ERAA 2023 Stakeholder workshop: Methodological Insights

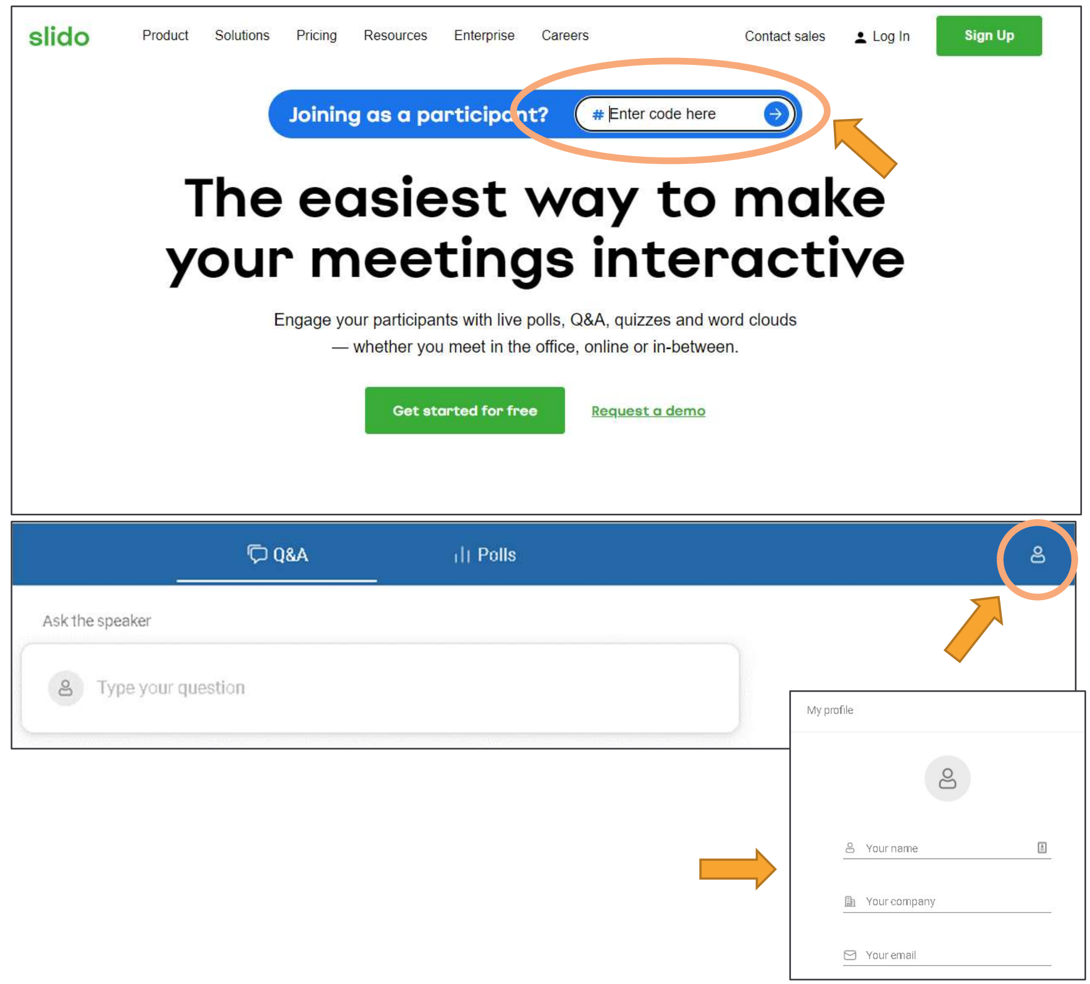
Part 1

13 June, 2023

Reliable Sustainable Connected

Housekeeping Rules

- The Webinar will be recorded
- Ask questions directly through sli.do
  - Log-in method in next slide
- Enter your name & company details
- Vote for the most relevant questions
- The moderator will select most relevant questions and ask the speakers to comment
- The teams "chat" and "hand raising" features will not be used.



Submit your questions and answers on Slido

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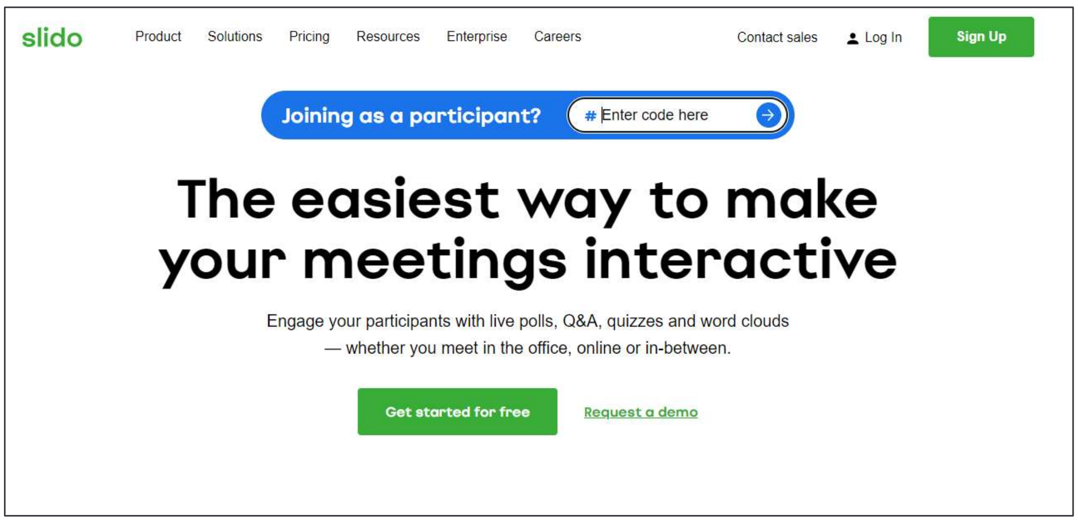


The recording will start now

Today's Agenda : focus on methodologies

Part 1

Introduction

1. Introduction and feedback from last public workshop and the call for evidence
2. ACER's focus on ERAA 2023
3. ERAA scenarios and main steps

Methodologies #1

4. Price cap evolution
5. Explicit DSR modelling and expansion potentials

Break (5 minutes)

Part 2

Methodologies #2

6. Maintenance Optimization in ERAA
7. Reserve modelling

Q&A

Conclusions & next steps

Introduction

Patrick van de Rijt,
ERAA Steering Group Member

Background

- ERAA is an ENTSO-E legal mandate (Article 23 of Electricity Regulation), which aims to identify resource adequacy concerns by assessing adequacy of the electricity system to supply current and projected demands.
- It is a full pan-European monitoring assessment of power system resource adequacy, unique on its kind, based on a state-of-the-art probabilistic analysis, looking up to a decade ahead.
- Stepwise implementation of the methodology already began with ERAA 2021, with new improvements in the methodology in each edition (2022, 2021).
- ERAA 2023 aims to be an effective tool to identify adequacy risks, and includes an **enhanced Economic Viability Assessment** and advanced **Flow-Based market coupling** incorporated in the central reference scenarios.
- By proactively and factually identifying any system adequacy challenges, ERAA supports decision-makers in ensuring secure, affordable and sustainable energy to citizens and industries.

Progress on process and methodology

Fit-for-55 target

Public consultation and more intense communication

Input data as best available and aligned between MS, Regulators & TSOs

Meets the purpose of a risk assessment with robust input data

Interconnections (70% rule and evolution across the period)

70% rule issue integrated in the flow-based.

Accounting for network expansion

Consistency between EVA and adequacy modelling

Recalibration of climate year weighting factors in EVA based on LOLE

Cross-border representation in EVA & ED steps

Curtailment Sharing

Next webinar

Acronyms: Member State (MS), Transmission System Operator (TSO), Net Transfer Capacity (NTC), Economic Viability Assessment (EVA), Loss of Load Expectation (LOLE), Economic Dispatch (ED)

Call for evidence on preliminary input data

Closed on 5 April with participation of 6 stakeholders

Main drivers of the feedback:

- National data updates
- Neighbouring countries' influence on transfer capacities
- Need for consistency between the EVA and ED models
- Improve alignment with EU and national policy targets and plans (FF55 & 70% rule)

Stakeholders commented on

- Demand dataset
- PEMMDB National Estimates
- Net Transfer Capacities
- Climate data
- List of CNECs (ERAA 2022)
- Fuel and carbon price trajectory

Acronyms: Fit-for-55 (FF55), Pan European market modelling database (PEMMDB) , Critical network element monitored under contingency (CNEC)

Feedback summary & ENTSO-E actions (1/2)

Topic	Feedback Summary	ENTSO-E Actions
Climate	• Climate data were generally well received • Some feedback on the approach being used for the climate years	✓ No action needed
Demand	• Suggestions were made to clarify the assumptions regarding forecast of peak demand • Data updates based on TSO internal updates	✓ Complete demand profiles to be included in the post-consultation dataset
Transfer Capacities and CNECs	• Attention point regarding the inconsistent approach of cross-border capacities in the economic dispatch (ED) and EVA • Missing information for Greece and Switzerland	✓ Updated way of modelling network in the EVA aims in closing the gap between the two models ✓ Transfer capacities are updated in cases that an issue was confirmed by TSOs.

Feedback summary & ENTSO-E actions (2/2)

Topic	Feedback Summary	ENTSO-E Actions
RES	• Misalignment between planned projects and estimates • Inclusion of project delays	✓ RES assumptions are updated based on best available information ✓ Project delays are considered when official
Thermal	• Capacities for Denmark, Greece, and Switzerland.	✓ Capacities have been updated according to feedback received in DK, GR and CH.
Economic parameters	• Uncertainties and complex current international context can question the validity of the CO2 prices.	✓ ENTSO-E agrees with the feedback. ✓ CO2 price projections were not challenged. ✓ Results should be analyzed in view of the assumptions.
Other	• Concerns raised regarding battery parameters in both Denmark and Greece • Concerns raised regarding demand response capacity in Greece	✓ TSOs have submitted the best available information. No quantifiable feedback for updates was received.

ACER

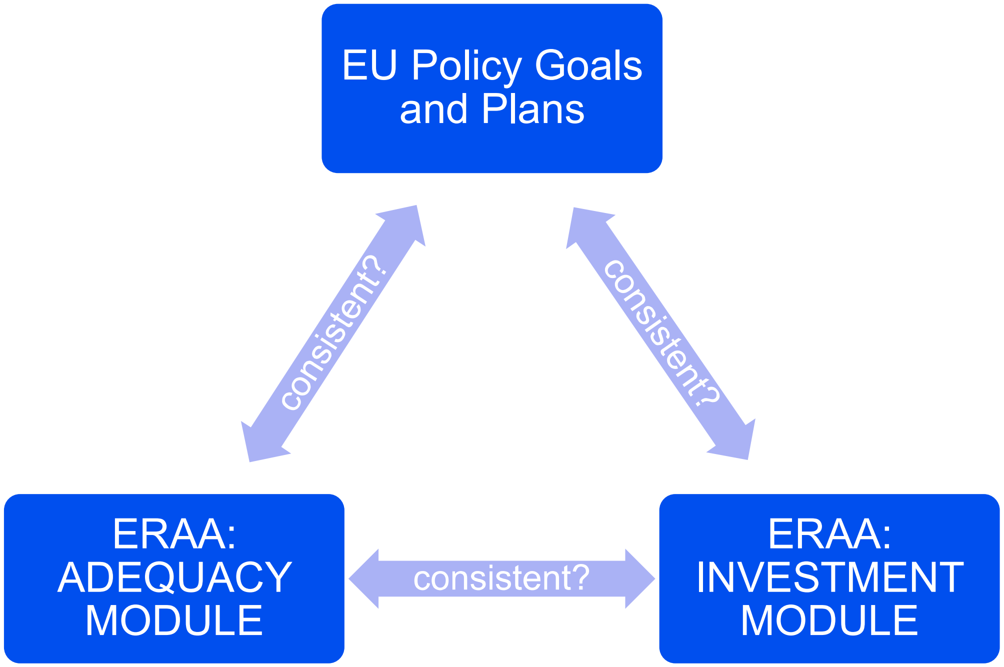
European Union Agency for the Cooperation of Energy Regulators

ACER closely follows the implementation of ERAA

ENTSO-E`s ERAA webinar

13 June 2023

ACER`s focus for ERAA 2023: CONSISTENCY



- ACER and ENTSO-E has achieved progress on key implementation choices with an expected positive impact on consistency.
- Developments will be covered in the next ERAA methodology webinar by ENTSO-E.

ACER highlighted in its past decisions: RECAP

Price cap determination

- In ACER's view, the maximum clearing price should reflect the highest price that can be achieved in the day ahead or the intraday markets. In addition, the maximum clearing price used in ERAA should take into account their dynamic increases.

Explicit DSR modelling and expansion potentials

- ACER welcomes the use of detailed national studies for the consideration of DSR potentials and associated parameters (e.g., capital costs). Specifically, the use of national VOLL, CONE studies, where available, which ensures consistency between the assessment and reliability standard calculations.
- It is important to reflect the cost of DSR (existing v. new) appropriately in the model to assess its economic viability.
- Where national studies are not available, ENTSO-E uses a centralised approach.

Questions?

Open floor

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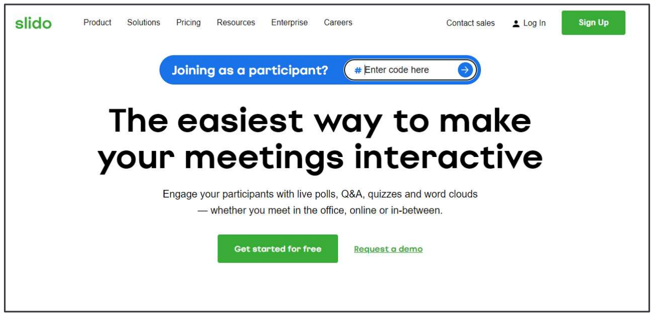
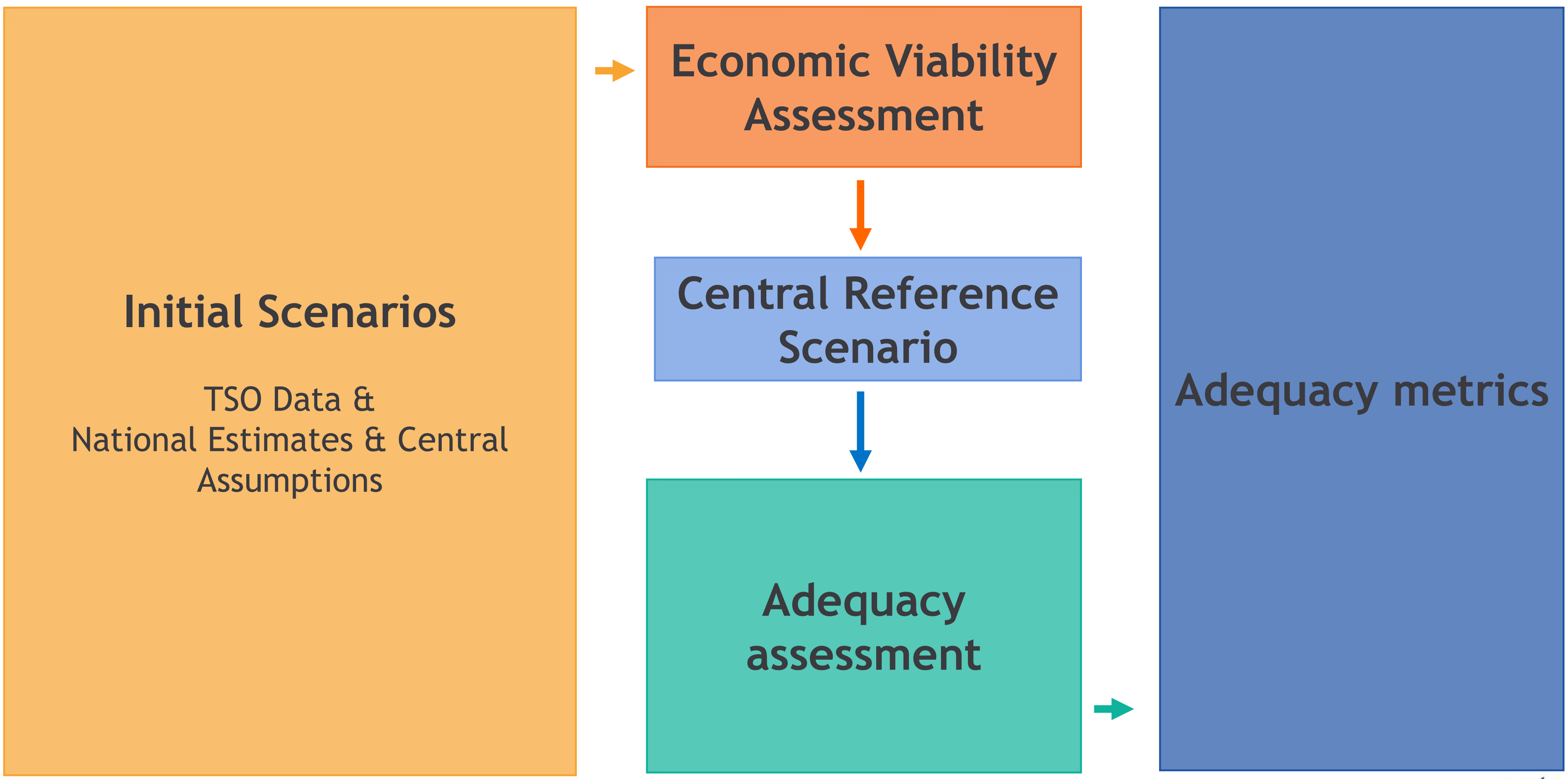


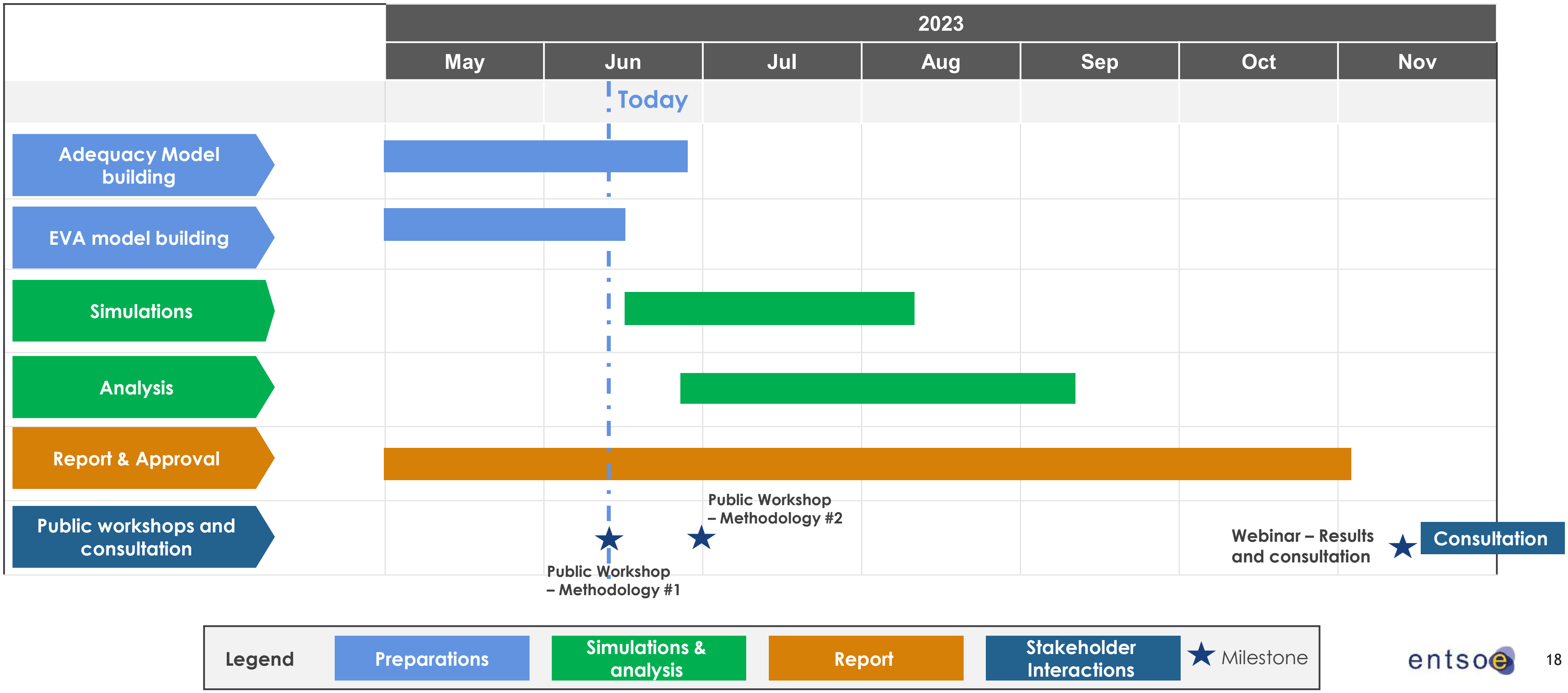
ERAA scenarios and main steps

Patrick van de Rijt,
ERAA Steering Group Member, TenneT

The ERAA – A multi-step process



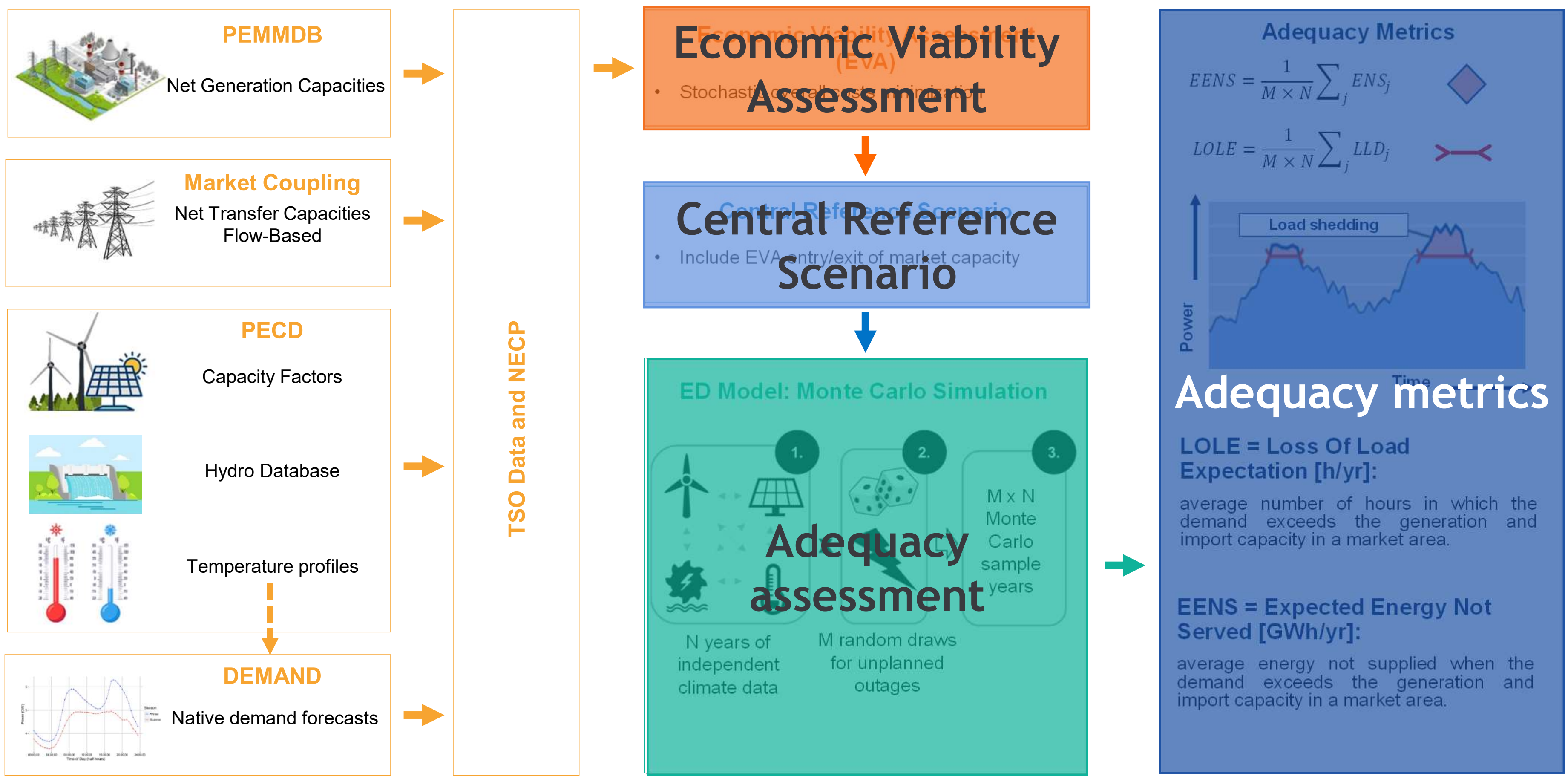
Ready for simulations



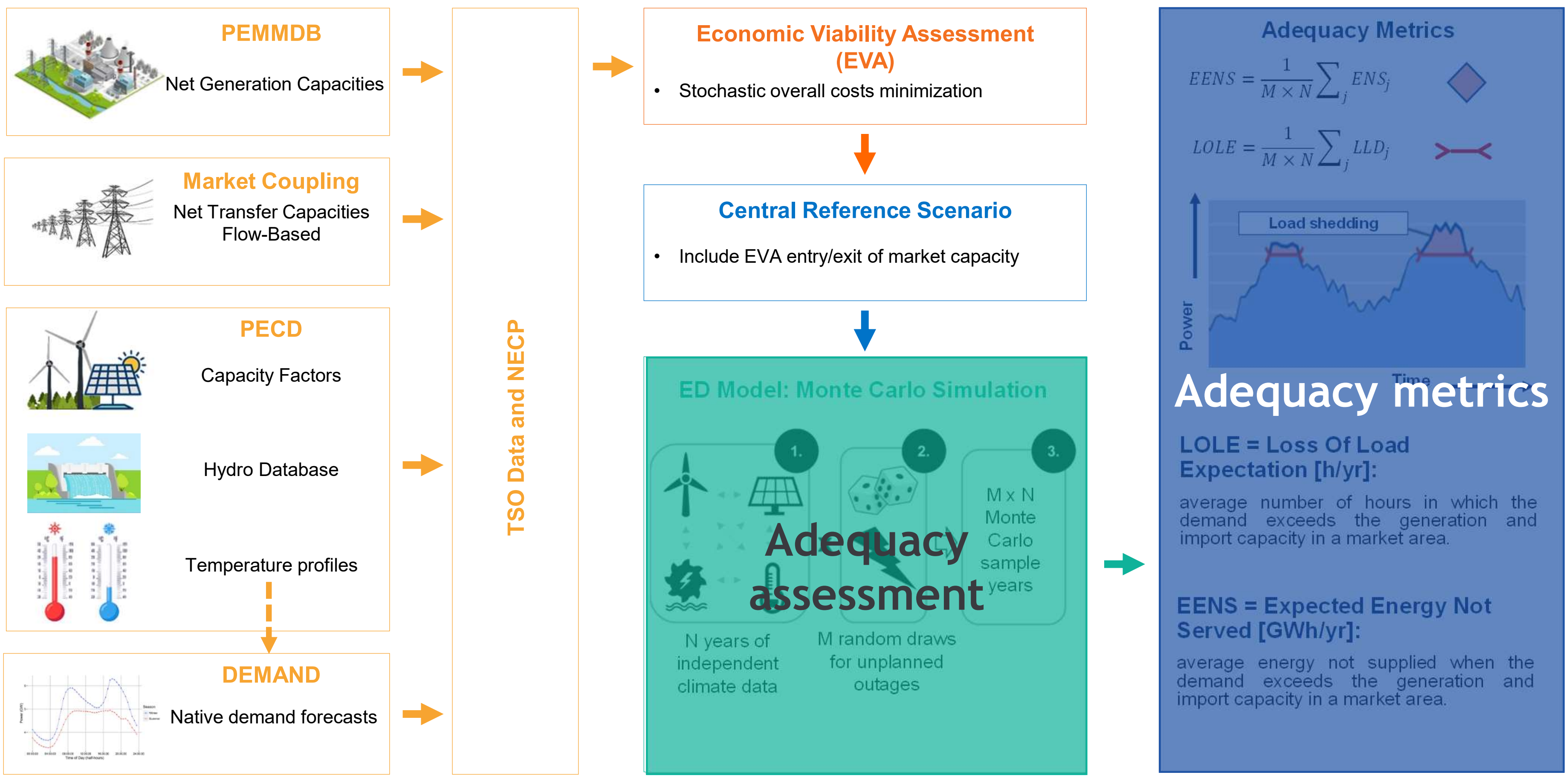
Overview of ERAA Methodology

Gregorio Iotti
ERAA Market Study Team, APG

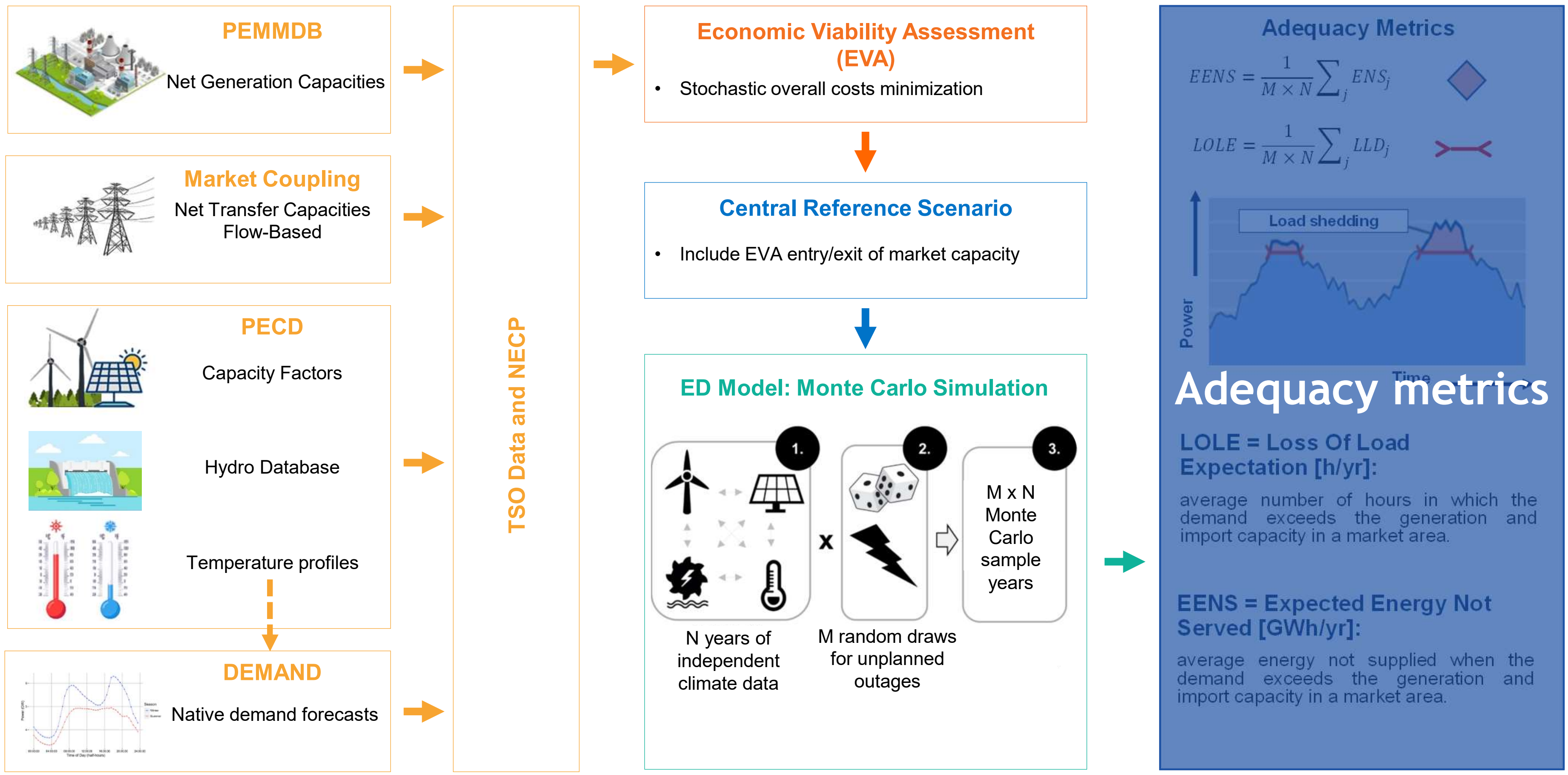
The Framework of the ERAA



The Framework of the ERAA



The Framework of the ERAA



The Framework of the ERAA

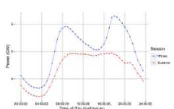
PEMMDB
Net Generation Capacities

Market Coupling
Net Transfer Capacities
Flow-Based

PECD
Capacity Factors

Hydro Database

Temperature profiles



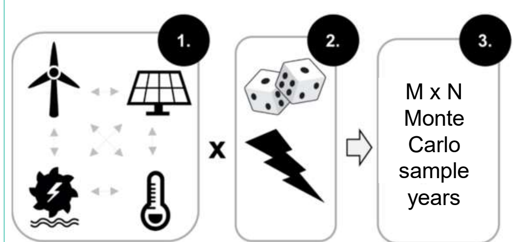
DEMAND
Native demand forecasts

TSO Data and NECP

Economic Viability Assessment (EVA)
- Stochastic overall costs minimization

Central Reference Scenario
- Include EVA entry/exit of market capacity

ED Model: Monte Carlo Simulation



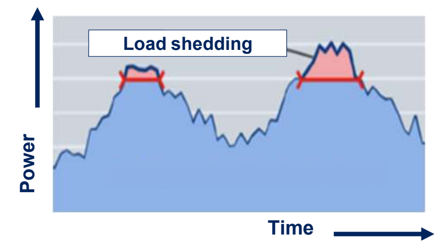
N years of independent climate data

M random draws for unplanned outages

Adequacy Metrics

$$EENS = \frac{1}{M \times N} \sum_j ENS_j$$

$$LOLE = \frac{1}{M \times N} \sum_j LLD_j$$



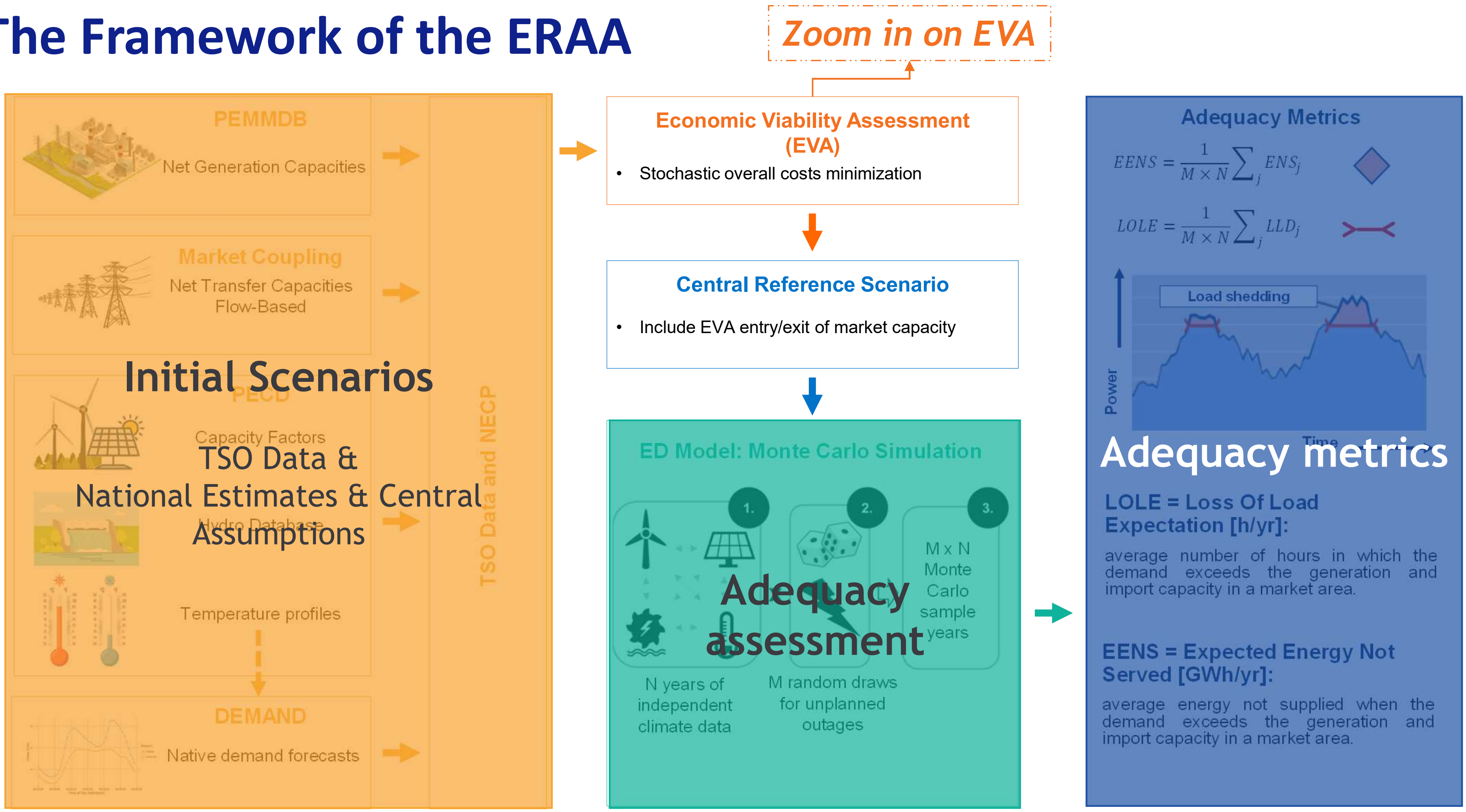
LOLE = Loss Of Load Expectation [h/yr]:

average number of hours in which the demand exceeds the generation and import capacity in a market area.

EENS = Expected Energy Not Served [GWh/yr]:

average energy not supplied when the demand exceeds the generation and import capacity in a market area.

The Framework of the ERAA



What is the purpose of the EVA?

Approach

Objective

Bring **insights** into the possible **impact** of **uncertainties** on **market-based capacity**

Tool

Use of state-of-the-art **pan-European investment model** through a **multi-year stochastic overall-cost minimization**

Answer

How likely are generation capacities to be:

- Retired,
- invested in,
- (de)mothballed
- extended in lifetime?

EVA, how is it done?

EVA input

- Technologies subject to EVA:
  - All thermal generators
  - RES, Nuclear and Hydrogen treated as policy technologies
  - New gas, batteries and explicit DSR as expansion candidates

- Techno-Economic parameters
  - CAPEX
  - WACC and risk premium
  - Fixed and variable O&M costs
  - Commodity prices
  - Expansion potentials
  - Market price caps

Modelling

- Investment model
  - Multi-year complexity
  - Stochastic approach
  - Selection of climate years and weights
  - Cross-border contribution

EVA results

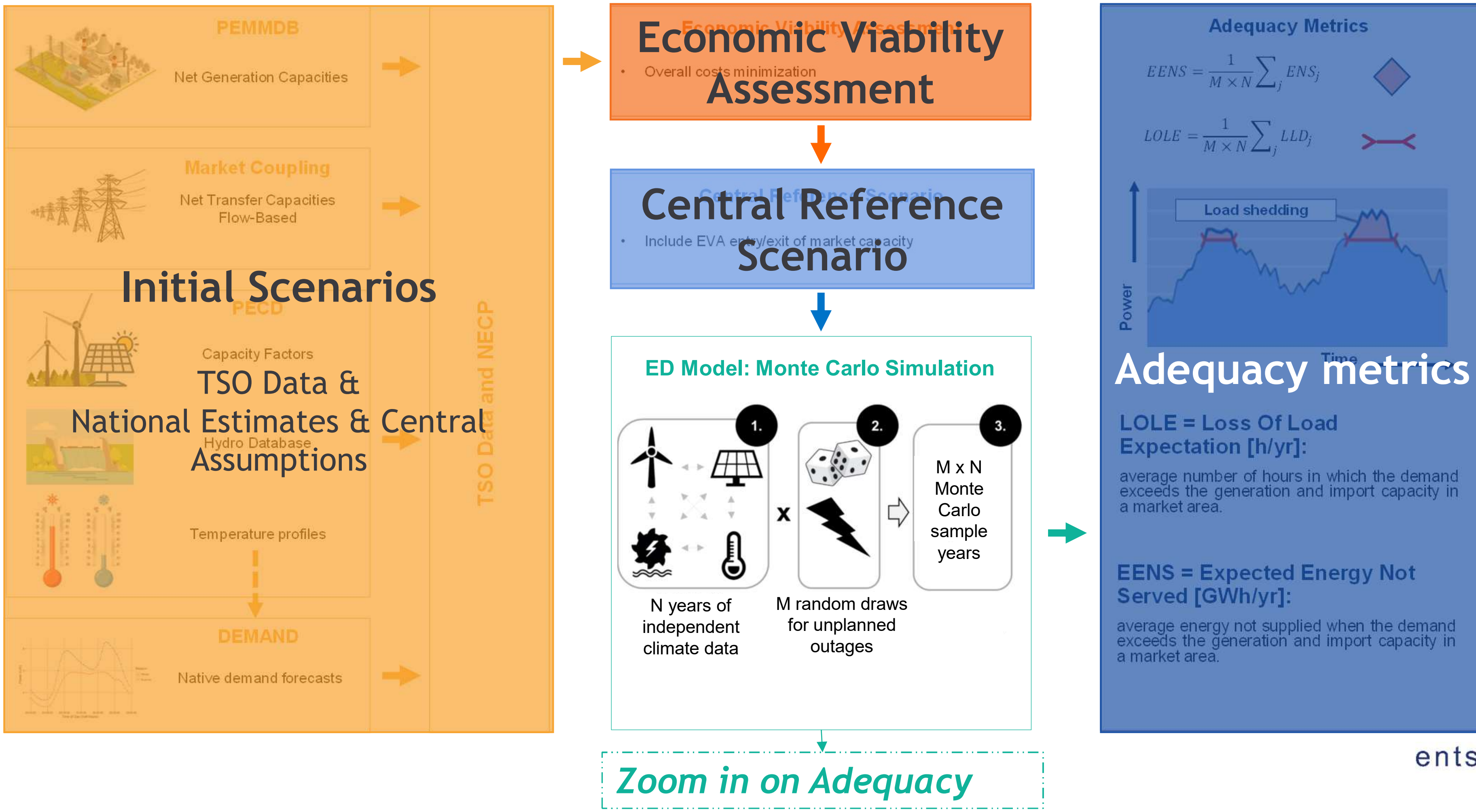
- Capacity likely to stay/leave/enter the market

- Regional impact

- Definition of the central reference scenario

Acronyms: Renewable Energy Sources (RES), Capital Expenditure (CAPEX), Weighted Average Cost of Capital (WACC), Operation & Maintenance (O&M), Demand Side Response (DSR)

Next: Monte Carlo Simulation



A grid is adequate when sufficient production and import capacity allow demand to be met, guaranteeing security of supply

Storage

Available Generation | Network Infrastructure | **Demand**

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Deterministic Forecast
- ENTSOs' Scenarios
- Planned Outages

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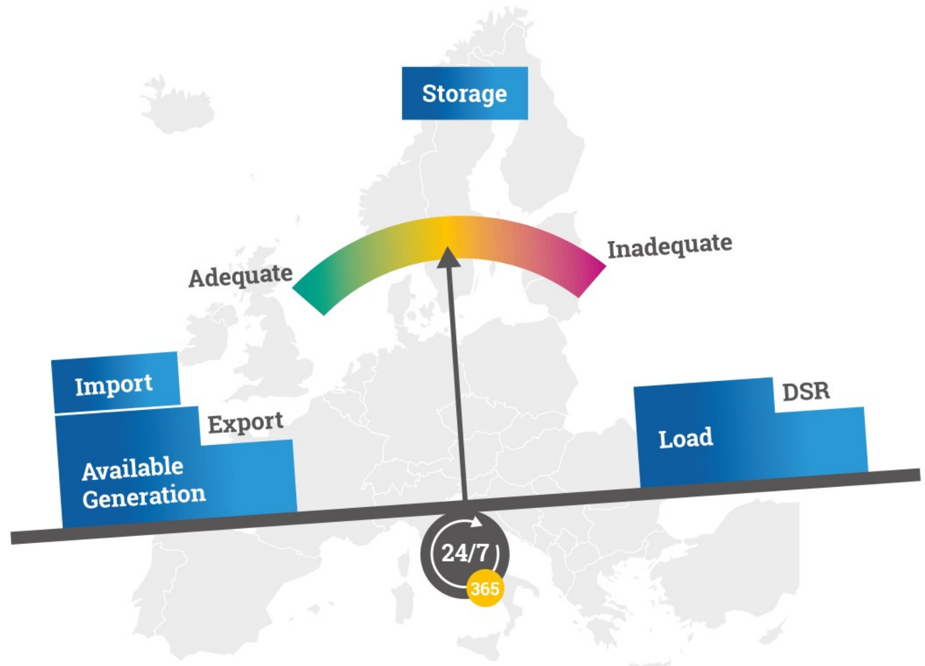
Uncertainty in supply:
- Wind generation
- Solar generation
- Hydro generation
- Forced outages



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Deterministic Forecast
ENTSOs' Scenarios

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Uncertainty in demand:
- Temperature

Price Cap Evolution

Gregorio Iotti
ERAA Market Study Team, APG

What is the price cap, and why model it?

- The market price caps are harmonized and regulated in the SDAC and SIDC electricity markets
- They define the minimum and maximum prices at which electricity can be traded on the markets
- Specific ACER regulations apply and describe the events that trigger an increase/decrease of the price caps
- The maximum price cap has a key role in the EVA model as it sets the maximum price at which generation capacity can be remunerated during hours of scarcity, and thus affects the decisions of (dis-)investing in market capacity
- In ERAA we focus on the DA maximum price cap, to estimate its likely evolution over the 10 years horizon

Acronyms: Single Day-ahead coupling (SDAC), Single Intraday Coupling (SDIC)

Update the methodology including the new ACER decision

ACER European Union Agency for the Cooperation of Energy Regulators

Overview of HMMCP methodology – Day-Ahead

Description	Former – until 10/01/20223	New – as of 11/01/2023
Reference price limits [€/MWh]	[-500€/MWh; 4000€/MWh]	[-500€/MWh; 4000€/MWh]
Price spike definition	Clearing price above 60% in coupled bidding zones	Clearing price above 70% in coupled bidding zones, excluding fallback and virtual bidding zones
Trigger conditions	1 price spike for at least one market time unit in one bidding zone	2 market time units of price spike over at least 2 days in a rolling 30 days
Transition period	5 weeks	28 days
Treatment of the transition period	Possibility to trigger the price adjustments	No possibility to trigger the price adjustments
Increase steps [€/MWh]	1000	500
Application to minimum price	No	Yes with -100€/MWh steps
Lowering of maximum price	No	No
Implementation date	N/A	At entry into force

Source: https://www.acer.europa.eu/sites/default/files/documents/Other Documents/HMMCP_PPT.pdf

Acronyms: Harmonized Maximum and Minimum Clearing Prices (HMMCP)

Calculation of representative price cap values for each TY

Principles of the methodology

- Exogenous step before EVA simulation run
- Based on marginal prices from ERAA 2022 ED post-EVA for 2025, calibrated on RS where applicable
- Simulated over 10 consecutive climate years (CYs) and 20 forced outage (FO) scenarios:
  - Starting value: 4 k€/MWh on 1st of January 2024
  - Increase of the price cap based on price spikes and market cap rules
  - In total: 26 CY sets X 20 FOs = 520 Multi-year scenarios

Result

- Average of all simulated scenarios leading to one single price cap estimate per target year

Note: Illustrative figure

Acronyms: Economic Dispatch (ED), Reliability Standards (RS)

Key take-aways

Estimate of market price cap evolution for ERAA 2023

- Building on ERAA 2022 price cap methodology, including latest HMMCP decision from ACER

- Representative set of price cap values per each target year, estimating the dynamic increase of the price cap over the horizon

Acronyms: Harmonized Maximum and Minimum Clearing Prices (HMMCP)

Questions?

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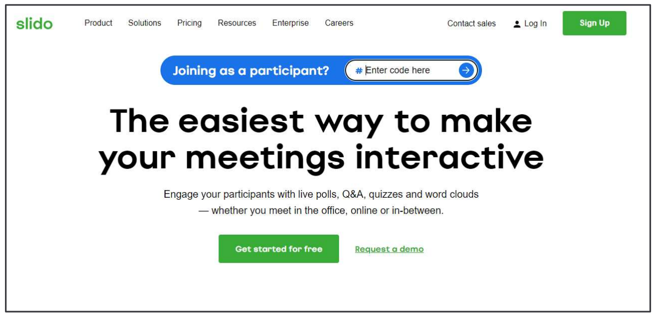
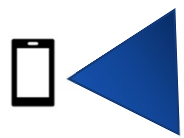




Agenda
Price cap determination
Explicit DSR modelling and expansion potentials
Maintenance Optimization in ERAA
Reserve modelling

Explicit DSR

Gregorio Iotti
ERAA Market Study Team, APG

What is explicit DSR, and why model it?

In ERAA we leverage exogenous demand forecasts that are inelastic to endogenous market prices, except for a share that we label as "Demand Side Response" (DSR).

DSR reflects the willingness and capability of consumers to reduce their electricity needs when the price of electricity exceeds a certain value.

This type of demand flexibility can play a key role during hours of scarcity and can in some cases prevent load shedding (ENS).

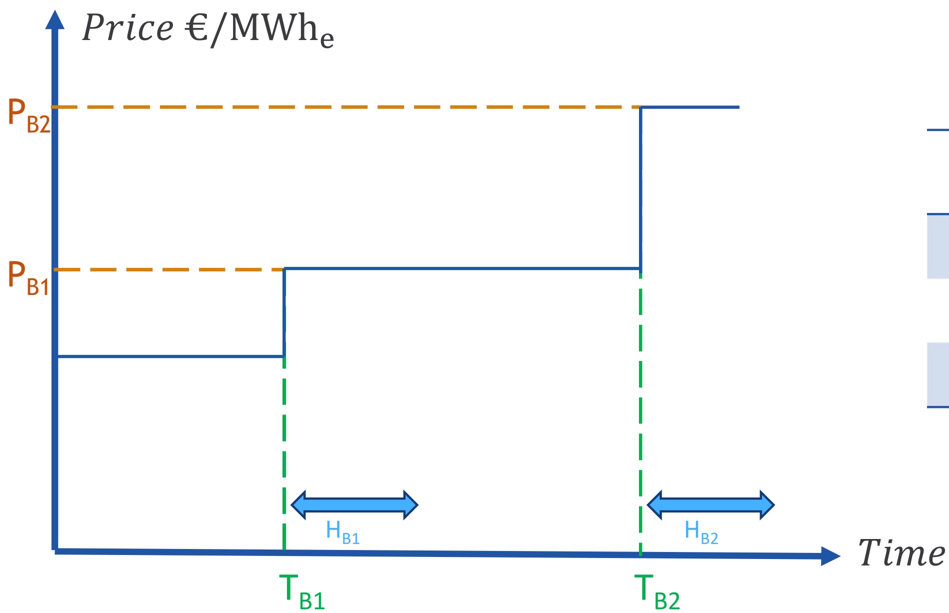
Today we focus on explicit DSR, thus on the share of DSR that is expected to actively participate to the electricity market and thus contribute on setting the hourly market price.

Explicit DSR has an important role also in the EVA model as it directly affects the magnitude and frequency of price spikes.

Acronyms: Demand side response (DSR), Energy not served (ENS), Economic Viability Assessment (EVA)

Explicit DSR (exDSR) resources modelled as multi-band generator

- Composed by activation price [EUR/MWh] & capacity bands [MW]
- Price bands can be activated sequentially or simultaneously depending on market needs
- Explicit DSR can be dispatched multiple times a day up to their maximum daily operation hours

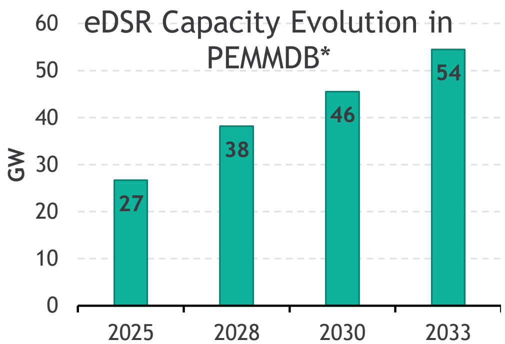


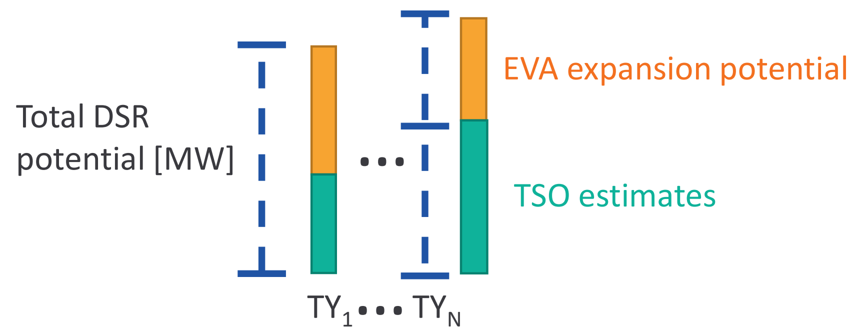
	Activation Price	Max Hours	Capacity
Band 1	P_{B1}	H_{B1}	C_{B1}
⋮	⋮	⋮	⋮
Band N	P_{BN}	H_{BN}	C_{BN}

Note: Illustrative figure

Calculation of eDSR EVA expansion potential using available literature

- TSO national estimates for DSR treated as policy units:





- DSR investments in EVA need to reflect realistic techno-economic potentials
- The DSR expansion potentials are associated with activation price bands, max daily operation hours, CAPEX and FOM

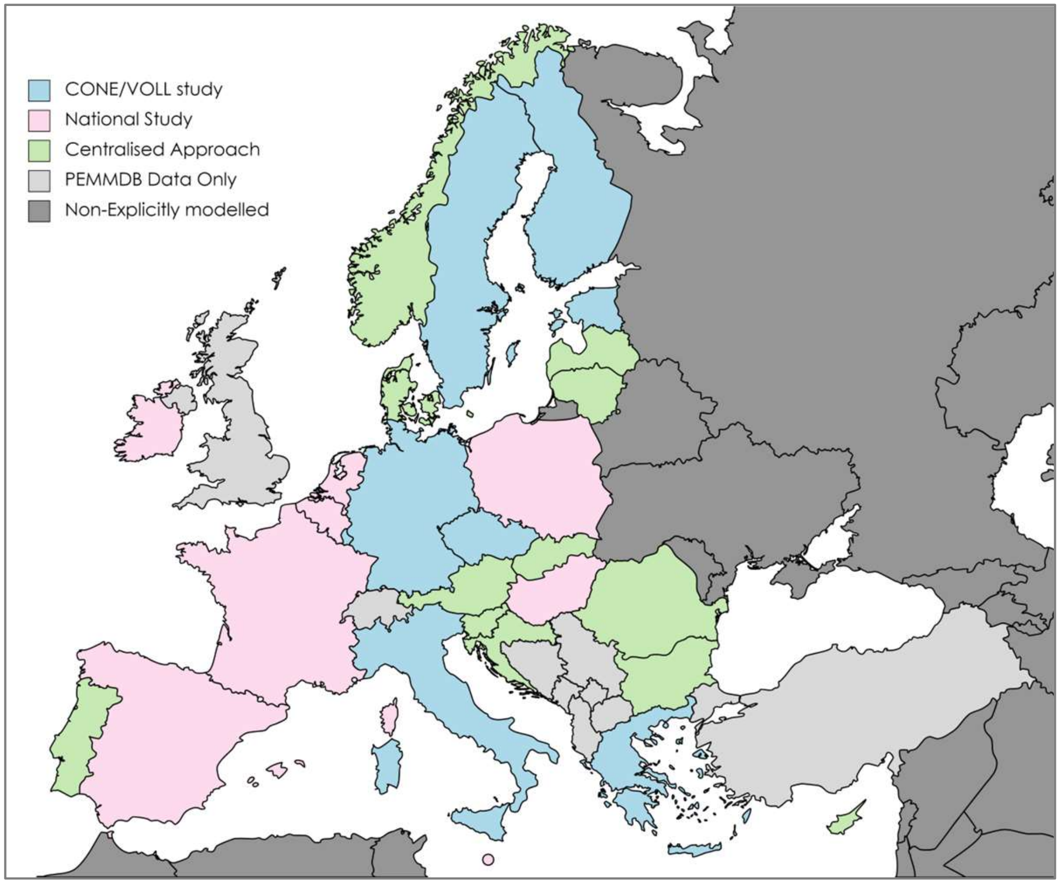
DSR VoLL/CONE study → If not available → DSR National Study → If not available → Centralised approach

- No DSR expansion potential will be considered for countries whose most recent VOLL/CONE study not retaining DSR as reference technology

Acronyms: explicit Demand side response (eDSR), Capital Expenditures (CAPEX),Fixed Operations & Maintenance (FOM), Cost of New Entry (CONE), Value of Lost Load (VOLL)

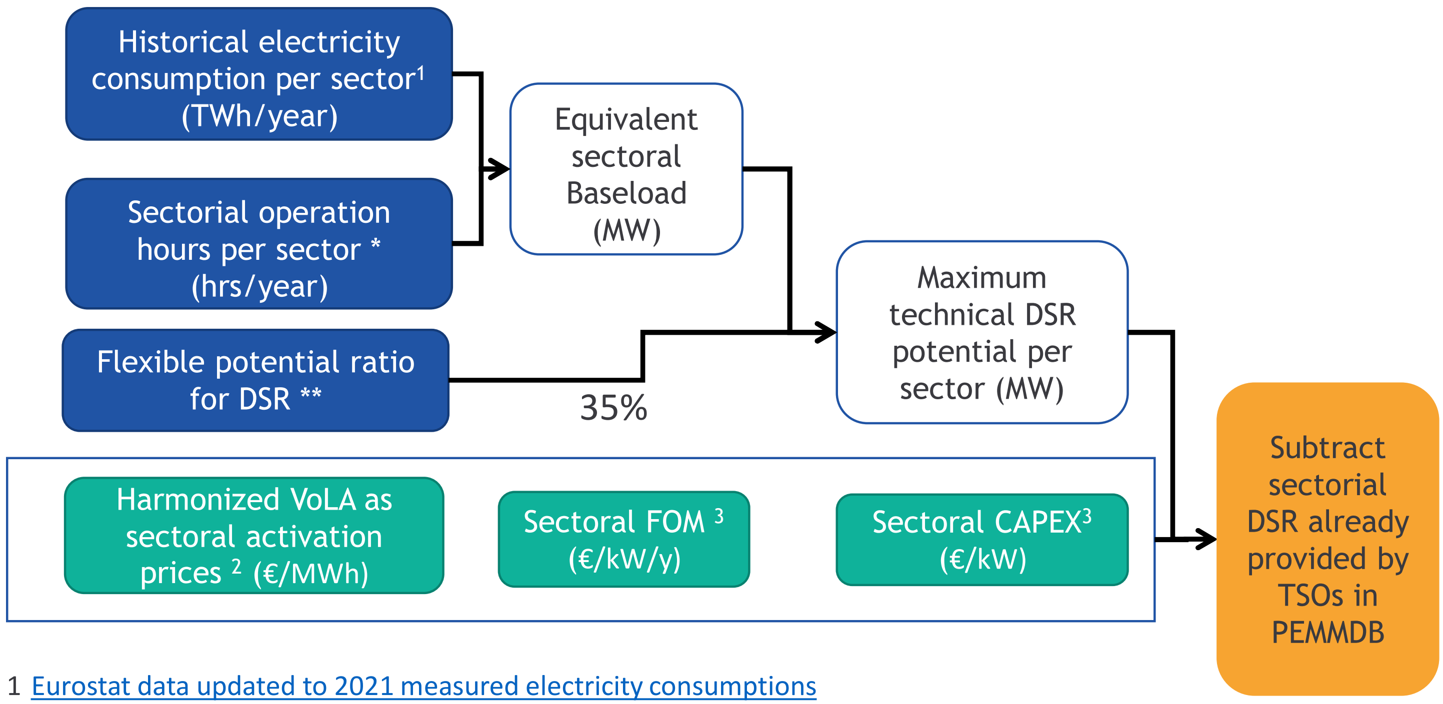
Note: *final updates may apply

Source of data for explicit DSR expansion potential



Preliminary figure.

Updated centralized approach to estimate DSR potential



1 Eurostat data updated to 2021 measured electricity consumptions

2 VoLA: Value of Lack of Adequacy (24h notice). CEPA 2018, Study on the estimation of the value of lost load of electricity supply in Europe

3 Harmonized values from available VOLL/CONE studies

*Consumption assumed as baseload

** Assumption: checked against ratios between capacities in National studies and "Equivalent sectoral load" values

Key take-aways

Explicit DSR modelling for ERAA 2023

- Explicit DSR modelled as equivalent multi-band generators offering specific (daily) energy quantities at specific activation prices
- DSR market capacity flagged in PEMMDB data is treated as policy (not subject to EVA)
- Additional DSR potential for expansion is taken for each MS based on the following hierarchical availability of data:
  (1) VoLL/CONE study; (2) DSR National study; (3) ENTSO-E centralised approach
- The centralised approach used is the same as for ERAA 2022, while the historical electricity consumptions have been updated to 2021 Eurostat data

Acronyms: Pan European market modelling database (PEMMDB)

Questions?

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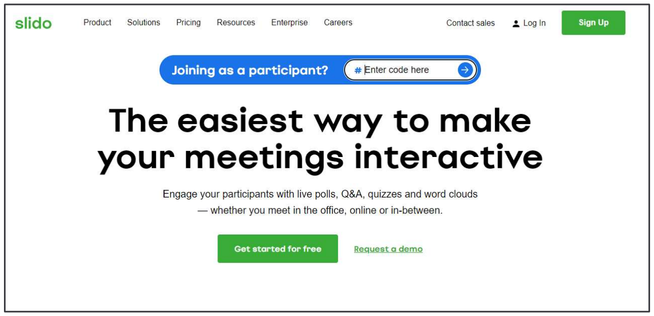

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5 min Break – Exact time communicated in chat

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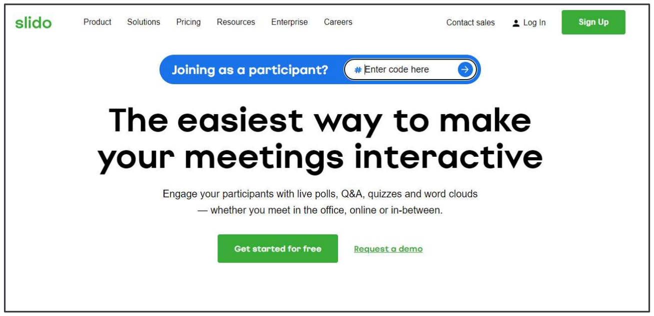

Maintenance Optimization

Alexander Haas
ERAA Market Study Team, APG

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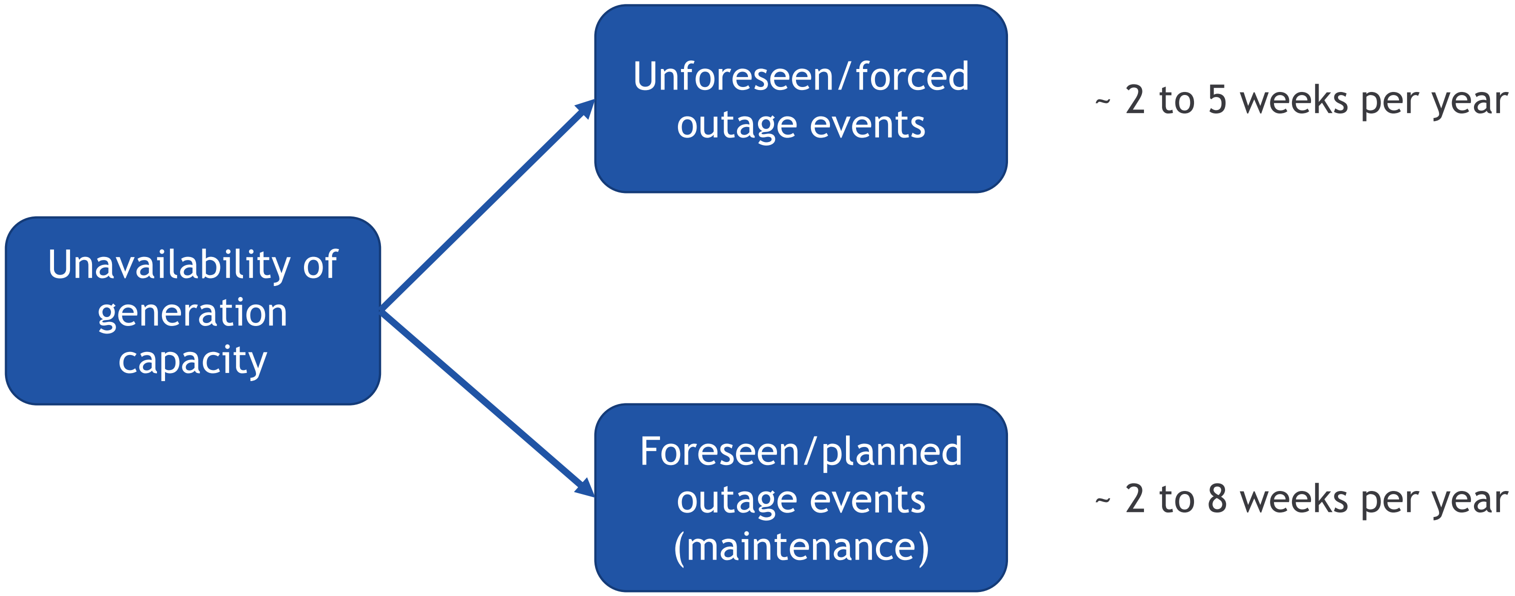
Why do we do maintenance optimisation?

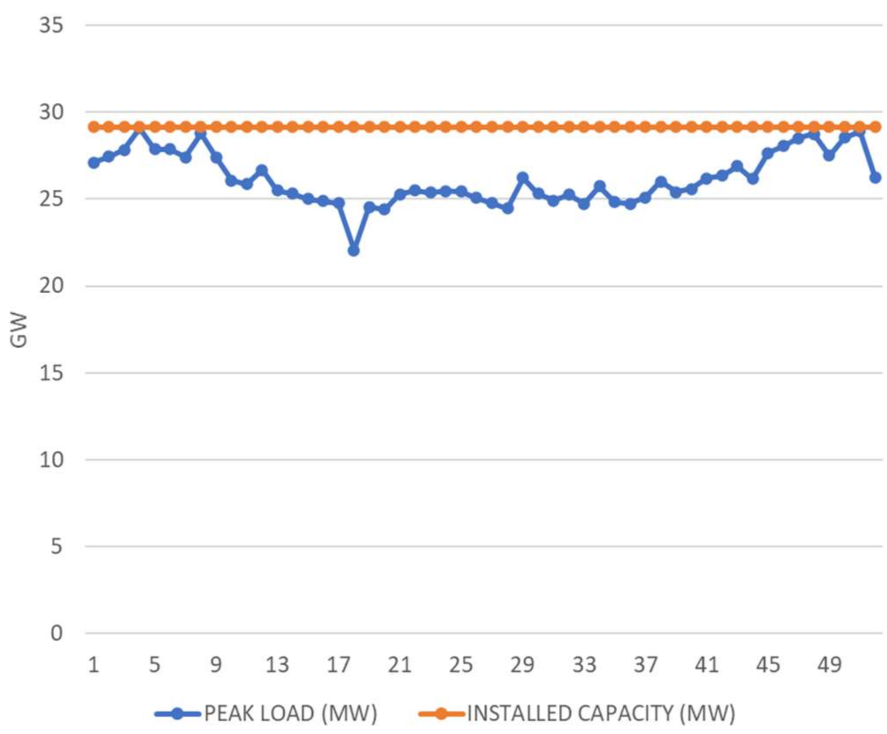


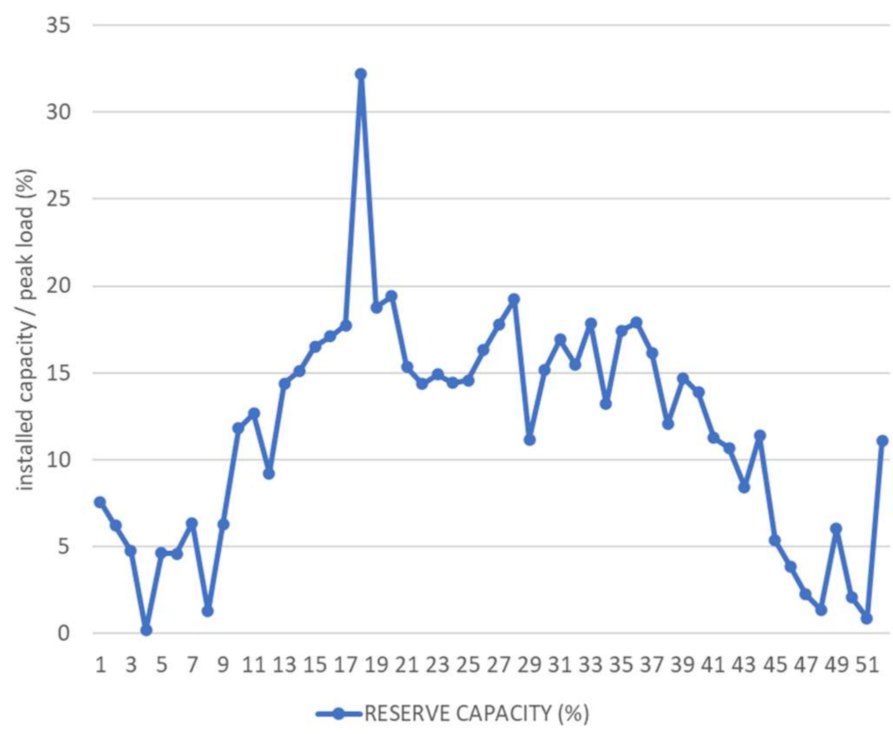
Process


Data gathering
Model building for maintenance
Maintenance optimisation
TSO Consultation
Fix input for simulation process

Methodology of maintenance optimisation

Key assumption: avoid maintenance during high price periods => levelizing the weekly loss of load probability.

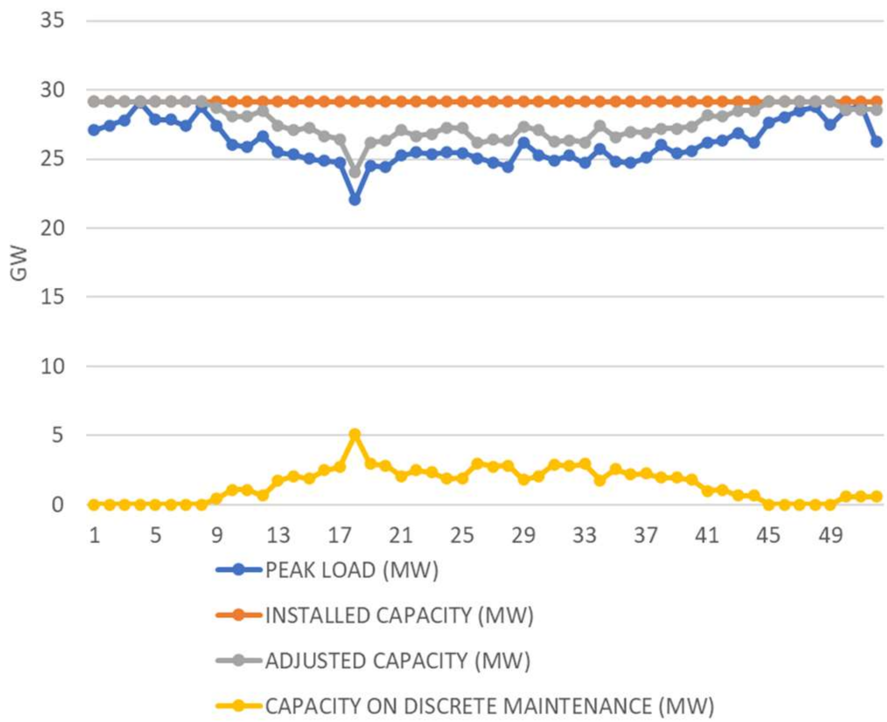


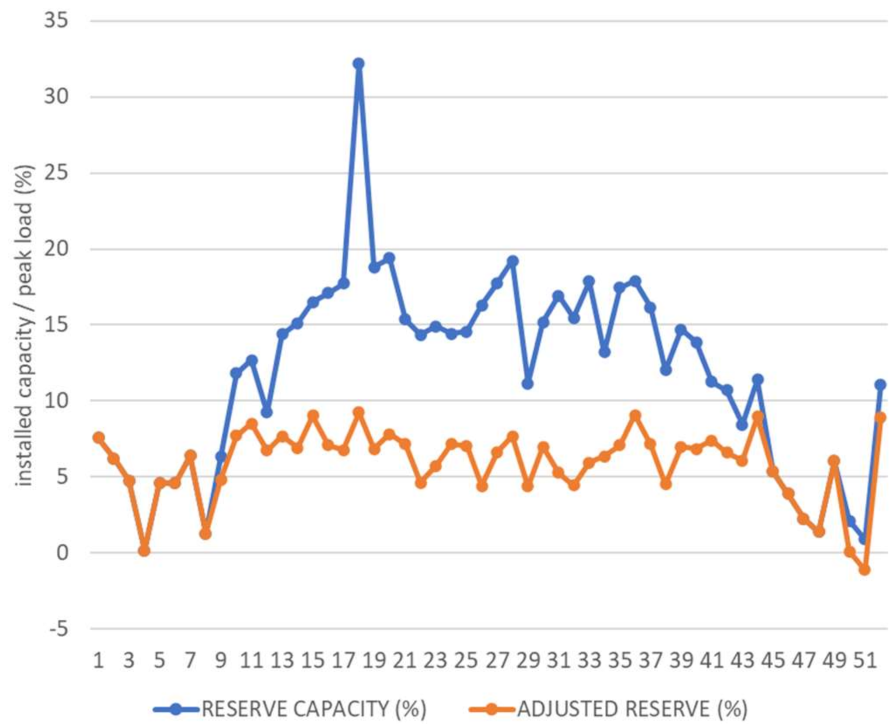


Note: Illustrative figures

Methodology of maintenance optimisation

Key assumption: avoid maintenance during high price periods => levelizing the weekly loss of load probability.





Note: Illustrative figures

Assumptions for maintenance optimisation

Maintenance related inputs:

- Maintenance rate of the power stations (number of days)
- Limited to one period of maintenance per generating unit, per target year
- TSOs can provide Predefined maintenance for specific power stations.

Additional assumptions:

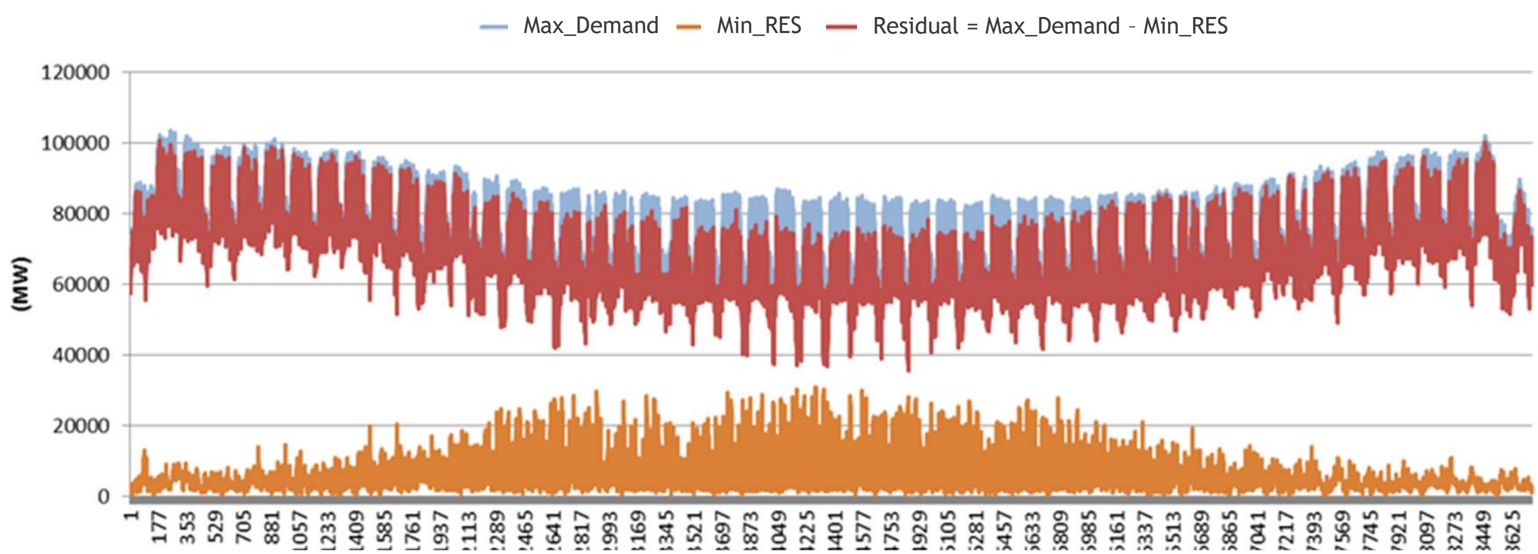
- No interconnection between market nodes
- No limitations for stored hydro energy, assuming the operations have the foresight to conserve energy for the peak periods

Calculation of Residual Demand

Residual demand is taken as the basis for maintenance planning, and all climate year data is taken into account.

$$Residual\ demand\ (t) = \max\big(native\ demand(t)\big) - \min(RES(t) + inelastic\ infeed(t))$$

Where $max()$ and $min()$ are taken over all the climate years



Note: Illustrative figure

Key take-aways

- Maintenance events have a significant and non-negligible impact on the availability of generators.
- Maintenance is scheduled during periods in the year such that the risk of scarcity situations is minimized.
- Residual demand taken as basis for maintenance planning to account for the contribution of growing RES infeed.
- Maintenance planning based on all available climate data.

Questions?

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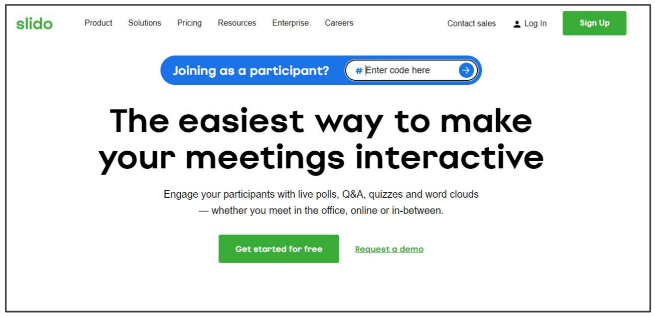

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Reserve modelling

Noelle Ameijenda
ERAA Market Study Team, Eirgrid

What is Reserve, and why model it?

Balancing reserves are power reserves contracted by TSOs that help stabilise or restore the grid's frequency following minor or major disruptions due to unforeseen factors such as outages or rapid changes in load.

By reserving capacity, we limit the capacity available for meeting the customer demand.

We need to model the effect of these reserves in our adequacy modelling.

How to model Reserve

We can model reserve in different ways:

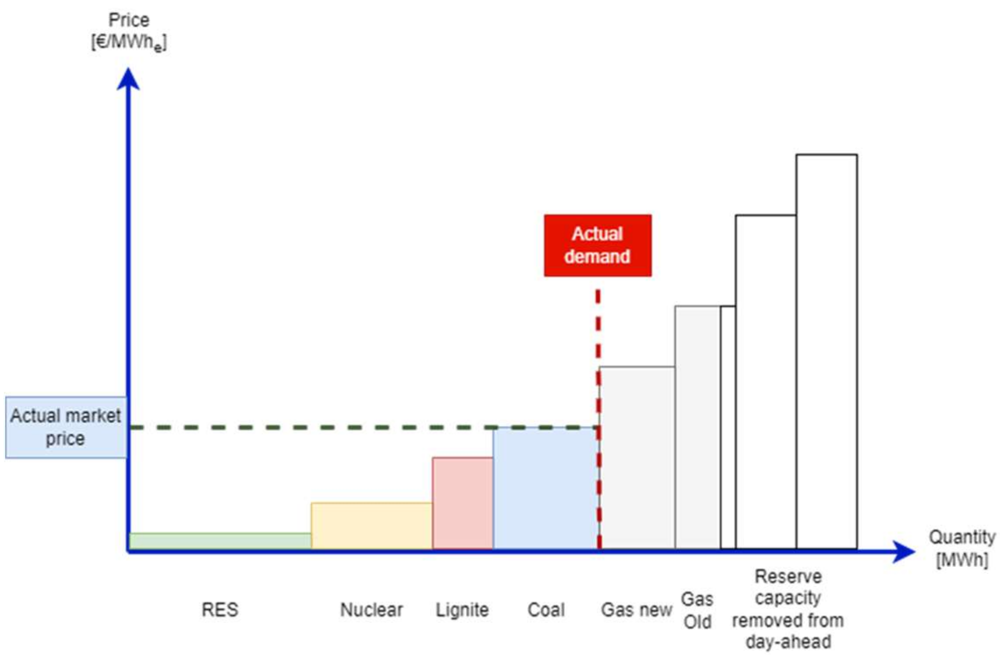
0. *Increase the Demand – but this distorts the pricing*
1. Derate Hydro generating units by a set MW amount for every hour of the year.
2. Derate Thermal generating units by a set MW amount for every hour of the year.
3. Assign some capacity of Battery or Demand side to cover reserve.
4. Assign certain thermal units the ability to provide reserve, and **dynamically** choosing the optimal units to provide the reserve required for every hour of the year.

Different market nodes can choose one or more of these options 1-4.

Reserves provided by Thermal units, as in ERAA 2022

Supply and Demand Curve when Reserves are Provided by Thermal Units

- When reserves are provided by dispatchable technologies in the form of thermal plants, this will yield electricity prices equal to the market price while still accounting for balancing reserves in adequacy simulations
  - An alternative methodology (which models reserves by using higher demand) distorts the market price.



**Graph is only for illustration purposes*

Note: Illustrative figure

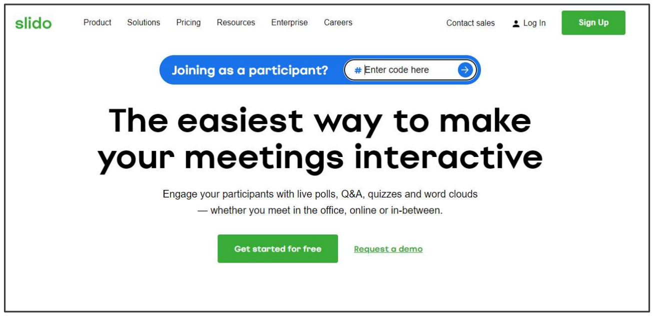
Key take-aways

What are the benefits of this reserve methodology:

- It models reserve in a dynamic fashion, according to the operational practices of power systems
- It models appropriate electricity prices and other outputs related to the prices
- Results in appropriate adequacy indicators

Questions?

Go to www.sli.do and enter **#2304846** **OR** Scan the QR code with your phone



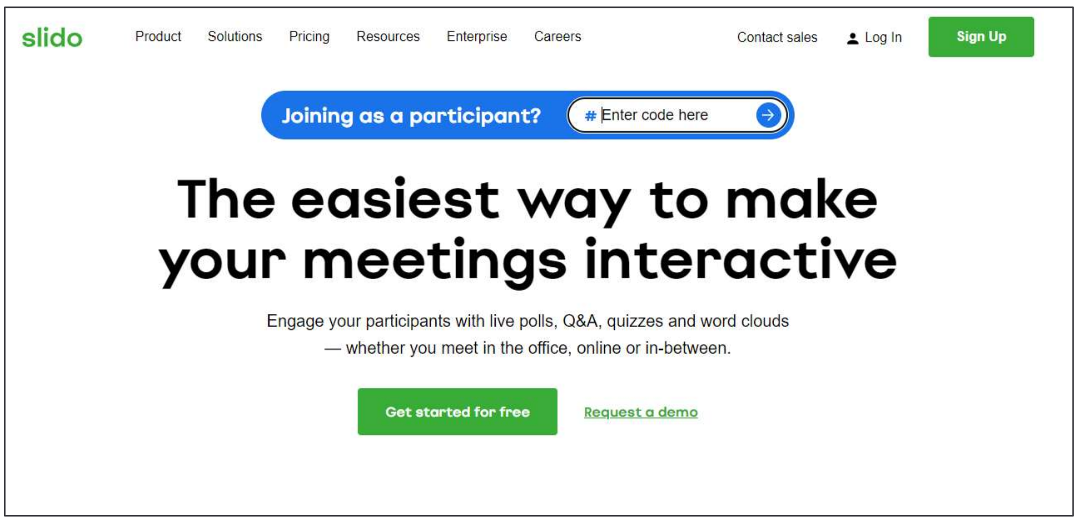
Agenda
Price cap determination
Explicit DSR modelling and expansion potentials
Maintenance Optimization in ERAA
Reserve modelling

Q&A

Lazaros Exizidis,
ERAA Project Management, ENTSO-E

Submit your questions and answers on Slido

Go to www.sli.do and enter **#2304846** **OR** Scan the QR code with your phone



Conclusions & next steps

Don’t forget to join us for the next public webinars & workshops

15 March
- Webinar **“Preliminary input data”**
- Call for Evidence window opening

5 April
Call-for-Evidence window closure

Today
Webinar
“ERAA 2023 Methodological Insights - Part 1”

29 June
Webinar
“ERAA 2023 Methodological Insights - Part 2”

REGISTER HERE

Preliminary agenda:
- Multi-year approach for the Economic Viability Assessment (EVA) step
- Network modelling (Flow based Market Coupling domains)
- Run time improvements
- Flow factor competition & curtailment sharing

Early November
Publication

Mid November
- Webinar on **“ERAA 2023 results”**
- Launching ERAA 2023 consultation

Key enhancements for ERAA 2023

Stakeholder interaction

- Multiple consultations and webinars on input data, methodologies and results
- Integrating views into ERAA 2023 and next ERAAs

Expanded methodology

- Scenarios heading towards Fit for 55
- Enhanced EVA with multi-year approach
- Flow-based in central reference scenarios, expanded to reflect additional project
- EVA network modelling brought closer to the adequacy model
- DSR, storage and electrolysers considered

Thank you for your attention

Cooperation

Planning, cooperation and targeted measures are key for a secure electricity system.

Coordination

Adequacy issues deeply interlinked; regional coordination is crucial.