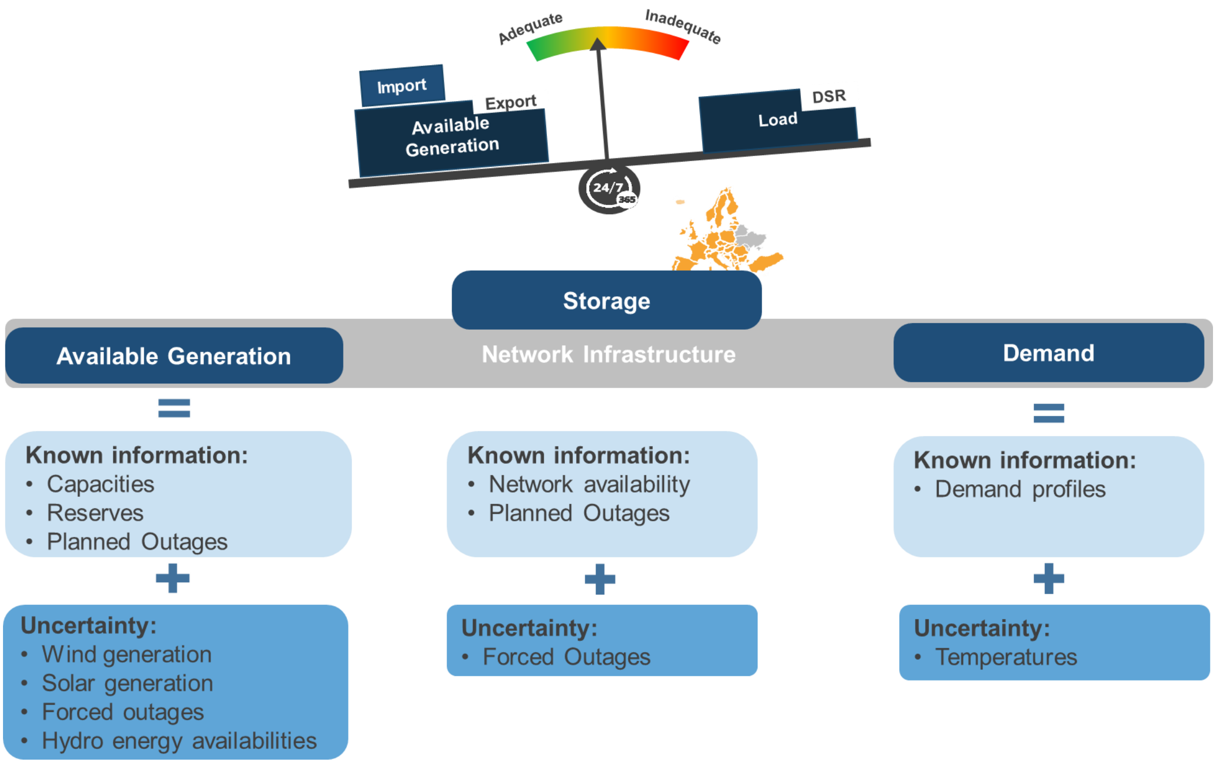

Figure 3: General Adequacy methodology

A number of possible scenarios for each variable are constructed to assess adequacy risks under various conditions for analysed timeframe. For all those scenarios, at least hourly calculations are performed for whole geographical scope.

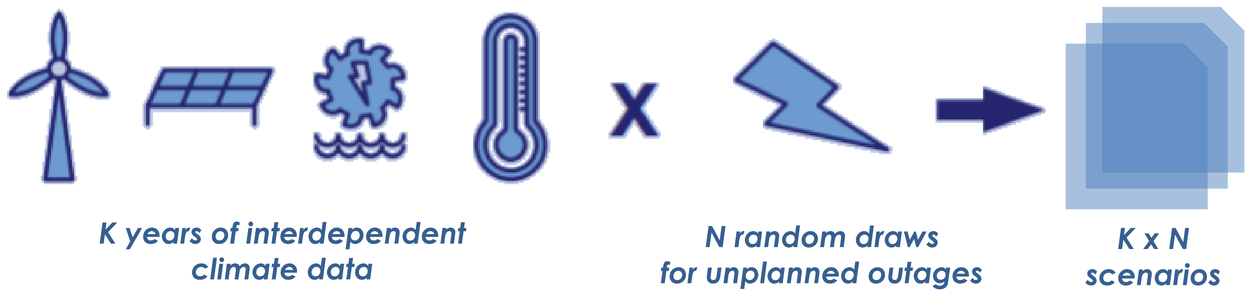

Figure 4: building set of scenarios

Scenarios are constructed ensuring that all variables are correlated (interdependent) in time and space. Correlation is ensured by the analysis of historical weather conditions and variable input statistical data (e.g. demand). To ensure highest quality of data used in assessments, they are prepared by experts working within dedicated teams.

Resources shall be considered if they are market based. Any non-market resources, as strategic reserves, shall be disregarded in the base case calculations. They may only be considered as a possible remedial action in sensitivity study.

Dispatch price (which sets a merit order) is determined on common fuel and CO_2 prices assumptions that are used as best estimate. These prices are future prices of CO_2 and fuels or when such prices does not exist, latest statistical information is taken (e.g. nuclear fuel prices).

Supply and interconnector availability consider scheduled maintenances and other known outages (mothballing, etc.). Unplanned outages of supply and interconnectors (HVDC and HVAC) are considered in probabilistic manner with the best expertise available by TSOs. However, modelling unplanned outages of supply units and HVDC interconnectors are rather straight forward, but modelling HVAC interconnection unplanned outages is more complicated, because these interconnectors does not represent a physical cross-border interconnectors, but rather represents physical capability to exchange energy between two systems.

V Model Elements

Adequacy models are built using three major pillars: demand (including demand-side response and system reserve requirements), supply (e.g. generation, storage units) and grid representation which connects demand and supply in different zones. Additionally, climate data are used to address uncertainties of three major pillars.

1. Demand

Demand data shall be best estimates of demand available at the assessment moment. This data set shall especially reflect electric vehicle and heat pump penetration as well as electricity growth assumptions. A number of demand profiles are created to represent demand variability on weather conditions.

Demand for system reserves shall be defined based on the practice of system operations of each specific system.

Furthermore, available contribution of market-based demand-side response as well as additional demand during charging of storage units shall be considered as individual elements responding to market signals. Demand-side response which provides system reserves shall be disregarded. .

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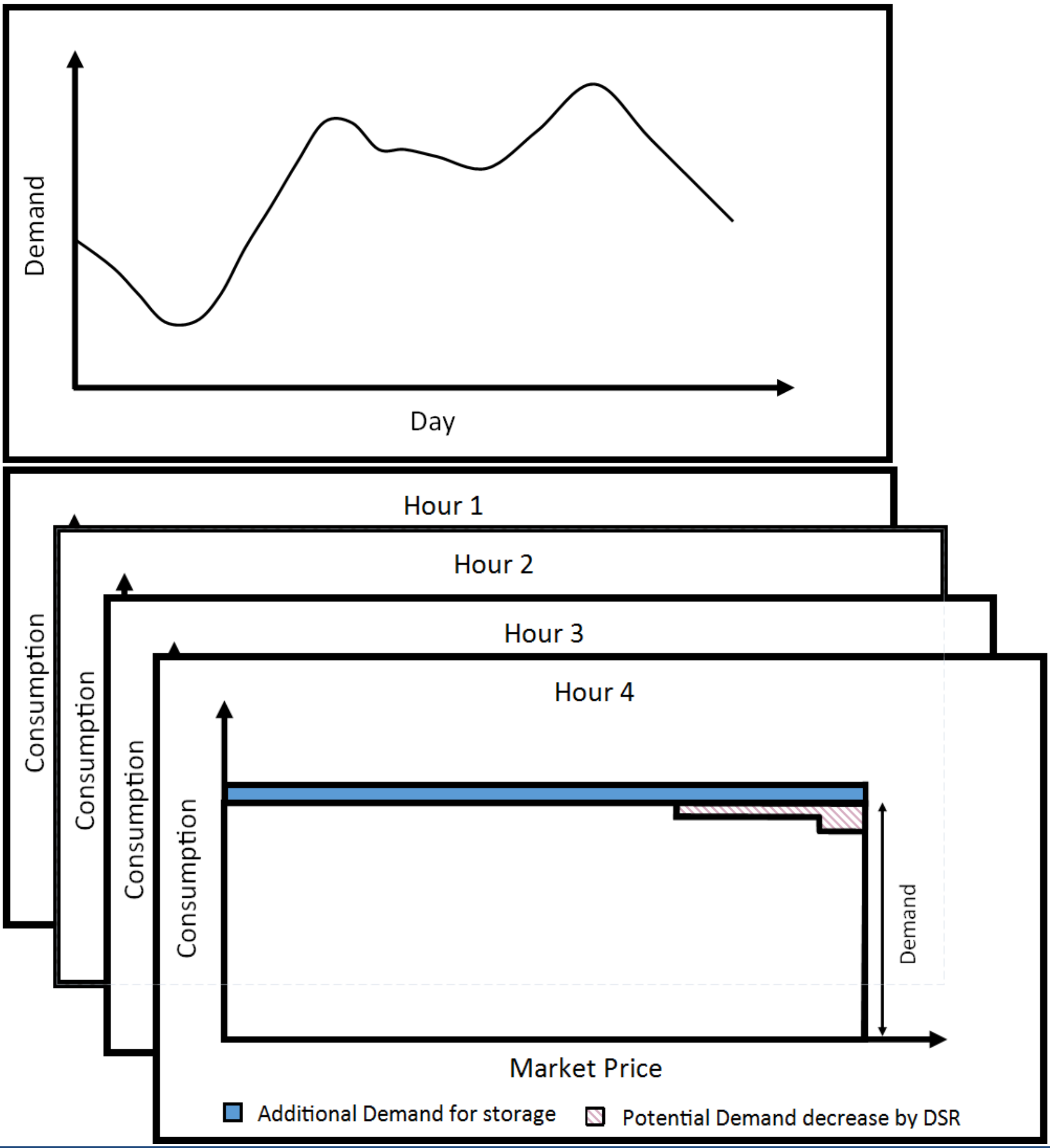
Example



2. Supply

Supply data shall include best estimates of available supply resources considering planned and unplanned outages. Any supply resources shall be considered. Supply resources may be generation, storage and available exchanges with non-explicitly modelled neighbouring countries. Hydro generation shall be modelled considering energy availability.

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Definition Explanation – Planned Outage

These outages are all outages known at the moment of adequacy assessment. These include maintenances, mothballing, existing outages due to forced outages and any supply unavailability due to other reasons.

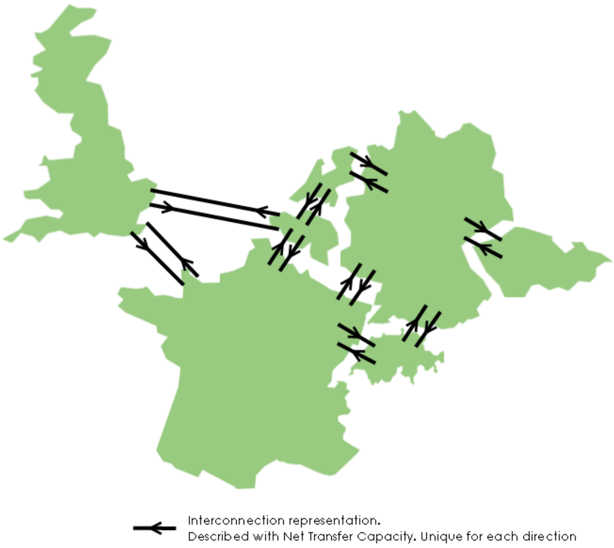
Definition Explanation – Unplanned Outage

These outages are not known in advance. Unplanned Outages may occur due to technical or human faults and are modelled as outages in addition to planned outages. A number of random drawings is taken considering forced outage rates of generation or transmission assets to consider such outages.

3. Grid

Zones are represented as copper plates (single nodes), which are coupled via modelled interconnectors. Interconnectors are described by NTCs for each border which are based on the best estimates made by TSOs. It is striven to improve grid representation in the future, especially through a Flow-Based representation where such market coupling is already operational. Grid representation shall be evolutive, considering market coupling of each specific region in all analyses (pan-European, regional and national).

Example – Net Transmission Capacity model



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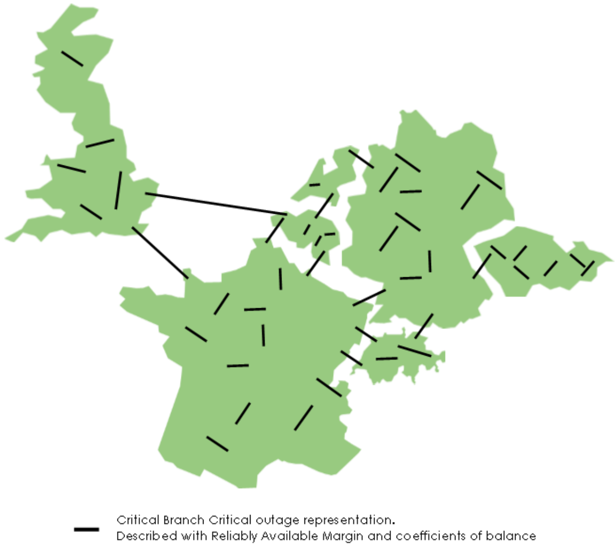
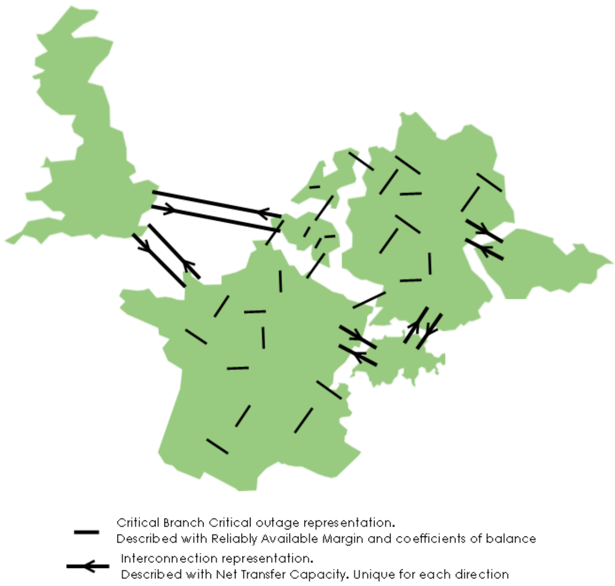
Example – Flow Based model



Example – Combined model



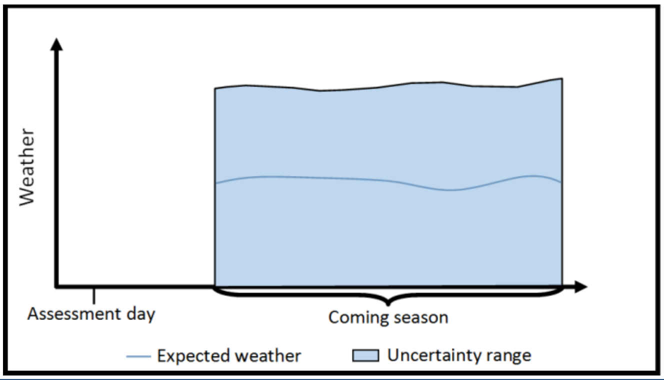
4. Climate Data

Various climate data are applied to consider variability of supply and demand. Wind, photovoltaic and concentrated solar power plant generation estimates as well as hydro inflow into hydro power plants are part of this data. Furthermore, other climate data, such as temperature and solar irradiance, are used to determine demand variability.

Seasonal adequacy assessments

These assessments are made rather long-time ahead of season, therefore forecasts for this time horizon are limited and uncertainty is high. Therefore, a variability of weather patterns by means of numerous scenarios is considered to account for potential risks. Correlation of all variables is ensured in time and space ensuring reliable assessment results.

Example

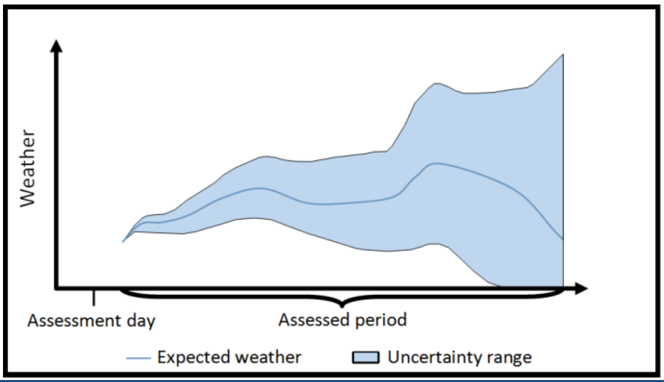


Short-term Adequacy Assessments

These assessments cover periods from at least day-ahead to month ahead. Some forecasts are available for this period and considered in study. Uncertainty of forecast is also accounted considering that uncertainty range of weather forecast decreases for study period closer to assessment moment (e.g. day-ahead).

The set of scenarios are built considering forecast uncertainty in different time horizon. Furthermore, correlation between each variable is ensured in time and space, based on historical data reanalysis.

Example



VI Indicators

Indicators are measures to quantify and interpret adequacy assessment results. Careful selection of indicators is important as well as explanation to the audience of their meaning. Furthermore, different indicators might be relevant for adequacy assessment results in analysis timeframes.

Seasonal adequacy assessment

A range of indicators might be used for seasonal adequacy assessments. Each indicator might provide specific insight on adequacy assessment; therefore, a combination of indicators might be used. For example, there might be a risk of load shedding affecting very small number of consumers, however for long period and therefore some might consider it as relevant. Further on, it might be the opposite as well–there might be a risk of very short supply scarcity which affects many consumers and therefore risk being very relevant.

Potential and well-known probabilistic indicators are described below. However, in some specific cases other indicators might be used, which would help to identify risks and quantify it. The need of such indicators might be considered in each study individually considering adequacy assessment results.

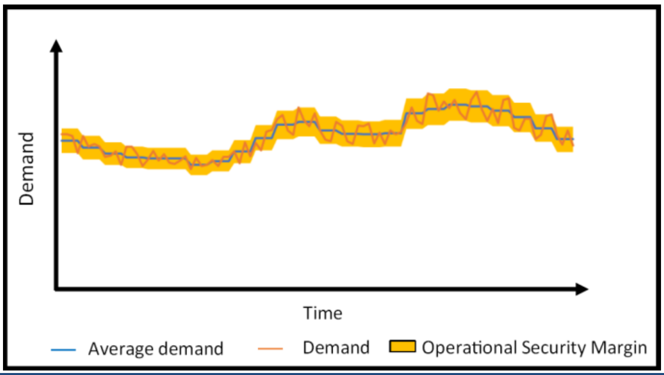
Loss of Load Expectation (LOLE) in a given geographical zone for a given period is expected number of hours when lack of market-based resources is expected to cover the demand needs with sufficient transmission grid operational security limits. This indicator is very useful for overview of adequacy in long period and is commonly used in adequacy assessments as mid-term adequacy forecast.

Explanation

Transmission grid operational security limits are margins necessary to ensure secure system operations. Those could be classified into two groups – power balance margins and network operational margins.

Network transmission grid operational security limits is ensured via application of N-1 operational security criteria. This security criteria ensures that any single contingency in a system can be managed. Furthermore, security margin is applied when determining exchange capacities (reducing NTCs or RAMs).

Power balance margins are needed to cope with variations of demand, generation and exchanges between zones. These are ensured through balancing reserves. In adequacy assessments capacity which is needed for balancing reserves are allocated to be always available for this purpose.



Expected Energy Not Served (EENS) in a given geographical zone for a given period, energy which is expected not to be supplied due to lack of market-based resources retaining a sufficient transmission grid operational security limits. This indicator describes the magnitude of adequacy issue expressed in energy for an analysed season.

Relative EENS is more suitable indicator to compare adequacy across geographical scope as it represents percentage of annual demand which is expected to be not supplied.

Loss of Load Probability (LOLP) in a given geographical zone for a given period, is probability to have lack of market-based resources to cover the demand needs with sufficient transmission grid operational security limits. This indicator represents likelihood of adequacy issues in an analysed period.

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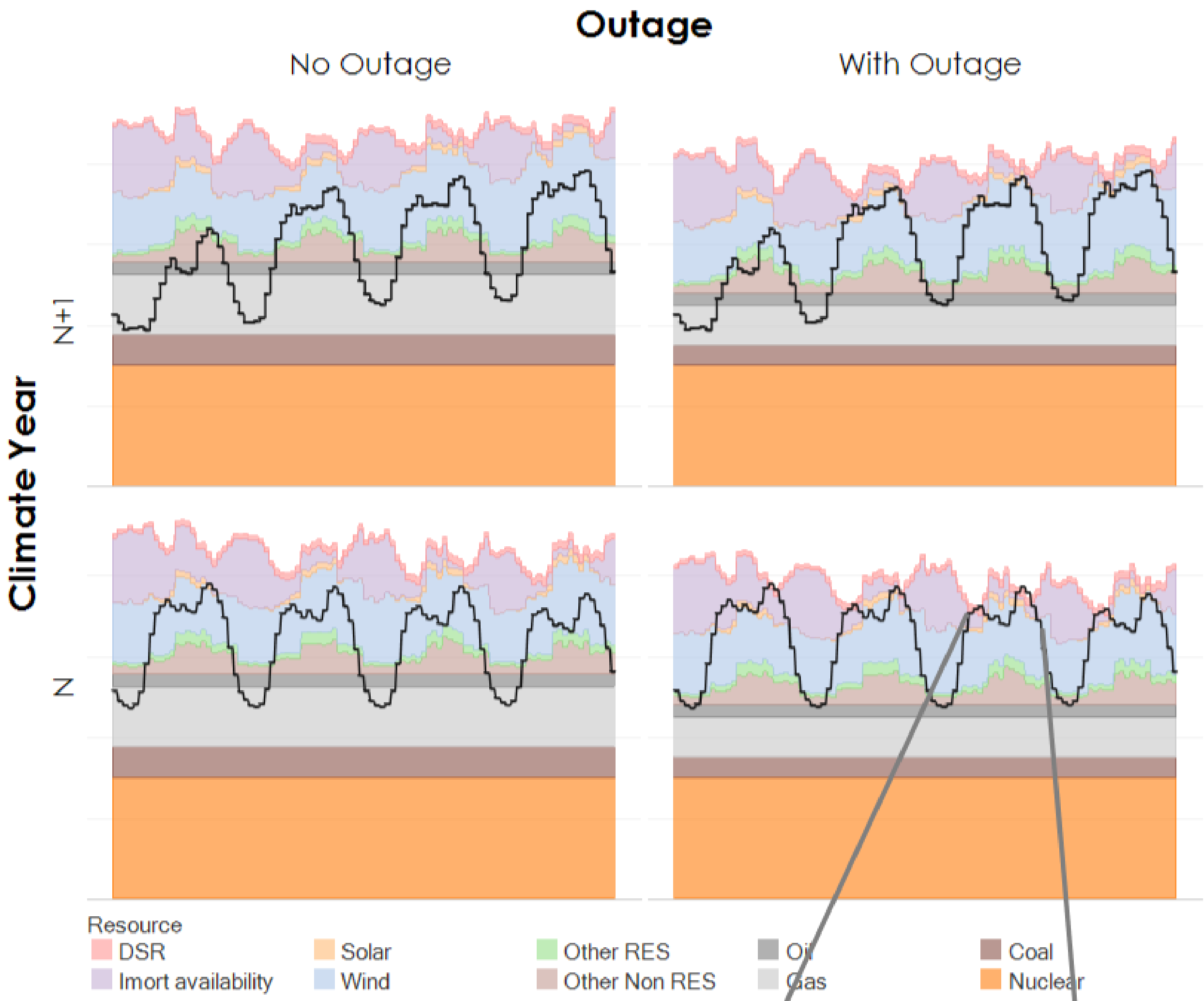
Example with 4 Monte Carlo samples



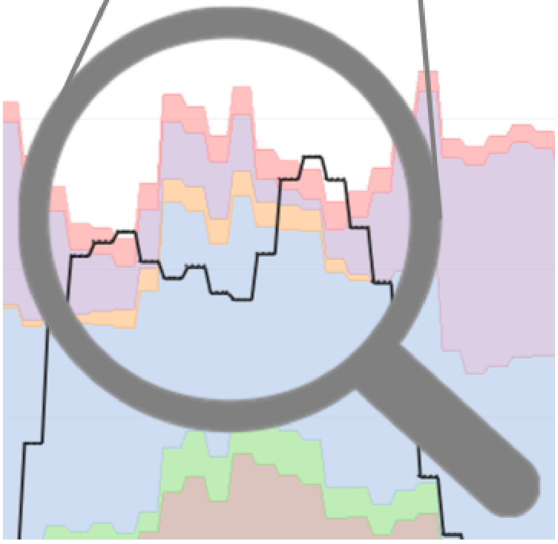
Indicators for this example period

LOLE—average number of hour with lack of market based resources to cover demand with sufficient security margins. LOLE = 3/4 = 0.75 h

EENS—energy which is expected not to be supplied with market based resources considering need of sufficient security margins. EENS is area between demand curve and resources divided by 4.

Relative EENS—EENS divided by annual typical consumption.

LOLP—probability of lack of market based resources to cover demand with sufficient security margins.
LOLP = 1/4 = 25%



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Short-term adequacy assessment
Adequacy probability indicator is main indicator to assess adequacy in short-term period. Furthermore, other supporting indicators are used such as expected energy not served and loss of load expectation. If high risk is identified, further analysis is performed.

Adequacy probability indicator in a given geographical zone for a given period, is probability of market-based resources being sufficient to supply demand with sufficient transmission grid operational security limits. Sum of this indicator and LOLP yields 100%.

VII Result analysis

Result analysis (and presentation) is integral part of adequacy assessment. This step of adequacy assessment employs indicators as a mean to present adequacy in assessed geographical perimeter.

Seasonal adequacy assessment

Seasonal adequacy assessment shall consist of three main steps. First, seasonal spatial screening shall be performed. Purpose of this is to give general indication for coming season in Europe. Second, temporal screening shall be performed to analyse when adequacy risks are highest. Third, and if relevant, circumstances under which risks exist shall be investigated.

Spatial risks screening shall present a generic indicator for the coming season on the large geographical perimeter. This shall raise awareness of adequacy situation in each assessed geographical zone as well as raise awareness of neighbouring zones. One of potential indicators can be relative EENS which is the ratio between EENS during the period and zone demand during the same period.

Example

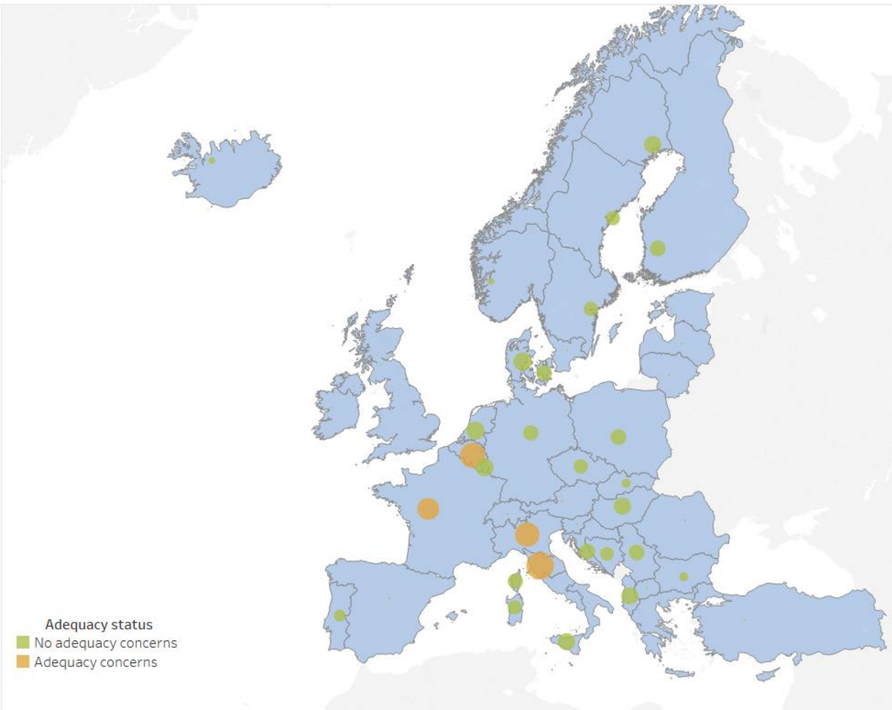

Figure 5: Principle of spatial screening (fictive example)

Temporal risks screening can be supported by a chart of LOLE or LOLP on European level at weekly basis (Monday to Sunday). This would allow to detect which weeks are mostly at risk.

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Example

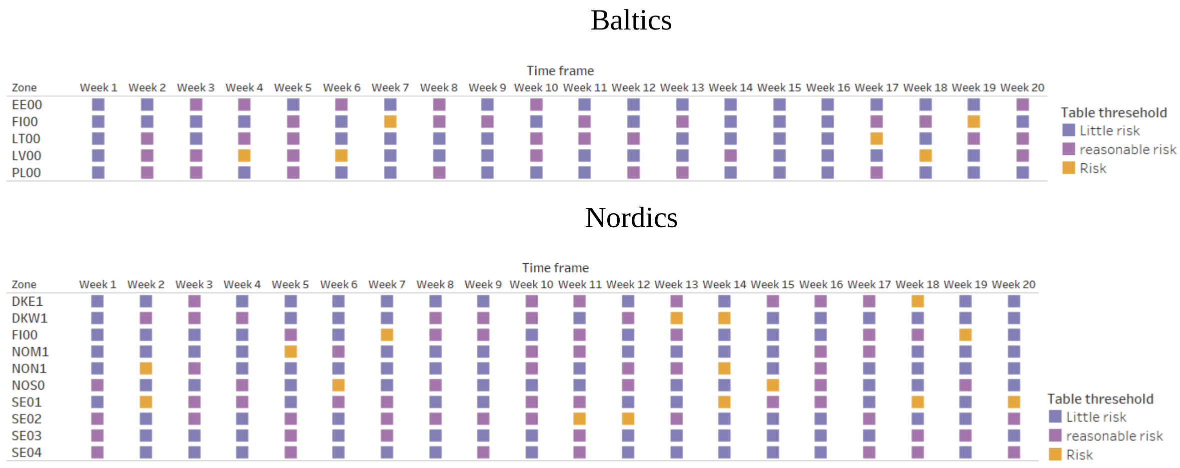

Figure 6: Principle of temporal screening (fictive example)

Dedicated analysis on risks in weeks with high risks shall be performed. This analysis shall focus on understanding the risk (magnitude, probability and any other related parameter) and identification of circumstances when risks are relevant. Any tailor-made analysis might be done for this purpose and will depend on case by case situation. Some of potential analyse which might be done are:

- 5th percentile of supply margin (considering available imports) for each zone in given week. This would represent margin under severe conditions;
  - Supply margin – for a given time-step and zone, supply and import still available after demand is satisfied. In case of supply scarcity, supply margin is negative and represents demand which would be needed to be shed.
- LOLP per zone at daily basis. This could be used only if relevant risk for specific day is identified (e.g. risk due to coinciding maintenances on one specific day);
- Expected Energy Non-Served (EENS) per zone at daily basis during critical weeks;
- Energy Non-Served distribution within week and heat map of when it is most likely to occur.

Example

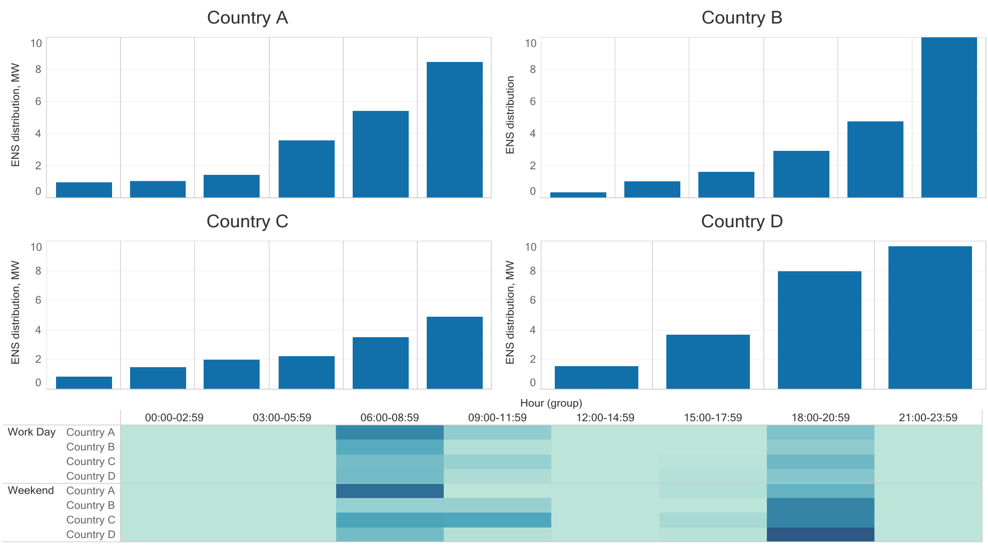

Figure 7: Focus on hourly risk within a given zone and week (fictive example)

For communication purposes it will be striven to communicate all results in easy perceiving format for non-technical readers. Some indicators could be translated into ‘tangible’ numbers–e.g. to representative thousands of households’ equivalent under potential load shedding or converting it to relative numbers (relative EENS).

Short-term adequacy assessment

Short-term adequacy assessment is performed in step-wise approach. First, system–wide lowest adequacy probability is investigated for each hour. If adequacy risk is identified at least for one hour, adequacy probability indicators are investigated for each study zone to understand extent of the risk (whether it is national or regional). Furthermore, adequacy under predefined scenario (e.g. most likely operational conditions) is checked to get a better quick insight on the risk. Lastly, resource availability and demand estimates are investigated to get a quality insight on adequacy risks and remaining resource margins for each systems.

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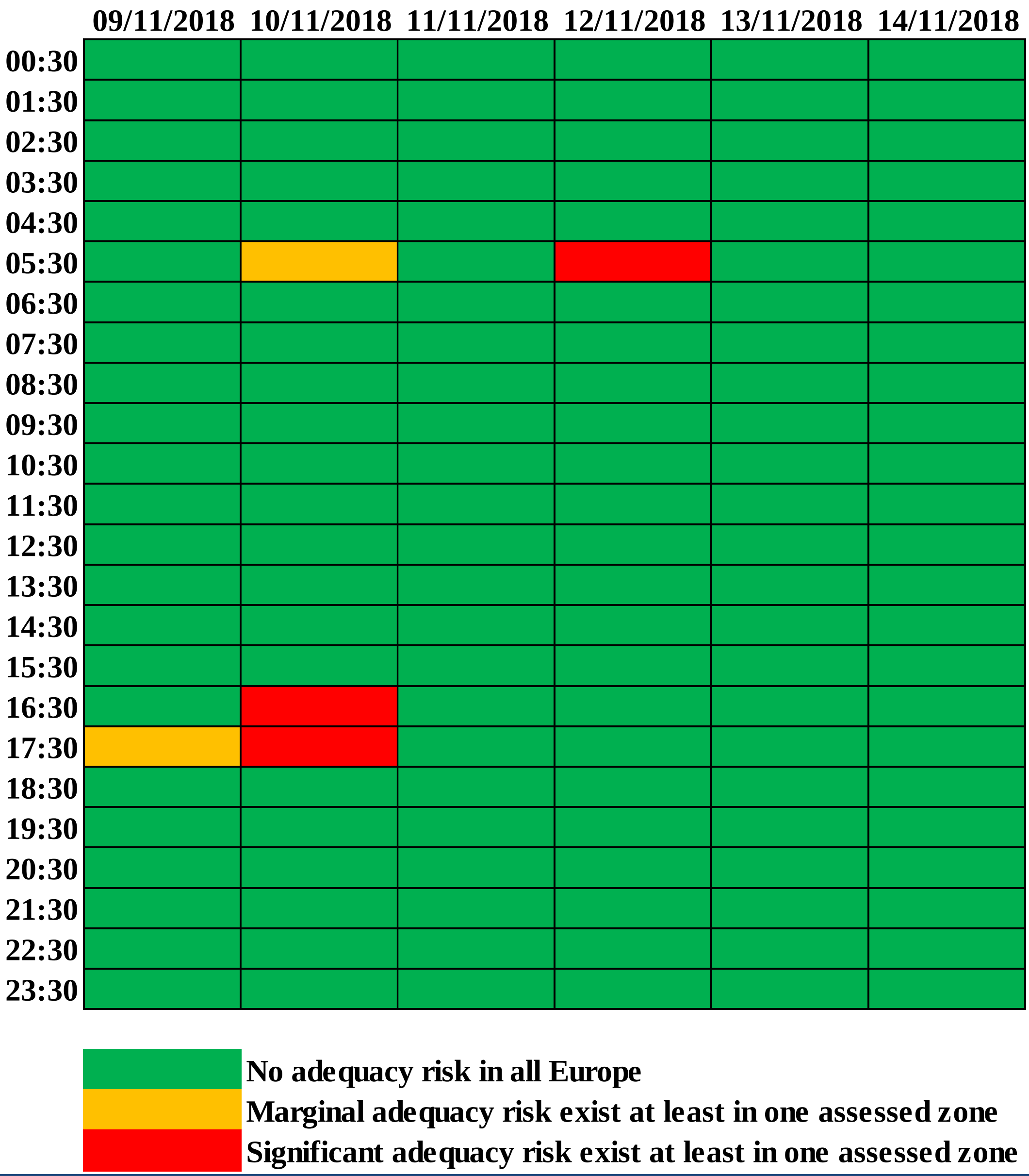
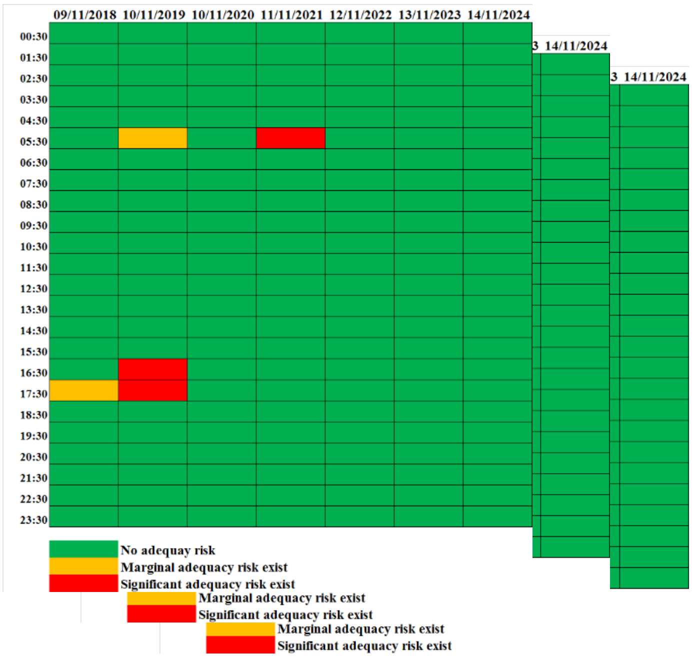
Examples

System-wide probabilistic results



Example–Study zone probabilistic results

Study zone A

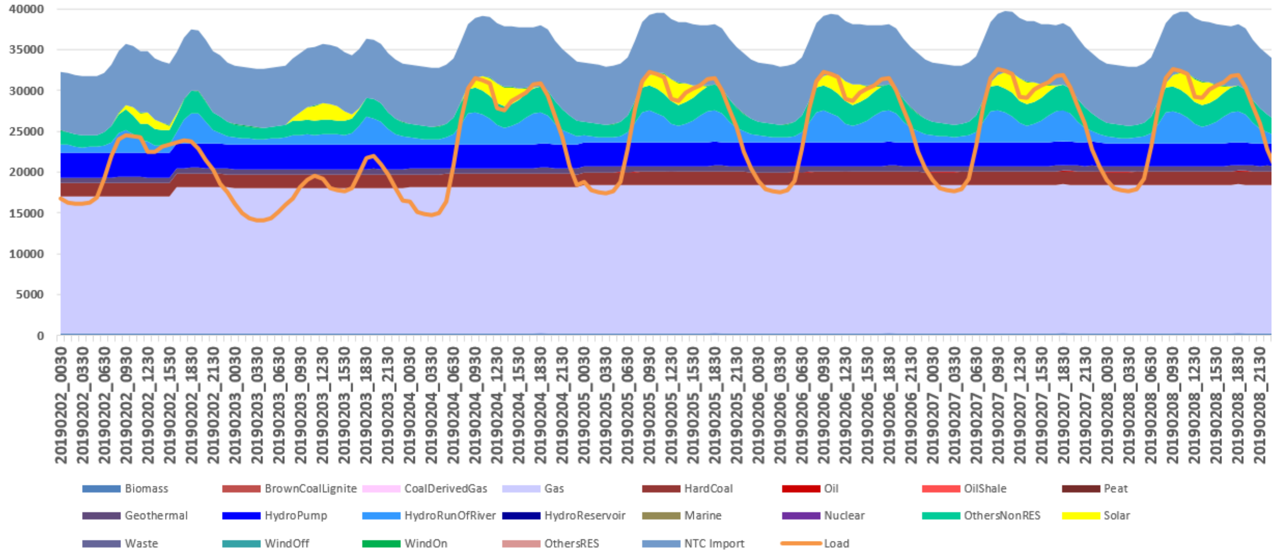


Example–Adequacy under predefined scenario

Study zone A

<u>Example</u>

<u>Supporting graph to assess adequacy risks. Supply availability and demand graph, along many other, might be used for this purposes.</u>



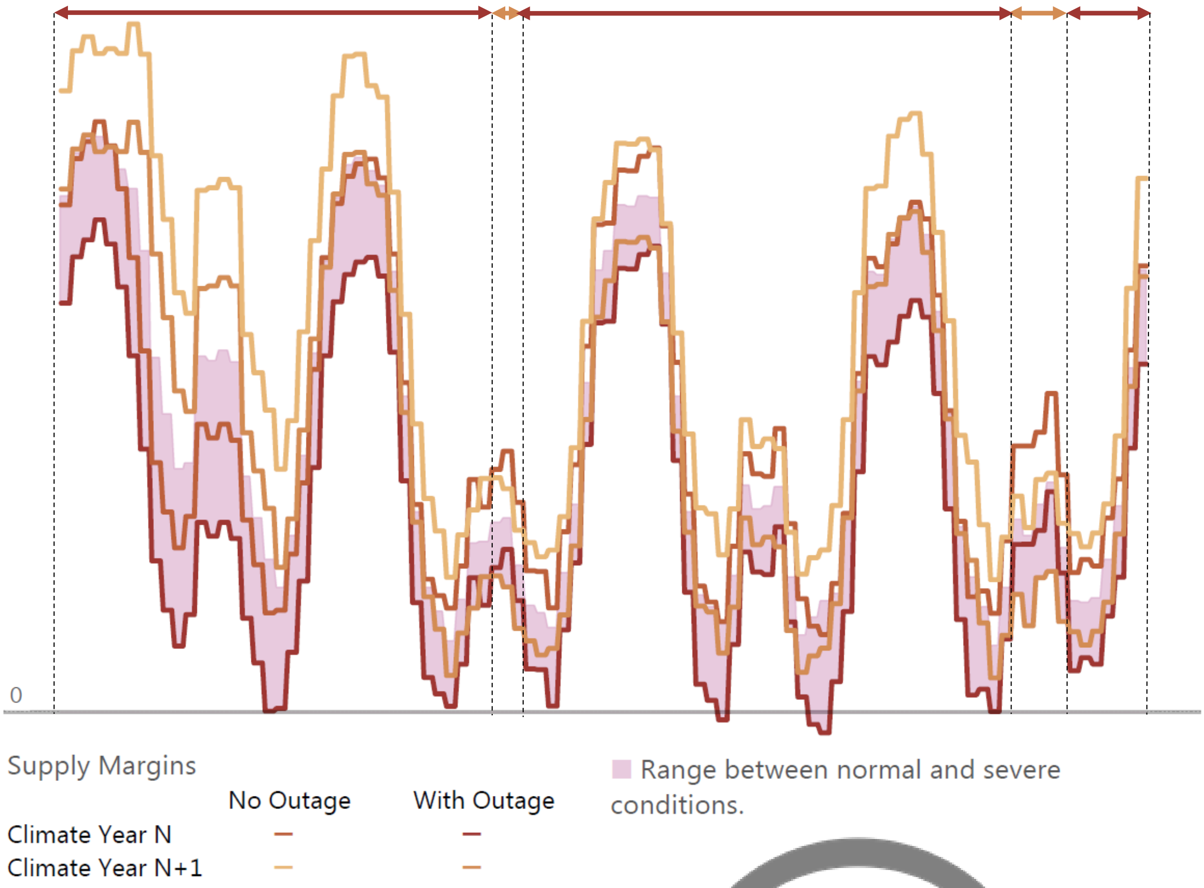
VIII Normal and severe conditions

Operational conditions are a combination of weather conditions and system element availabilities, which are determined in advance (e.g. planned outages) or unpredicted (e.g. unplanned outages), and includes import potential. Operational conditions are a combination of all conditions leading to specific margin in the system.

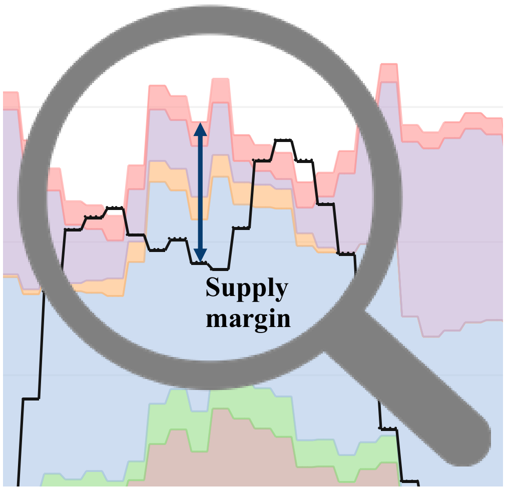
Normal operational conditions refer to typical operational conditions. This means that these are all possible combinations of weather conditions and system element availability scenarios leading to median of supply margin (50th percentile).

Severe operational conditions refer to extreme operational conditions. It is defined as all possible combinations of weather conditions and system element availability scenarios which lead to supply margin being close to 5th percentile.

Explanation–built on example with 4 Monte-Carlo samples in Section VI



Interpretation



Pink area represents supply margins (including available generation, DSR, imports and etc.) between normal and severe conditions. If supply margin of assessed scenario is below or close to bottom of this area, conditions might be considered as severe conditions.

Severe condition threshold is defined as 5th percentile of all possible supply margins. Normal condition threshold is defined as 50th percentile of all possible supply margins.

In given simplified 'Climate Year N with Outages' scenario conditions might be considered as severe condition definition. However, we may see that at some periods 'Climate Year N+1 with Outages' scenario represents severe condition situation.

Severe conditions might be supply margin level from high positive values to low negative–this is power system dependent characteristic. In exporting systems, it is likely, to be, but not necessary, high positive value, whereas in importing system it is likely to be, but not necessary, low negative value. In given example, it could be seen that under severe conditions resource margins get very tight.

With many analyzed scenarios (not presented in this example) combination of weather conditions and system element availabilities could be derived to describe severe and normal operational conditions.