Stakeholder Workshop on the European Resource Adequacy Methodologies

Stakeholder workshop
16 December 2019
9h00-15h00, ENTSO-E

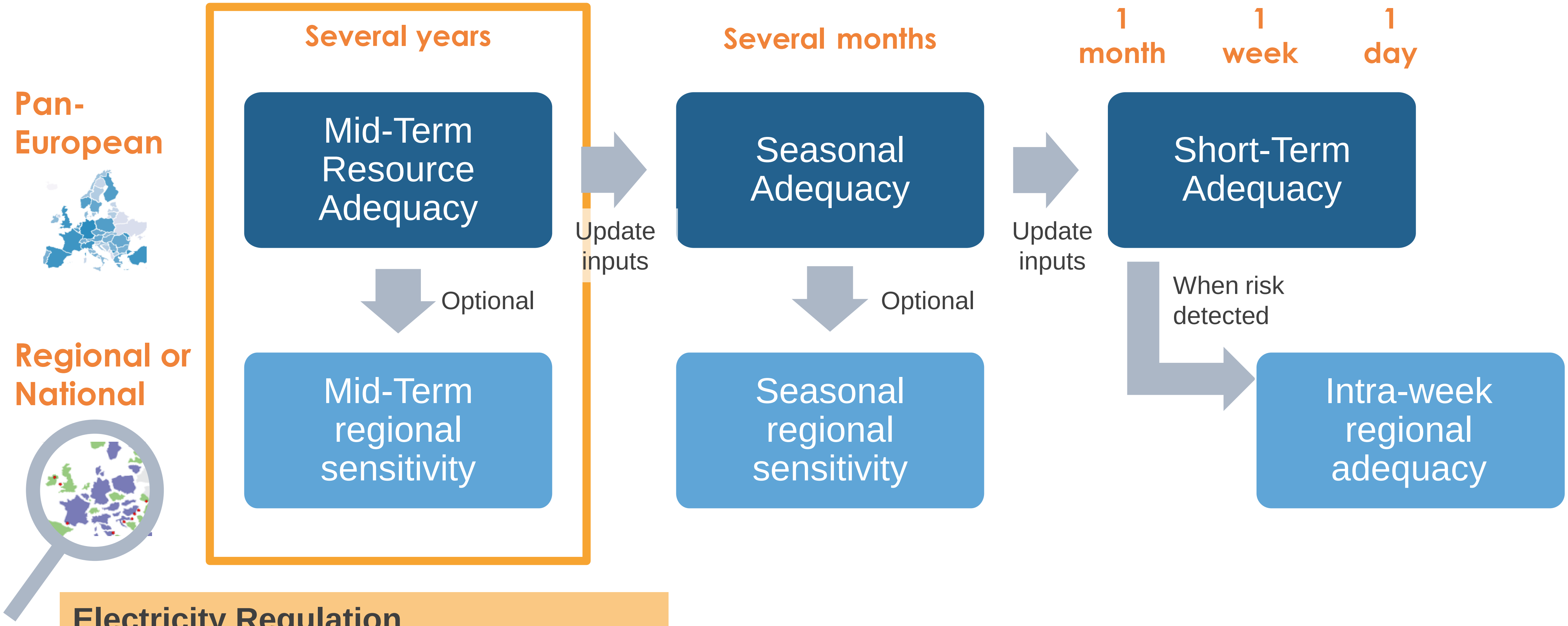
Agenda

1	Welcome and introduction
2	European Resource Adequacy Assessment methodology (ERAA)
3	Value of Lost Load methodology (VOLL)
4	Cost of new entry methodology (CONE)
5	Reliability standard methodology (RS)
6	Next steps on methodologies and conclusions

1. Welcome & introduction

Kristof Sleurs, Convener,
Mid-Term Adequacy Steering Group, ENTSO-E

Ensuring resource adequacy in all time horizons & regional scopes



Electricity Regulation

- Extend and replace MAF as of 2021
- Enhanced ambitious probabilistic methodology

The European Resource Adequacy Assessment

Three main methodology packages (to be delivered by ENTSO-E):

1. Methodology for the European Resource Adequacy Assessment (ERAA) (art. 23)

2. Methodology for:
   - Cost of New Entry (CONE)
   - Reliability Standards
   - Value of Lost Load (VoLL)

3. Methodology for calculating the maximum entry capacity for cross-border participation to Capacity Mechanisms (art. 26.11a)

European Resource Adequacy Assessment :

A basis for enhancements of market design and integration & security of supply

Methodologies to be developed within 6 months after entry into force

One adequacy methodology for European, regional and national assessments

Common adequacy indicators as a basis for regionally coordinated national security of supply standards

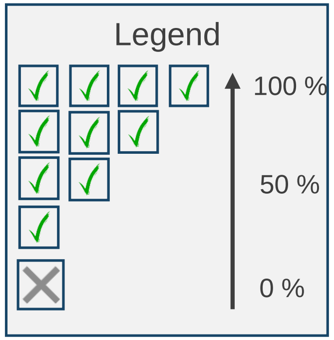
Pan-European and national assessments complementing each other in a consistent approach

2. European Resource Adequacy Assessment methodology

Daniel Huertas Hernando,
Convener, Task Force
Adequacy, ENTSO-E

Adequacy Assessment: current MAF already covers a large part of CEP requirements, but needs significant enhancements

Topic	MAF 2019	Target Methodology	Status	
Modelling approach	Probabilistic approach	Probabilistic approach	✓ ✓ ✓ ✓	
Communication	Annual publication	Annual publication	✓ ✓ ✓ ✓	
Network	NTC approach. Testing flow-based since 2018.	Compliance with FBMC	✓ ✓	Work in Progress
Time granularity	2 Target Years	10 Target Years	✓	
Available capacity	Bottom-up expectations: (de-)commissioning up to 7 years ahead	Economic viability of generation assets, integrated in the model (10 years ahead)	✓	Work in Progress
Capacity Mechanisms	No explicit CM considerations; Missing capacity investigation	Integrated consideration of CM	✓	Work in Progress
Sectorial coverage	No sectorial integration	Sectorial integration (P2X consideration)	✗	new



Structure of the European Resource Adequacy Assessment methodology

- Whereas
- Article 1 Subject matter and scope
- Article 2 Definitions and interpretation
- Article 3 Scenario Framework
- Article 4 European Resource Adequacy Assessment – Description
- Article 5 Data Collection
- Article 6 Economic viability assessments
- Article 7 Outputs, Results and Conclusions
- Article 8 Stakeholder Interaction
- Article 9 Process
- Article 10 Implementation

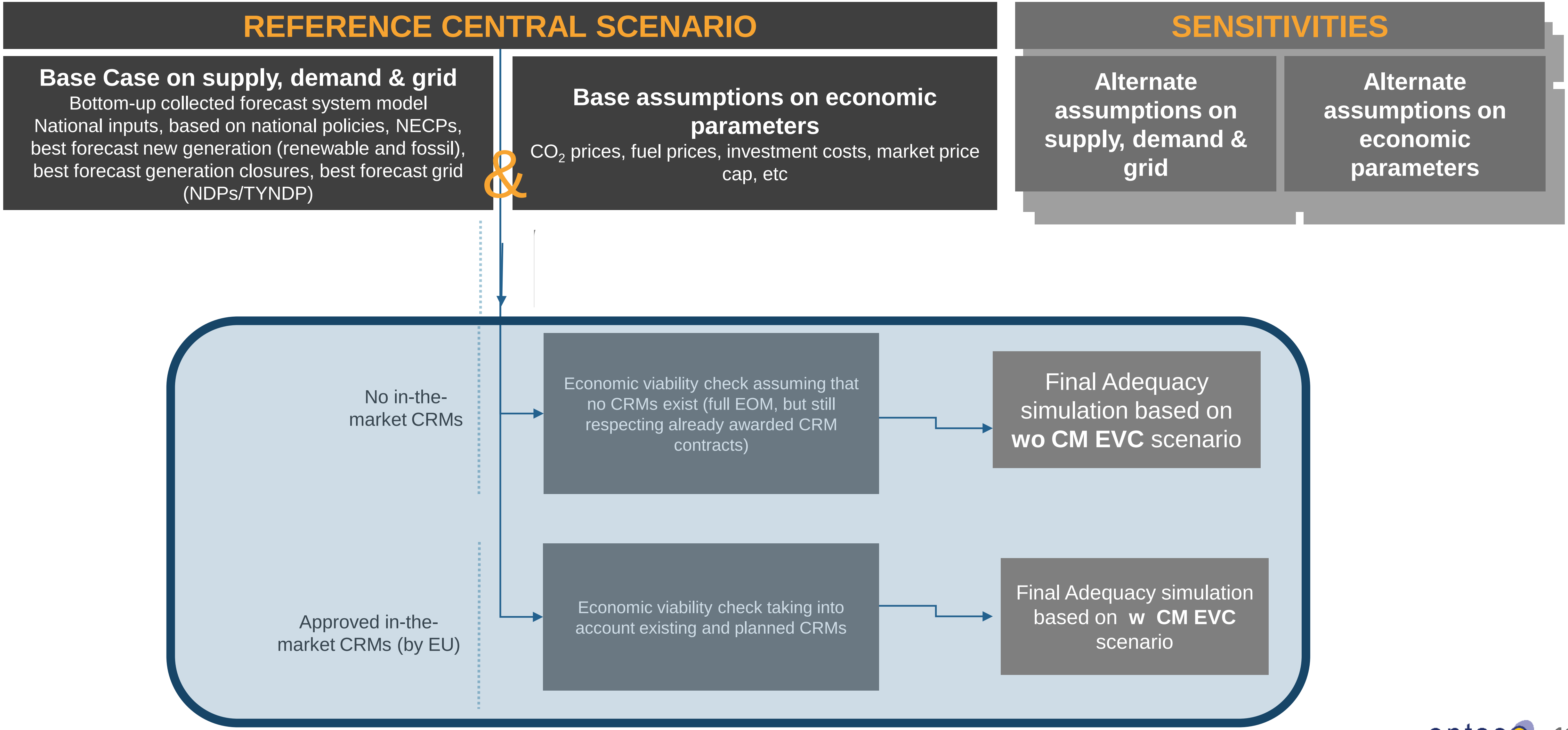
Scenario framework and Economic Viability Check

Based on NECP, in close coordination with TYNDP

Split between policy versus non-policy assets

Scenarios with and without CM, using transparent assumptions (e.g. CO2 prices, Primes, WEO, input from Market Parties, National consultations, etc..)

European Resource Adequacy (ERAA) concept



Modelling framework

Builds on and enhances ENTSO-E databases used for TYNDP/MAF (demand, supply, network, climate, etc)

Probabilistic Monte Carlo simulations (including large number of outage samples and climate years)

Unit Commitment and Economic Dispatch model

Probabilistic General Methodology

Storage

Available Generation | **Network Infrastructure** | **Demand**

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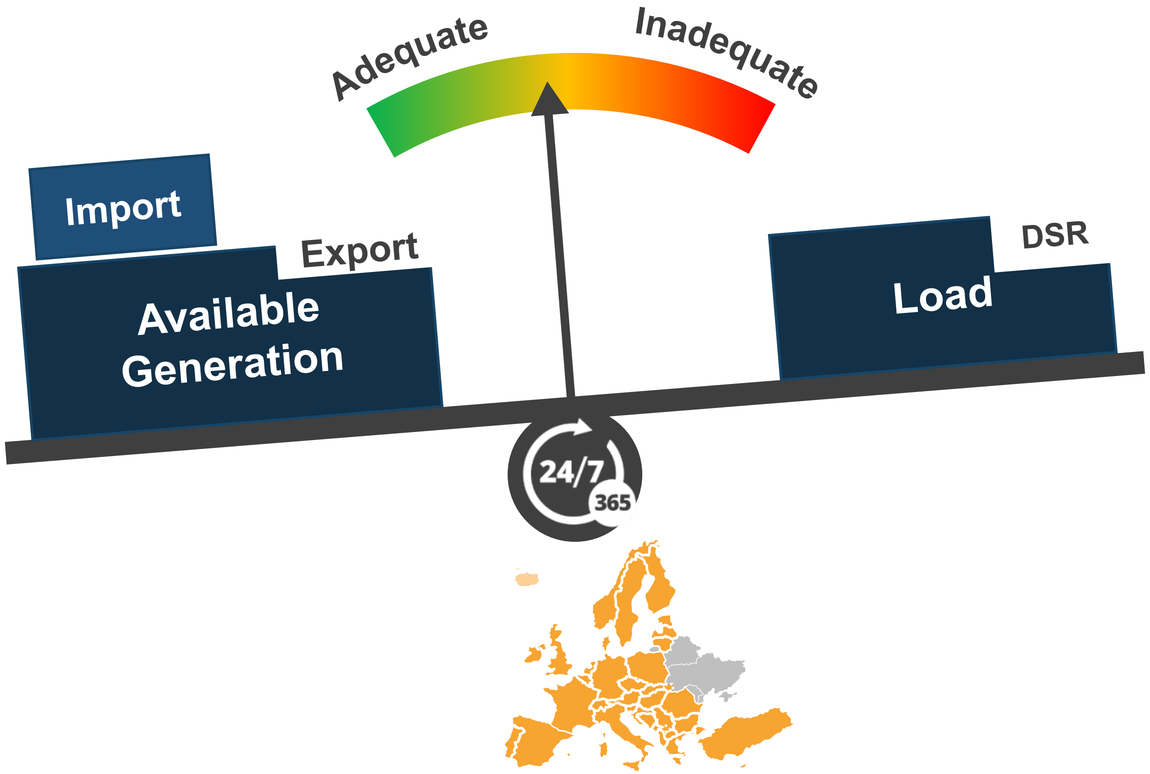
Deterministic Forecast
- ENTSOs' Scenarios
- Planned Outages

+

Uncertainty
- Wind generation
- Solar generation
- Forced outages



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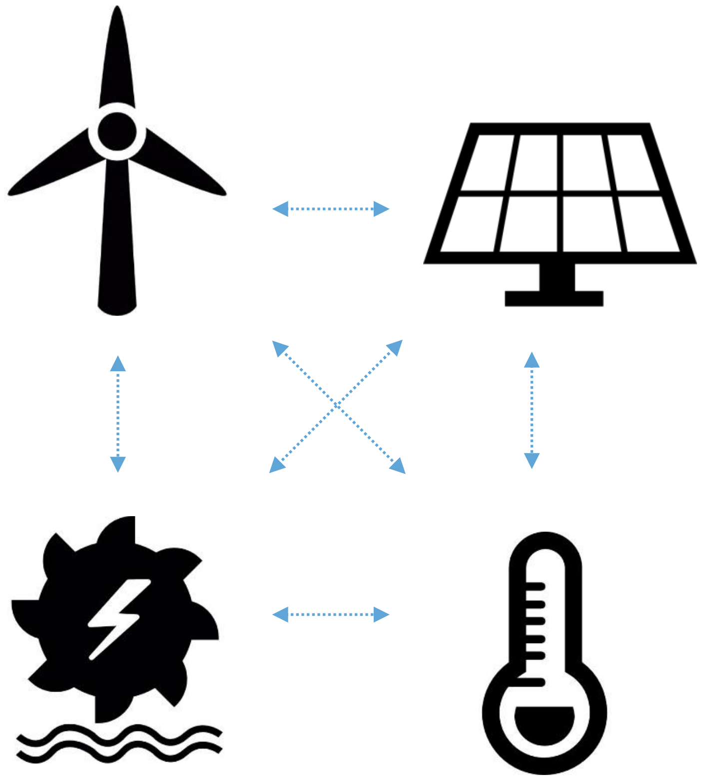
Deterministic Forecast
ENTSOs' Scenarios

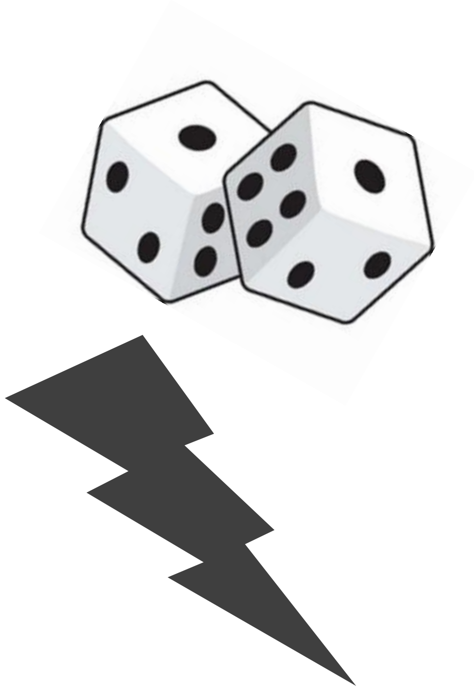
+

Uncertainty
Temperature

Construction of Sample Years



35 years of interdependent climate data



N random draws for unplanned outages

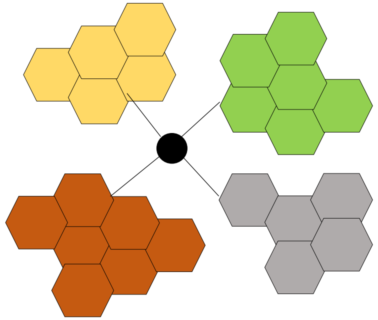
M x *N* (Monte Carlo) sample years

Ongoing improvements in Data granularity

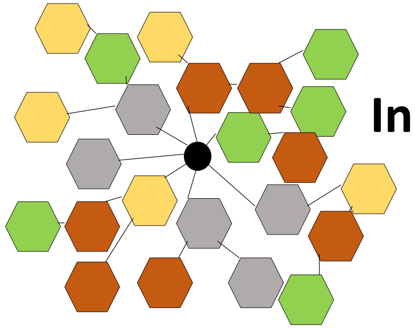
Data granularity, Data quality and Data management

Thermal Data (example)

PEMMDB 2.0 → PEMMDB 3.0



Technology aggregation



Individual power plant data

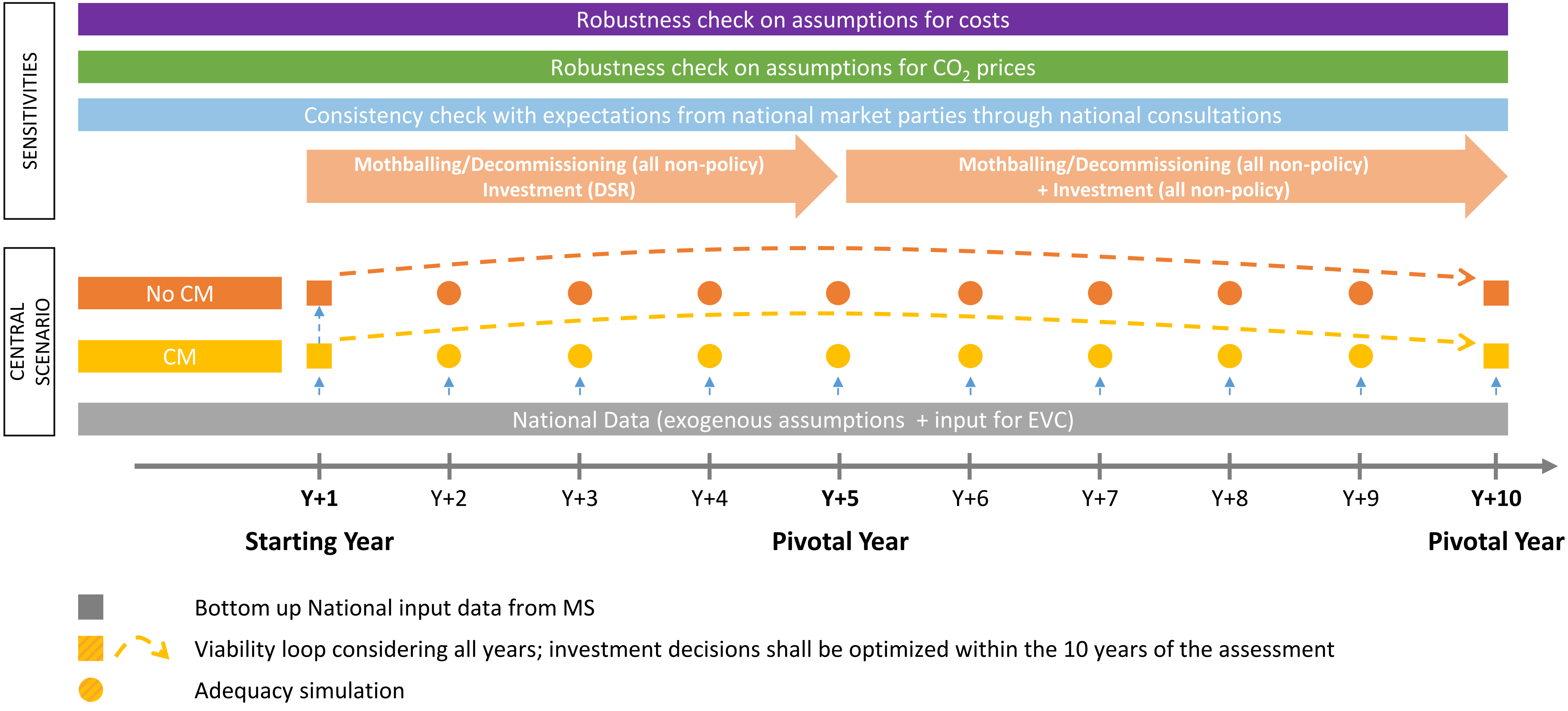
- Unit – by – unit granularity of thermal generation data is a long term milestone for ENTSO-E
- Detailed modelling of various properties, e.g. maintenance, derating of generation plants, ramping, expectations of commissioning and decommissioning, economic parameters etc..

Continuous progress on the whole data package (see methodology draft)

Economic and Technical Parameters

Climate DataBase

ERAA will significantly expand the scenario framework



Implementation principles

Proof of concept tests (feasibility and robustness) prior to deployment	Non-mature innovation not included in methodology until maturity and robustness has been shown	Security of the System needs to be maintained
• Designing, testing and implementing economic viability checks in particular will require significant time until operational	• The methodology can be updated at any time later on (as per Art. 27 of Reg 2019/943)	• System Operation Guideline provisions should be applied

Implementation principles

Proof of concept tests (feasibility and robustness) prior to deployment

Key principles:

- ENTSO-E will need at least 4 years to implement the large extension of ERAA scope compared to the current MAF.

- This is notably due to
    - Need to consolidate existing methods at ENTSO-E into the ERAA pan-EU + Y-10 framework
    - Need to perform impact assessments of the methodologies under implementation to ensure i) Feasibility and ii) Robustness
    - Additional need for implementation of new methods that are not readily available today.

- Implementation will be done in a stepwise manner based on a transparent stakeholder interaction process

Implementation principles

Non mature innovation not included until maturity and robustness

Key principles:

- Only once a part of the methodology is deemed **mature and robust**, it will be incorporated as an integral part of the ERAA study.
- **Mature** relates to a methodology which is not just possible in ‘academic’ terms but which has been discussed and is widely endorsed by EU stakeholders
- **Mature** relates to reliable data sources and methodology choices after relevant national and EU stakeholder consultation processes
- **Robust** relates to methodologies which have been tested after systematic impact assessments ensuring robustness of the results

Implementation principles

Security of the system needs to be maintained

Key principles:

- Reserves are aimed at ensuring that the frequency is maintained at 50 Hz. The reserves are dimensioned to cover the unexpected imbalances resulting from second-by-second random variations of generation and load and to face a range of contingencies. This is done under the assumption that the system is balanced on average**.**

- On the contrary, lack of adequacy reflects the expectation that the system is structurally not balanced, at least in some hours and days, e.g. during peak loads or low renewable in-feeds periods.

- Adequacy assessments shall assess the ability of the system to cope with the cases in which the system is structurally not balanced. In doing so, ERAA shall not compromise system security by eg. allowing the use of reserves to partially cover for these inadequacies.

- If reserves are used as (part of the) structural solution to cope with such structural problems, this practice might result in severe violations of the frequency quality criteria setup in other legislation than CEP, which operational reserves are designed to ensure.

ERAA principle process

Yearly publication will require non-sequential activities

		Year												Year + 1						
Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July

Consultation on assumptions and scenarios

Consultation on report results

Data collection & quality check

Economic viability and adequacy assessment

Report drafting

Data collection & quality check

Economic viability

Q&A on ERAA methodology

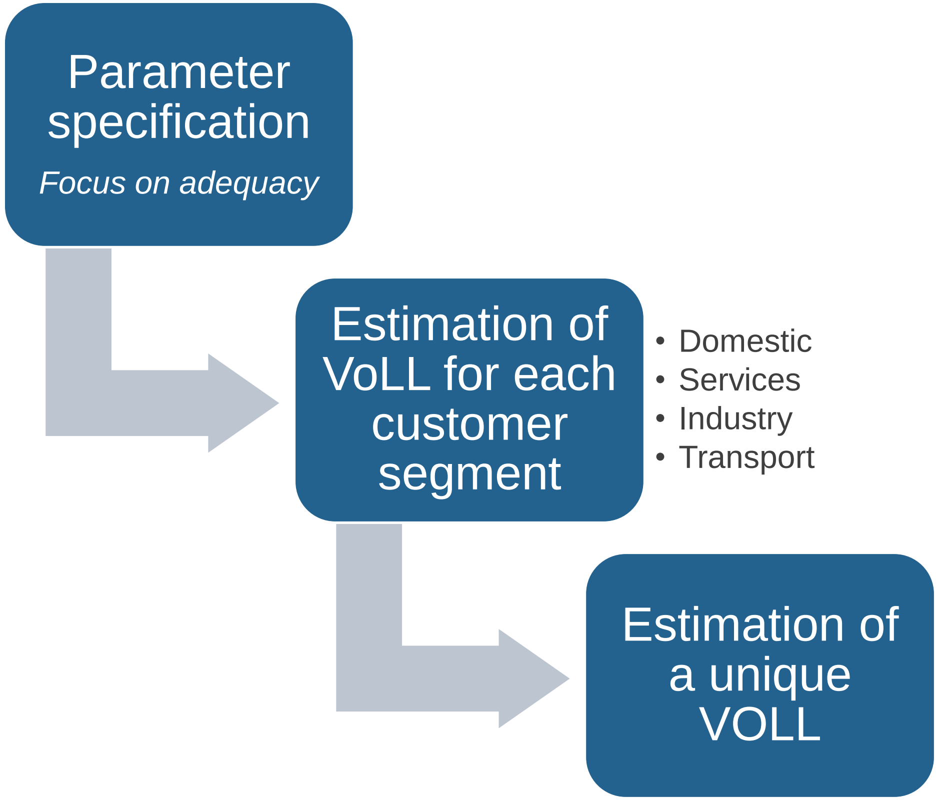
3. Value of Lost Load methodology (VOLL)

Isabelle Bailleul, Convener,
Task Force VOLL, ENTSO-E

Overview

The **Value of Lost Load** represents the **average losses generated by power outages**, which vary widely from one customer to another and from one outage to another, depending on its timing and duration.

The single estimate required for adequacy evaluation will be calculated through a **three-step methodology.**



1 – Specification of parameters – adequacy

Each NRA should specify the **parameters** that should be considered in the VoLL calculation for **adequacy issues** so that they can adapt to the particularities of each bidding zone.

- **Customer type**
- **Duration of interruption**
- **Time of interruption**
- **Pre-notification**

2 – Estimation of VoLL for each customer category
Methodological choice

	Stated-choice methodology (surveys)	Macro-economic approach
+	• All costs are taken into account. • Results are obtained directly from the consumers who are the more able to evaluate their losses. • Using hypothetical scenarios enables to have more information (parameters).	• Easy and cheap to implement. • Data is available from Eurostat.
-	• Potential biases (aversion for loss). • Cost and time to run the survey.	• Some costs are not taken into account. Ex: loss of comfort (light, cooking), damage, restart costs, loss of raw materials… • The parameters of the outage are not taken into account.

The methodological proposition is a **compromise** between

- **precision** of the evaluation through the realisation of surveys;
- **simplicity of implementation** using macro-economic evaluation where possible and relevant, for example for some industries.

2 – Estimation of VoLL for each customer category
Focus on domestic and tertiary sector (1/2)

Stated-choice methodology (surveys) has been selected to assess the VoLL for both the domestic and the tertiary sectors.

- More precisely, **contingent valuation** is recommended.
  - This methodology is transparent for administration and consumers and the survey design is easy.

- From the policy implications of setting a reliability standard, using **WTA approach seems more appropriate.**
  - It values the disturbance of the consumer if the reliable electricity service were to be interrupted.

- The hypothetical scenario of an electricity interruption shall be described with the **parameters** defined in step 1.

2 – Estimation of VoLL for each customer category
Focus on domestic and tertiary sector (2/2)

A – Characteristics of the customer

…

B – Cost estimation scenarios

In the following section, you will be asked about your preference between suffering an electricity outage with different characteristics and receiving money in compensation, or refusing the outage and continue your activities without perturbations.

Assume that the network company informs you about a potential interruption, [H] hours before the interruption will occur. The interruption would last [N minutes/hours] minutes/hours during [TIME SLOT], on a [WEEK DAY WEEK END] in [MONTH/SEASON]. Your household can choose whether it will accept the power interruption and simultaneously receives a financial compensation, or whether the power supply is not switched off and you may continue to use electricity normally. What is the minimum amount of compensation you would need to accept the power interruption?

Scenarios depend on the ***specification of the parameters of adequacy outages by each NRA.***
The question may be repeated if parameters have more than one value.

This question design follows guidelines from the Council of European Energy Regulators (2010).

Additional guidelines with survey examples will be proposed by ENTSO-E to help with the survey implementation, in support of the methodology.

2 – Estimation of VoLL for each customer category
Focus on industry - *overview*

- *damage costs*
- *restart costs*
- *discomfort (lack of light)*
- *injuries caused by the outage*
- *impact on final consumers*
- *etc*

$$VoLL_{Sector\ A} = Lost\ production\ (A) + other\ costs\ (A)\ [€/MWh]$$

- Main component
- Simple macro-economic approach possible

- Depending on the industries, can be significant or have a second order impact
- Can be assessed only through dedicated surveys

Base case: evaluation of the value of lost production with a **macro-economic methodology** and other costs are considered equal to 0.

Option: conduct additional surveys (direct worth methodology) for industries where those additional costs could have a significant impact on the final VoLL calculation

2 – Estimation of VoLL for each customer category
Focus on industry – *base case*

The **macroeconomic approach** used by CEPA in the study commissioned by ACER - *Study on the estimation of the value of lost load of electricity in Europe, 2018* **has been selected to assess the base case VoLL for industries**.

$$Lost\ production\ sector_{A} = PNF * SF * \frac{Annual\ gross\ value\ added\ of\ the\ industry\ Sector\ A}{Annual\ electricity\ consumption\ of\ the\ Sector\ A}\ [€/MWh]$$

pre-notification factor

substitutability factor

These values of lost productions have been estimated by CEPA for several industry sectors and for all Member States countries, but the calculation should be updated every five years with the latest data.

3 – Estimation of a unique VoLL

After evaluating the VoLL of each category, the RA shall calculate the single estimate of VoLL related to adequacy issues for his bidding zone.

The **single VoLL estimate** should represent the most likely cost of an adequacy outage, during which the different categories of consumers may be affected in different proportions, so the single VoLL estimate shall be calculated as the “expected energy not served”- weighted average of the values of the different categories of consumers:

$$\boxed{Final\ VoLL = \sum_i VoLL_i * w_i}$$

Q&A on VOLL methodology

4. Cost of new entry methodology (CONE)

Daniel Huertas Hernando,
Convener, Task Force
Adequacy, ENTSO-E

The selected reference technologies should be merchant, standard and based on potential new entry

Three main requirements for selected reference technologies:

Merchant technology

Merchant technology does not benefit from a legal State Aid (e.g. subsidy), with the exception of the State aid for adequacy objective, i.e. Capacity Mechanism.

Standard technology

a) Reliable and generic cost information is available for the cost components defined for CONE.

b) Costs of building and operating the technology do not vary significantly from one project to another.

c) Development of these technologies is not significantly bound by technical constraints. Technologies with limited capacity which can be aggregated in homogeneous clusters shall be considered as standard if reliable data is available to characterise each cluster. Reliable data might consist of cluster capacity, cluster activation price and economic and/or technical activation constraints representative of the cluster.

Potential new entry

a) Capacity representing this technology has been developed in the recent past, is in the process of development or is planned for development in the near future.

b) Future development of this technology is not significantly bound or banned by the national or European energy policy.

Main steps of the methodology for calculating the CONE

Step 1: Review and select potential candidate technologies that can be assessed as Reference Technologies

- Reflect that investment decisions on technologies are made by rational and competitive investors
- Considering generation capacity, storage facilities or demand-side response resources
- Selection criteria: merchant technology, standardisable and representative for future capacity additions

Step 2: Define the detailed technical characteristics of each candidate Reference Technology

- Determine the technical specifications for each Reference Technology
- Detailed characteristics shall encompass de-rated capacity, construction periods and economic lifetime
- Other elements that may have an impact on cost estimate may be included (e.g. plant type and configuration, fuel type, location…)

Main steps of the methodology for calculating the CONE

Step 3: Develop a bottom-up Capital and Annual Fixed Costs estimates for each candidate Reference Technology

- Capital Costs shall include all costs incurred during the construction period, until the capacity resource is available.
- Annual Fixed Costs refer to costs incurred each year once the capacity resource starts operating and which do not depend on the generated volume.

Step 4: Determine an appropriate cost of capital (WACC) for each candidate Reference Technology

- Shall represent the minimum rate of return required by fund providers (shareholders and/or creditors) to finance investment in the Reference Technology in the Member State and shall be based on transparent market data

Main steps of the methodology for calculating the CONE

Step 5: Compute the Equivalent Annualized Costs (EAC) of each candidate Reference Technology and determine the Cost of New Entry as the lowest value among the candidate Reference Technologies

For each candidate Reference technology, the EAC can be computed as:

$$\boldsymbol{EAC} = \frac{\left[\sum_{i=1}^{X} \frac{CC(i)}{(1+WACC)^{i}} + \sum_{i=X+1}^{X+Y} \frac{AFC(i)}{(1+WACC)^{i}}\right] \cdot \frac{WACC \cdot (1+WACC)^{X+Y}}{(1+WACC)^{Y}-1}}{K_d}$$

The final CONE shall use the **lowest EAC across the candidate Reference Technologies**

The Cost of New Entry for a **given candidate Reference Technology** should be calculated as the ratio between the Equivalent Annualised Costs and the De-rated Capacity:

$$\boldsymbol{CONE} = \min(\boldsymbol{EAC})_{Ref\ Tech}$$

Impact of Capacity Limits

Cost of New Entry

If the candidate Reference Technology with the lowest CONE has a **capacity limit**, a capacity need shall be defined for the period studied.
The capacity need shall be based on analysis from the latest adequacy assessments at regional, national or Union level (e.g. based on the relation between observed number of hours with EENS and capacity margins of the electric system).

The **final CONE** shall be defined as the lowest CONE (c) across candidate Reference Technologies verifying the following condition:

- The sum of the capacity limits of candidate Reference Technologies with a CONE equal or lower than the CONE (c) is higher than the capacity need as referred above.
- If a candidate Reference Technology with a CONE equal or lower than the CONE (c) has no capacity limit the condition is automatically respected.

Q&A on CONE Methodology

5. Reliability standard methodology (RS)

Daniel Huertas Hernando,
Convener, Task Force
Adequacy, ENTSO-E

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Reliability standard

Electricity Regulation 943/2019 requests (Article 25): when **applying Capacity Mechanisms**, Members States (MS) shall have a **Reliability Standard (RS) in place**.

- The RS shall express the optimal level of security of supply, found when the incremental cost of additional capacity insuring customers against load curtailments is equal to the incremental cost of load curtailments to customers. When considering this social perspective, costs shall be considered to determine the RS.
- Before proposing a RS to the relevant MS or competent authority designated by the MS, the National Regulatory Authority shall coordinate with neighbouring National Regulatory Authorities, to assess any risk related to non-harmonized Reliability Standards among their respective Member States

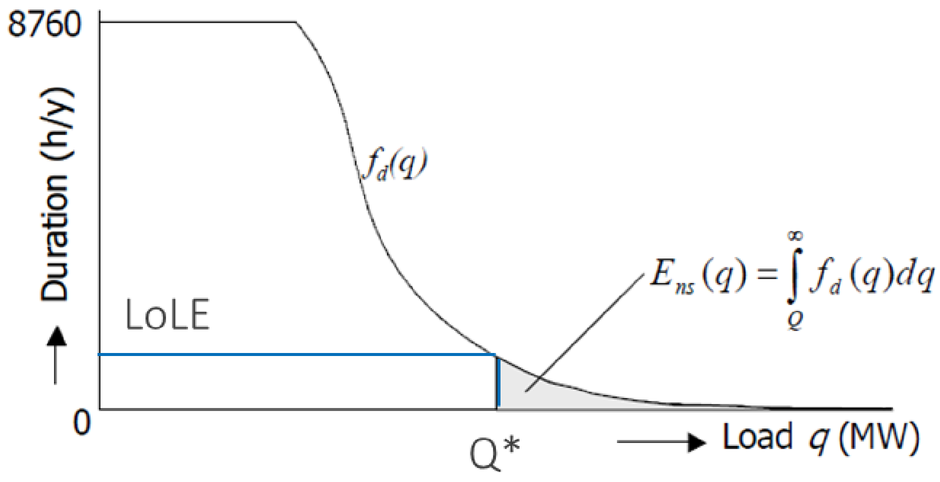
The Economic approach to define reliability standard: Underlying Math

For a given load duration curve, it can be shown that:

$$\frac{dEENS(Q^*)}{dQ} = -\,\mathrm{LoLE}$$

This leads to the following optimal relationship:

$$\boxed{CONE = LoLE * VoLL}$$



An economic approach to set the optimal reliability standard can be expressed as a the **Loss of Load Expectation**, in hours per year, and be derived from the value of **CoNE and VoLL only**

An economic approach for reliability standard is based on incremental EENS (LOLE) and not on the total EENS

Reliability standard (RS) – applicability/consistency

The Main Reliability Standard expressed in terms of a target LOLE:

$$\boldsymbol{LOLE_{target}}[\mathrm{h}] = \frac{\boldsymbol{CONE}\ [local\ currency/MW]}{\boldsymbol{VOLL}\ [local\ currency/MWh]}$$

This economic optimality theory is valid under various assumptions*:

i. The marginal reduction of EENS can be expressed in terms of LOLE, i.e., the following formula holds:

$$dEENS[Q]\ /dQ = -LOLE$$

In particular, this assumption holds if:

- no energy constraint affects capacities of the electric system, or energy constraints are properly represented through the de-rating modelling introduced in Article 16(3) and
- The capacity mentioned in the formula above represent certified quantities (i.e. installed capacity multiplied by the de-rating factor Kd).

ii. Near the optimal, the marginal cost of capacity is mainly determined by the fixed cost of the units.

iii. New capacity is required in order to reduce EENS.

iv. EENS is only reduced in the concerned country.

Q&A on RS methodology

6. Next steps on methodologies and conclusions

Alban Joyeau, Adequacy Manager, ENTSO-E

Kristof Sleurs

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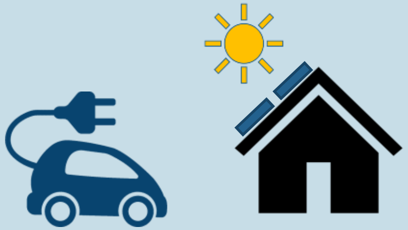
European Resource Adequacy methodologies: Have your say!

European Resource adequacy assessment (ERAA)

Value of Lost Load (VOLL)



Cost of new entry (CONE)

Reliability standard (RS)

- Public consultations on all methodologies until 30 January 2020
- Find the documents and the consultations at the ENTSO-E consultation hub

Resource adequacy – From scratch to implementation

2019	2020	2021	2022	2023

MAF reports, replaced by European Resource Adequacy Assessment (ERAA) from 2021

MAF 2019 → **MAF 2020**

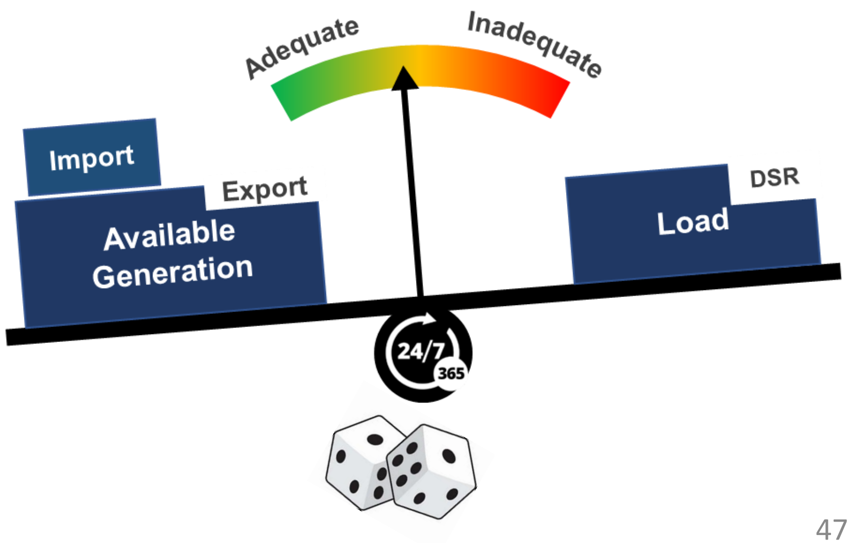
European Resource Adequacy Assessment (ERAA)

ERAA 2021 → **ERAA 2022**

Resource adequacy methodologies:
ERAA;
VoLL, Cost of New Entry, Reliability standard

Capacity mechanism (CM) methodologies:

- **Methodologies for max entry capacity for XB participation to CM & for sharing XB revenues;**
- Common rules for availability checks; determining non-availability payments; identifying capacity eligible to participate in CMs
- Terms of operation of registry



Thank you for your attention

Regulation (EU) 2019/943 sets the principles of the European Resource Adequacy Assessment

"The European resource adequacy assessment shall be based on a transparent methodology which shall ensure that the assessment:

a) *is carried out on each* ***bidding zone level*** *covering at least all Member States;*

b) *is based on appropriate* ***central reference scenarios*** *of projected demand and supply including an economic assessment of the likelihood of retirement, mothballing, new-build of generation assets and measures to reach energy efficiency and electricity interconnection targets and appropriate* ***sensitivities*** *on extreme weather events, hydrological conditions, wholesale prices and carbon price developments;*

c) *contains* ***separate scenarios*** *reflecting the differing likelihoods of the occurrence of resource adequacy concerns which the different types of capacity mechanisms are designed to address;*

d) *appropriately takes account of the* ***contribution of all resources*** *including existing and future possibilities for generation, energy storage, sectoral integration, demand response, and import and export and their contribution to flexible system operation;*

e) *anticipates the likely* ***impact of*** *the* ***measures*** *referred in Article 20(3);*

f) *includes variants without existing or planned* ***capacity mechanisms*** *and, where applicable, variants with CM;*

g) *is based on a market model using the* ***flow-based approach****, where applicable;*

h) *applies* ***probabilistic calculations*** *and* ***single modelling tool****;*

i) *includes at least the following indicators : — '****expected energy not served****', and — '****loss of load expectation****';*

j) *identifies the* ***sources of possible resource adequacy concerns****, in particular whether it is a network constraint, a resource constraint, or both;*

k) *takes into account* ***real network development****;*

l) *ensures that the* ***national characteristics*** *of generation, demand flexibility and energy storage, the availability of primary resources and the level of interconnection are properly taken into consideration."*

to eliminate any identified regulatory distortions or market failures as a part of the State aid process.