European Network of
Transmission System Operators
for Electricity

Scenario Outlook & Adequacy Forecast Evolutions

Updated Version after Consultation

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1. Main stakeholder expectations

The main outcome of the inaugural stakeholder consultation workshop on ENTSO-E methodology improvements for adequacy assessments held by TF ADAM on April 16th was the identification and prioritisation of the Stakeholders' expectations.

In this context, the following main areas of improvement in the ENTSO-E adequacy methodologies applied in the SO&AF and in the Summer/Winter Outlook Reports have been identified:

2. Flexibility assessment

Due to the increased volatility of generation caused by renewables and rising fluctuations of load, a higher flexibility of the entire system is required. The current market structure does not provide the TSOs with sufficient conditions to meet the new flexibility requirements and this trend will continue in the future.
The overall goal is to measure potential lack of flexible generation in the expected power system operation.

3. Harmonization of methodology

The analysed scenarios should be harmonised on the whole geographical perimeter of the assessment to fully benefit from the assessment of the entire interconnected system as a whole. Thus, the datasets provided should have common underlying assumptions:

- TSO's should follow specific guidelines to calculate the figures requested for example GDP used in the demand forecast
- Some values could be built centrally to ensure consistency for example RES capacity factors, and TSO's will have the opportunity to validate and modify these values.

The core methodology should be the basis for short and mid-term reports (Outlook and SO&AF) even if slight particularities might be required.

4. Data transparency

The transparency of this reports data is based on the public access and its quality. The data can be arranged in subcategories such as: scenarios, sources, input and output. These subcategories can explain in more detail the evolution of the variables or parameters used in the methodology. Transparency of data in these subcategories will allow stakeholders to understand the evolution of the variables and parameters used in the methodology employed. However, confidence in the results and confidentiality issues might require some data to be publicly released in an aggregated manner.

Detailed specifications are an important part of the reports as it is necessary to have common understanding and procedure. The publication of this methodology is an important part for transparency of data and will be accessible to stakeholders through the public consultations foreseen.

5. Cross-border exchanges

An accurate adequacy assessment cannot avoid taking into account the role of interconnectors as a contribution to the ability of each area to balance its load and generation. In order to achieve this, a harmonized methodology to model the contribution of cross-border exchanges to adequacy is required. Such a model should consider the limited capacities between areas of the interconnected grid and properly evaluate the potential support provided by the interconnections to each area.

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6. Probabilistic approach

The objective is to implement a probabilistic methodology to better model the volatility and uncertainties of the system, and meet stakeholders' expectations.

7. Specific constraints on SO&AF reports

ENTSO-E publishes the SO&AF reports according to the provisions of Article 8 of Regulation (EC) 714/2009. As set by Article 8(4), the Outlook report shall cover the overall adequacy of the European electricity system for the next five-year period as well as for the period between five and 15 years from the date of the outlook report. National generation adequacy outlooks prepared by each individual transmission system operator shall serve as a basis for preparing the European generation adequacy outlook.

Mid-term analysis is characterized by growing uncertainty. Beyond an appropriate forecast period and a number of scenarios, balance should be found between the timely production of the outlook reports and the depth of analysis. The goal is to reduce as much as possible the time needed to collate the data from TSOs and publish the report. During this period several processes have to be followed including: data verification, iterations with TSOs, input preparation, adequacy simulations, analyses of the results, drafting of the reports and finally TSO approval process. It is key to optimize every step as much as possible to avoid time delays, repetition of processes and early advancement of the start of data collection.

To ensure an efficient data collection phase, ENTSO-E proposes to create default data centrally to provide a base value for the TSO's, and a backup value for when data is not provided on time. TSO's will have the opportunity to validate and modify these values. As the methodology transforms further, care has to be taken on the time needed to perform simulations.

8. Implementation timing of methodology evolutions

The transition of the current methodology for the SO&AF report should be a gradual step by step approach in order to ensure transparency of the evolutionary process, to allow all stakeholders to have a clear comprehension of the improvements in the reports, and to enable them to take all the benefits deriving from these evolutions.

Additionally, the time needed for ENTSO-E to effectively implement the necessary changes and develop and test necessary tools should be considered; this implies a minimal period required between subsequent evolutions in the proposed methodology.

For those reasons we propose an approach where the methodology evolves gradually year by year. Additional results will be introduced for every SO&AF report reflecting additional or improved assessments. Using a gradual step by step approach will allow ENTSO-E to gain experience on the improved methods as well as identify any potential problems and create solutions. It will also allow ENTSO-E to develop the necessary tools to improve the SO&AF report and most importantly to gather feedback from stakeholders on this new process whilst still maintaining a steady pace in the SO&AF methodology improvements.

9. Proposed improvements for next SO&AF Report related to the five main issues identified by stakeholders

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Step 1 (SO&AF 2015)

The proposed improvements are focused on the first SO&AF report to be published in 2015 in order to start with achievable improvements reflecting the key requirements mentioned in the methodology target documents and stakeholder expectations. As a preliminary step to this proposal, it will be necessary to ensure the consistency of scenarios.

Harmonization of assumptions taken and data used

More detailed categories for non-usable capacity in existing methodology can enhance data transparency for the assumption on the availability of variable generation. A similar approach to the present summer outlook report and winter outlook report methodology will be applied.

- Non-usability due to technological constraints such as energy resources availability, seasonality in hydro inflows and climate conditions and authorisation constraints.
- Better specification of the non-usability of wind and solar during the year related to the expected peak and real production in given reference time; non-usable capacity of wind and solar power plants to be computed centrally
- Non-usability due to portfolio optimisation *e.g.* generation costs, mothballed units, i.e. they are not available for activation in case of shortage of generating capacity/flexibility

To cope with these shortcomings, such as aggregated non-usable capacity where only a total capacity in MW is given for hydro, wind, solar and mothballed conventional power plants, an approach is proposed where ENTSO-E produces selected data centrally to provide a default value to the TSO's. TSO's are asked to validate the centrally generated values, and provide alternative values if desired. This approach will allow ENTSO-E to decrease the risk of time delays due to late delivery of data by applying a deemed acceptance principle.

Additionally ENTSO-E will provide a detailed description on how "normal conditions" was calculated and should be interpreted. It will remain the responsibility of the individual TSO's to determine the expected load under these "normal conditions"; however they will be asked to provide the temperature assumptions in order to allow central simulations of load fluctuations under different temperature conditions to be projected, enabling ENTSO-E to produce consistent regional "severe conditions" scenarios complementing those national severe conditions already reported by the TSO's.

Assessing the system flexibility

Assessing the flexibility of generation is a complex issue, the current SO&AF methodology assesses remaining capacity and analysis of the system margins cannot show the potential lack of flexibility in the system. Since present analysis is limited to reference times, not all critical situations can be captured and information on correlation of simultaneous events is necessary. However, an assessment can only be done based on time series of load, wind and solar production. The most efficient way to combine the effect of different weathering impacts is the assessment of the residual load.

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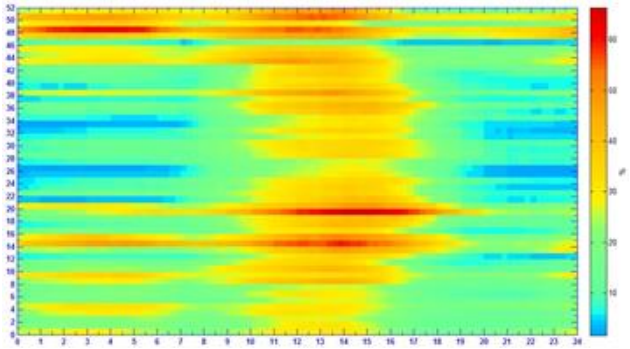

Figure: An example for assessment of the temporal distribution of residual load

It requires hourly time series for one year for load, wind and solar generation. Yearly load curve needs to be standardized on 'temperature normal'. For wind and solar we can use data from the PECD.

Considering different scenarios, we need to ask for different load curves/time series including dependence on the main drivers for electricity demand (Temperature, GDP growth rates, EV penetration levels, energy efficiency measures, etc.). As a first step, we need to harmonize the methodology. For load time series collection, a data collection platform has to be developed based on the current experience with PECD data collection. Consistency checks can be performed in order to evaluate the validity of data submitted by the TSOs.

Results of residual load assessment:

- Statistical distribution during the year,
- Daily or weekly chromatic representation of maximum and minimum occurrence,
- Ranges – spreads between daily/weekly minimum and maximum to be balanced by the system,
- Short term residual load volatility based on statistical analysis of the ramps, and
- Hourly fluctuations based on the simulations of climate factors such as solar PV, wind load factors all available from the Pan European Climate Database.

Enhancing transparency towards stakeholders

One of the main expectations identified in the inaugural consultation workshop, was increased transparency towards stakeholders. In the current SO&AF report a high-level description of the methodology used is already included.

We propose to increase transparency in the SO&AF reports, both on the methodology and the inputs, outputs and assumptions taken. First of all the applied methodology, including the models for considering cross-border exchanges, descriptions of the scenarios including RES will be described in more detail.

Secondly more information will be published on the assumptions taken including the following:

- Evolution of installed generation capacity throughout Europe on a regional basis, separated by power plant type
- Sensitivity of consumption to temperature conditions
- Transparency on key assumptions related to load forecast including *e.g.* GDP growth rates, number of households and energy efficiency efforts.
- Expected consumption per country for normal and severe conditions

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- Load management potential
- Publish all acceptable data respecting confidentiality issues (SO&AF country balances)
- Assumptions on unavailability

Improvement of the treatment of cross-border exchange capacities

It is proposed to improve the data collection procedure by also including a request for bilateral NTC values at the time points used for the adequacy analysis.

Extension of the SO&AF reports with a probabilistic assessment of RES and temperatures

For the assessment of the flexibility in the next SO&AF report it will be necessary to do reclassification and formulation new categories, balance formulas for hourly assessment and load curves for sensitivity analyses.

Especially due to the integration of variable RES, stochastic factors play an increasing role in generation adequacy. Probabilistic adequacy assessment methods are able to take into account stochastic effects; and the adequacy indicators resulting from the analysis can be used for the quantification of risks related to generation adequacy.

For the evaluation of probabilistic adequacy indicators, two basic techniques can be applied:

- Analytical approach (mathematical models providing mathematical solutions)
- Simulations techniques

Several TSOs have tools to perform probabilistic production simulations computing adequacy indicators. ‘Adequacy runs’ were part of the TYNDP 2014 Pan-European market studies enabling the assessment of generation adequacy after thermal reductions.

The proposed SO&AF reports analyse the expected level of adequacy considering the following scenarios.

10. Definition of scenarios

At present, the Adequacy Forecast assessment of the SO&AF report considered three scenarios: EU2020, Conservative Scenario (A), and Best Estimate Scenario (B). These three scenarios cover the period until 2020/2025. The Scenario EU2020 has the underlying assumption that the government targets set in the National Renewable Energy Action Plans or equivalent national plans are met by 2020.

In the Scenario Outlook part of the SO&AF report the four “2030 Visions” are provided for the 2030 time horizon. The different scenarios and Visions serve as a basis for the generation outlook projections on renewable and conventional generating capacity for the mid-term and long term assessments respectively.

The *current mid-term forecast scenarios* are subject to a high level of uncertainty and considering that it can take several years to build a new power plant (with its related condition, e.g., planning consent status, financial closures, etc.), two bottom-up scenarios [Conservative Scenario (A), and Best Estimate Scenario (B)] have been developed to help in assessing the range of uncertainty and to evaluate the risk for the security of supply over the coming years and the observation of the market conditions.

Total Net Generating Capacity and its breakdown by primary energy sources are provided for each country according to these generation scenarios. Beyond Net Generating Capacity forecasts, the individual country balances assess the level of unavailable capacity and contain forecasts for load, load management range, import and export capacities.

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Harmonization and transparency of the proposed methodology will be considered in the construction of the two mid-term scenarios for adequacy assessment in SO&AF, Conservative scenario (A) and the Best estimate scenario (B).

Both scenarios consider time series of load, wind and solar, which are related to PECD

Conservative scenario (Scenario A)

In this scenario, the real investment in generation is assessed for all considered technologies in each country, including, the delay of the buildings plans, the application of energy policy that concerns CO_2 reduction, the integration of RES, also the realistic estimated fuel prices and realistic market conditions. Only sure investments can be taken into account whose commissioning decision can no longer be cancelled.

Regarding decommissioning, the most likely shutdown of power plants expected during the study period should be considered, the decommissioning can be based on additional criteria such as technical lifetimes.
Load forecast in this Scenario is the best national estimate available to the TSOs, in relation to the Pan European measurement and temperature. It is estimated according to technical, economic and political assumptions, especially on demography, economic growth and energy efficiency policy, where the application of energy policy delivers “the best results” of its application, and assumptions on market structure.

Best estimate scenario (Scenario B)

This scenario has clear incentives based on reasonable regional economic considerations and the planning consent status of new power plants in the definition of the scenarios of generation projects and will based on the gathering of national best-estimates scenarios available to the TSOs with adjustment (as long as the principles for building these individual "best estimate" scenarios are sufficiently harmonized). The decommissioning of power plant should be treated as a realistic scenario. Load forecast in this scenario is the best national estimate available to the TSOs, in relation to the Pan European measurement and temperature. It is estimated according to technical, economic and political respective assumptions, especially on demography, economic growth and energy efficiency policy, where the application of energy policy delivers “the best results” of its application, and assumptions on market structure.

ENTSO-E is aware of the added value of harmonizing the principles for building these individual "best estimate" scenarios between TSOs.

Visions

The visions from year 2030 are used as a bridge between the European energy targets for 2020 and 2050. The Visions are not forecasts and there is no probability attached to them. These Visions are based on previous ENTSO-E and regional market studies, public economic analyses and existing European documents. A dedicated Task Force within ENTSO-E (TF Scenario Building) exists for the definition of these long-term Visions.

This is a markedly different concept from that taken for the three Scenarios EU2020, Conservative Scenario (A), and Best Estimate Scenario (B), which aim to estimate the evolution of parameters under different assumptions.
On the other hand, the 2030 Visions aim to estimate the extreme values, between which the evolution of main parameters is foreseen to occur. Visions are scenarios designed for grid infrastructure analysis, which typically require to consider a long term horizon ~15 years ahead. Visions present ’Storylines’ of possible futures within certain socio – political – economic – technological assumptions. These are not precise predictions of the future but possible *visions* of the future upon which the grid should be optimized.

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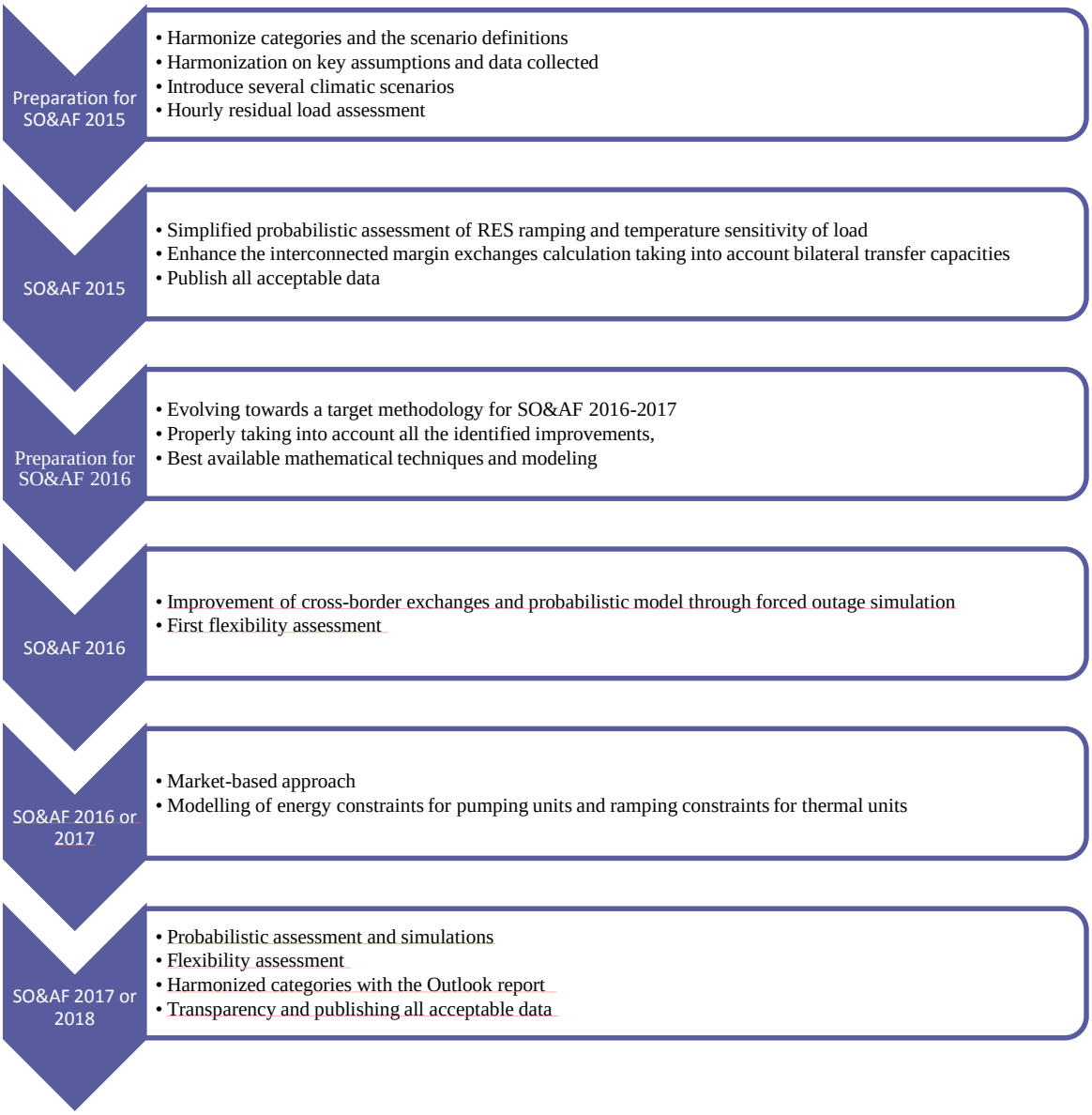
On the other hand the 'Conservative' Scenario (A) and the 'Best Estimate' Scenario (Sc B) are different than the Visions in the sense that these scenarios are defined and used to assess the risk of the system due to lack of adequacy and to provide a diagnosis of the status of the system in the mid-term future. In this sense these scenario A and B shall build on national generation adequacy outlooks prepared by each individual transmission system operator

11. High level steps for forthcoming SO&AF reports

After the first improvement step described above, in order to evolve the current methodology towards a target methodology which properly takes into account all the identified improvements, with the best available mathematical techniques, the following successive steps have been identified:



Step 2 (SO&AF 2016)

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An improvement step will be made in the methodology which will be applied in the SO&AF Report 2016. In order to improve the probabilistic approach, which will have already been introduced in a simplified way for the SO&AF Report 2016, the adequacy assessment will have an hourly resolution over the whole period covered by the study.

Additionally to the RES infeed and temperatures, which are already treated as probabilistic inputs, also forced outages of generators and interconnectors will be simulated as a probabilistic variable. This evolution will allow a more detailed modelling of cross-border exchanges in which, not only the impacts of the planned outages of the interconnectors on the cross-border capacities, but also their forced outages are taken into account in the simulations.

Hence, the level of reliability of the Pan-EU electricity system will be assessed throughout an hourly probabilistic simulation of the whole interconnected system in which, for every time point (hour), an optimization procedure will try to cover the estimated load demand of each country using the generation capacity available both inside the country and in other countries, properly taking into account the constraints on the interconnections.

It should be pointed out that in this step no market model will be introduced; hence a simple simulation of the exchange of capacity margins is performed.

Additionally, due to the complexity of such constraints and the high amount of data required, no links between subsequent hours of the simulation will be taken into account (e.g. energy constraints of pumping units and ramping rates of thermal generators will not be modelled).

Additionally, a first simplified flexibility assessment will be introduced in the report, taking into account the data collected according to the forecasted evolution in step 1 and the ramping ability of the generation park and data on power plant ramp rates. This assessment will be performed separately from the probabilistic simulation and it will be aimed at assessing the ramp requirements to face with load and RES volatility, comparing these requirements with the ability of the generation park to follow such kind of ramp.

Step 3 (SO&AF 2016 or 2017, depending on available tools)

Although a model which simply simulates the exchange of capacity margins might be enough for an adequacy assessment, the future ENTSO-E adequacy studies will be integrated with appropriate market simulations. It is to be analysed what detail in such a model is appropriate for the SO&AF reports considering the specific constraints related to these reports.

These simulations will provide an estimation of the expected cross-border flows and, in addition, such modelling will allow ENTSO-E to produce an extensive range of indicators such as: e.g. loss of load expectancy LOLE, the loss of load probability LOLP, full load hours of generation, RES curtailment, effective load carrying capability ELCC, etc. In addition other types of general indicators, such as CO2 emissions will also be reported as an output of the simulations since have been listed as indicators of importance by Stakeholders

To maximize the quality of the obtained results, the study will be improved with an appropriate modelling of the constraints which requires a link between subsequent hours of the simulation, energy constraints of hydro-pumping units and ramping rates of thermal generators.

Step 4 (SO&AF 2017 or 2018)

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The last step considers obtaining the result of the methodology with a probabilistic assessment and simulations, the harmonized categories with the outlook report, the flexibility assessment with transparency and publishing all acceptable data and the coherency with the bidding zone review process.

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