ERAA 2025 Stakeholder webinar: Methodological refinements

20 August 2025

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Reliable Sustainable Connected

Agenda

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Introduction & Background

Daniel Huertas Hernando,
ERAA StG vice-convenor, Elia

Background

- ERAA is an ENTSO-E **legal mandate**, which aims to understand how the rapid changes to our energy system will affect security of supply.

- It **supports decision-makers** in ensuring secure, affordable and sustainable energy to citizens and industries.

- It is a **full pan-European monitoring assessment** of power system resource adequacy, based on a state-of-the-art, globally unparalleled **probabilistic analysis** looking up to a decade ahead.

- **ERAA 2025** builds upon the previous editions (including the approved 2024) with **continuous improvements** to enhance this key adequacy assessment even further.

- ERAA 2025 aims to be an effective tool to **identify adequacy risks.**

- ERAA is built on **the latest and transparent pan-European reference dataset** emerging from two main domains: data driven by the national and European policies; and cutting-edge common pan-European dataset

Role of the ERAA

Assess potential adequacy risks of the European power system in medium term

With focus on TY 2028, 2030, 2033, 2035

Inform decision makers and stakeholders

Common basis for MS to introduce capacity mechanisms

Strengthen Europe's trajectory to net-zero

Strengthen and complement system planning activities

Continuous improvement

ERAA 2025 focus on improvements in the Economic Viability Assessment (EVA) maintaining robustness of ERAA framework.

Weather Scenario selection improvements

Risk aversion enhancements

Maintaining robust EVA (cost-based)

Alternative EVA testing (revenue-based)

ACER
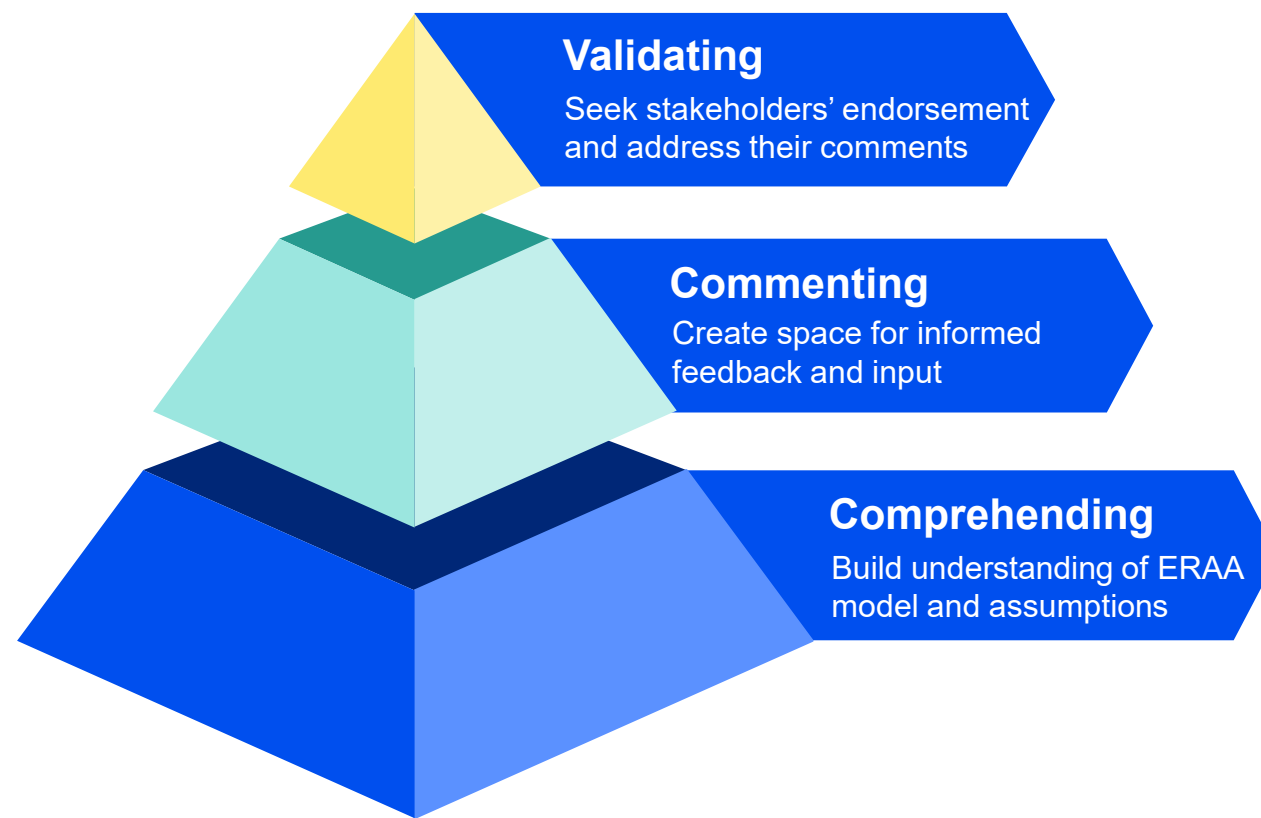European Union Agency for the Cooperation
of Energy Regulators

- **Ensuring clarity** and creating space for dialogue is critical for the stakeholder engagement.

- With the ongoing improvements to the ERAA and a number of changes introduced in every edition, it is difficult to follow the developments.

- Proposed solutions:

  - **Refine the ERAA report descriptions** to ensure they are both clear and sufficiently detailed.

  - **Provide a release note** to every future edition, informing what has changed and how it impacts the model.

Validating
Seek stakeholders' endorsement and address their comments

Commenting
Create space for informed feedback and input

Comprehending
Build understanding of ERAA model and assumptions

Steps of the stakeholder engagement

Two ERAA modules: they should be closer than ever

Adequacy module (ED)

Investment module (EVA)
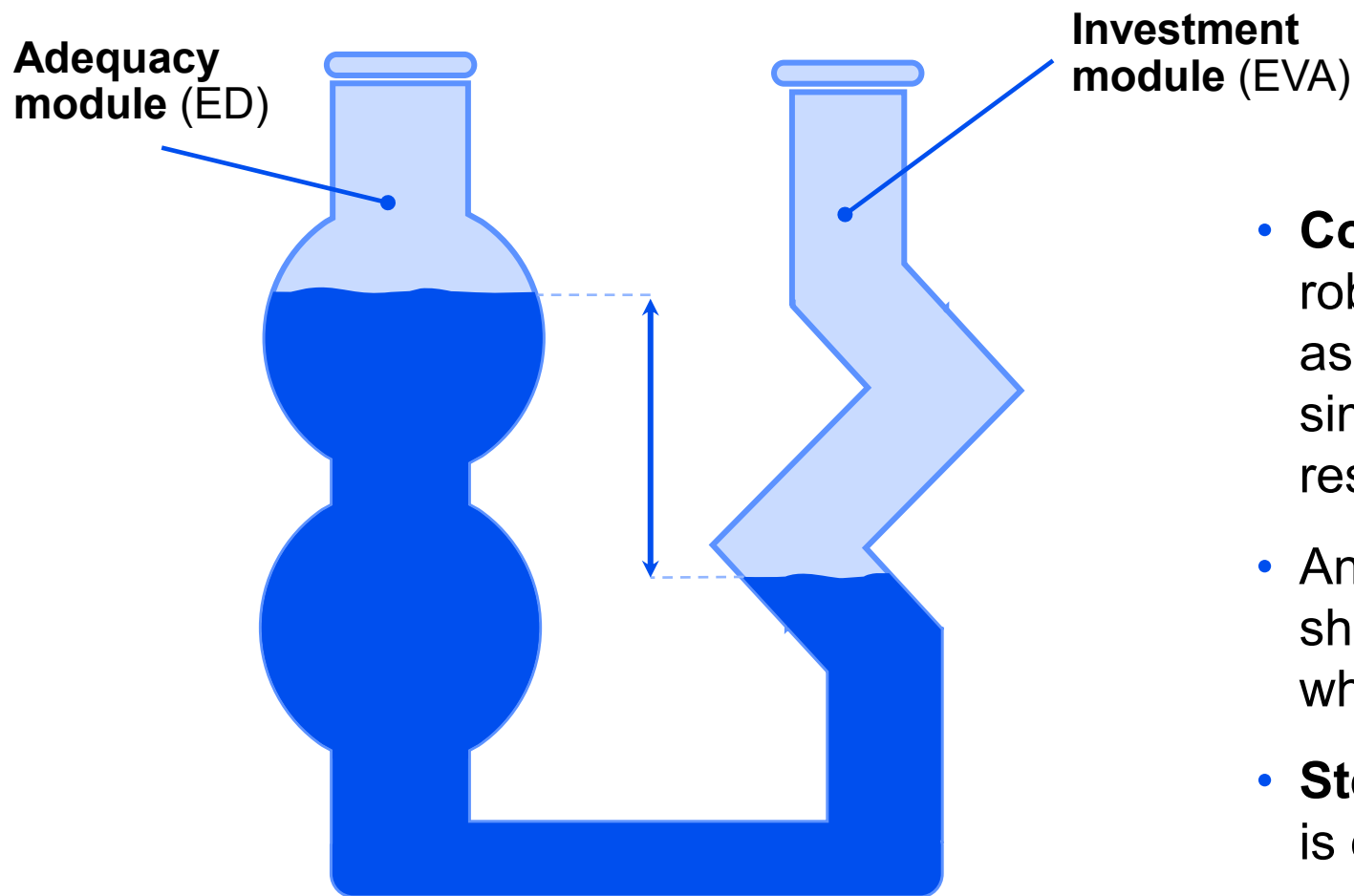
Inconsistency can seriously impact the robustness

- **Consistency remains key** for a robust ERAA. Both modules of the assessment should use adequately similar assumptions to deliver reliable results.

- Any change in the adequacy module should also be visible for the model when it makes investment decisions.

- **Steady consistency improvements** is expected with each ERAA versions

ERAA streamlining is underway. Engage in the process

- Consultation about the ERAA streamlining has started. ENTSO-E is to submit the draft amendments in October and will be adopted by ACER in January. The next ERAA is expected to be based on the updated methodology.

- **ACER does not anticipate any major change in ERAA 2025, prioritising consistency and transparency.** Any structural change would be discussed in the streamlining.

Have your say.

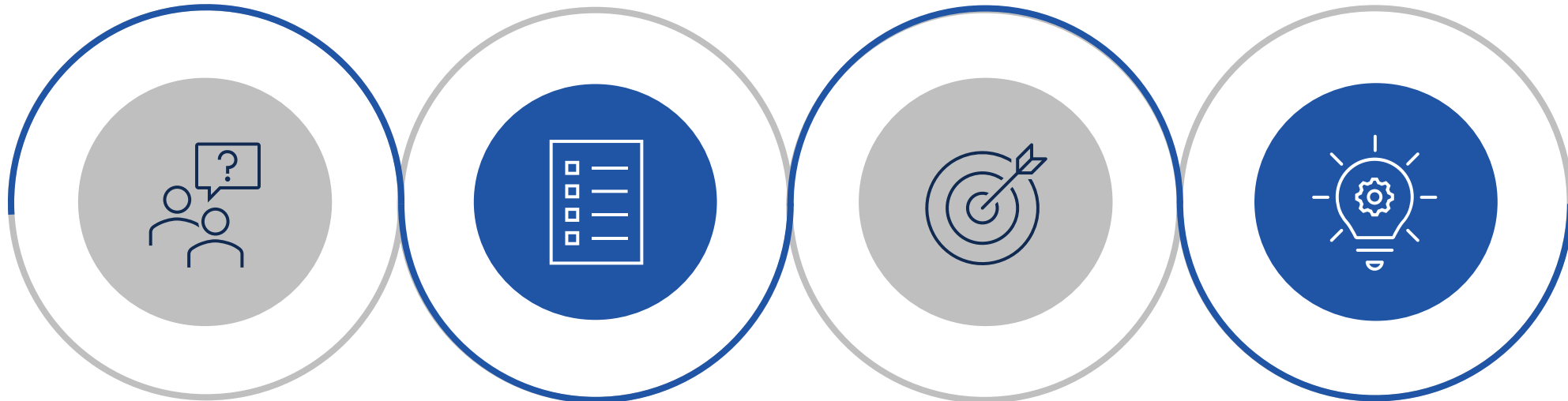Access the public consultation and share your views on the ERAA streamlining.

Weather Scenario Selection

Laura Torralba Díaz
Market Modelling Analyst, TransnetBW

Background

Why do we need to select a subset of weather scenarios (WSs) for the EVA?

CAUSE

The EVA requires **model size simplifications**

CONTEXT

Due to **updates regarding data collection**, new WSs must be selected for ERAA 2025
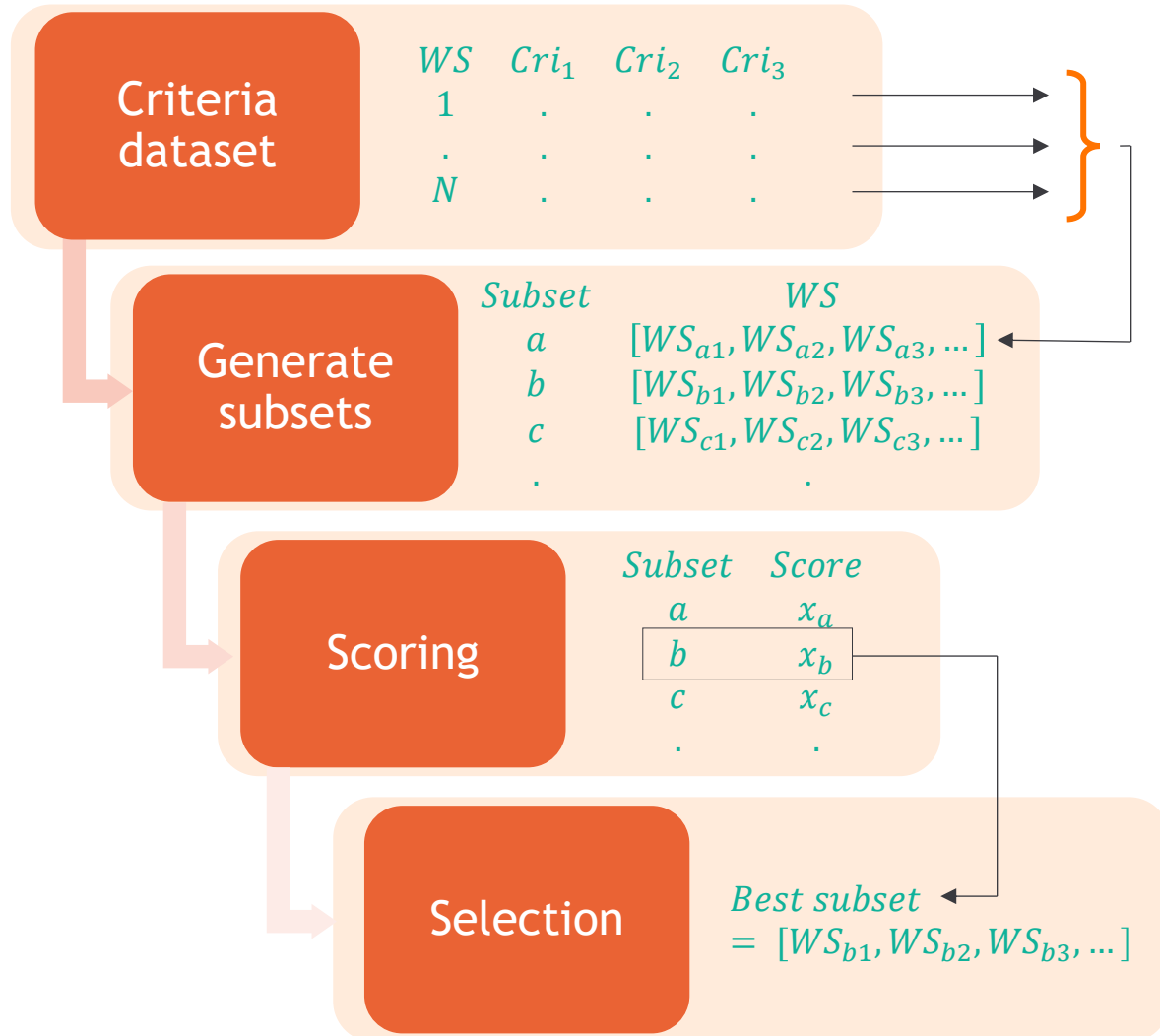
GOAL

Selection of a **representative subset of WSs** (capable size)

APPROACH

An **impact-based** approach was adopted in ERAA 2024, which is also applied with improvements in ERAA 2025

Impact-based Methodology

Criteria dataset

WS	Cri_1	Cri_2	Cri_3
1	.	.	.
.	.	.	.
N	.	.	.

→ **Definition of a criteria dataset for qualifying a subset of WSs as representative of the full set**

The impact-based approach is characterized by the use of criteria based on ED revenues

Generate subsets

Subset	WS
a	$[WS_{a1}, WS_{a2}, WS_{a3}, ...]$
b	$[WS_{b1}, WS_{b2}, WS_{b3}, ...]$
c	$[WS_{c1}, WS_{c2}, WS_{c3}, ...]$
.	.

→ **Generation of WS subsets to be tested**

In ERAA 2024 and 2025 all possible subsets of 3 and/or 6 WSs are explored

Scoring

Subset	Score
a	x_a
b	x_b
c	x_c
.	.

→ **Scoring of WS subsets**

For scoring, the Wasserstein metric is applied, i.e. the distance between each subset of WSs and the full set is measured as the area between their cumulative distribution functions

Selection

Best subset $= [WS_{b1}, WS_{b2}, WS_{b3}, ...]$

→ **Selection of the most representative WS subset**

The most representative WS subset is the one that minimizes the sum of Wasserstein distances

ERAA 2025 Improvements and Refinements

ERAA 2024

WS selection for EVA was based on a **net revenue proxy** on **pre-EVA preliminary ED results** for **TY 2030** only and a **single FO sample**.

Pre-EVA ED results

TY 2030 only

A single FO sample

ERAA 2025

A new WS selection for EVA was performed based on the ERAA 2024 methodology with improvements on:

1. Using final **ERAA 2024 post-EVA ED net revenues**. This represents an improvement compared to using pre-EVA preliminary ED results in terms of expected representativeness and consistency with ERAA 2025 post-EVA ED revenue distribution.
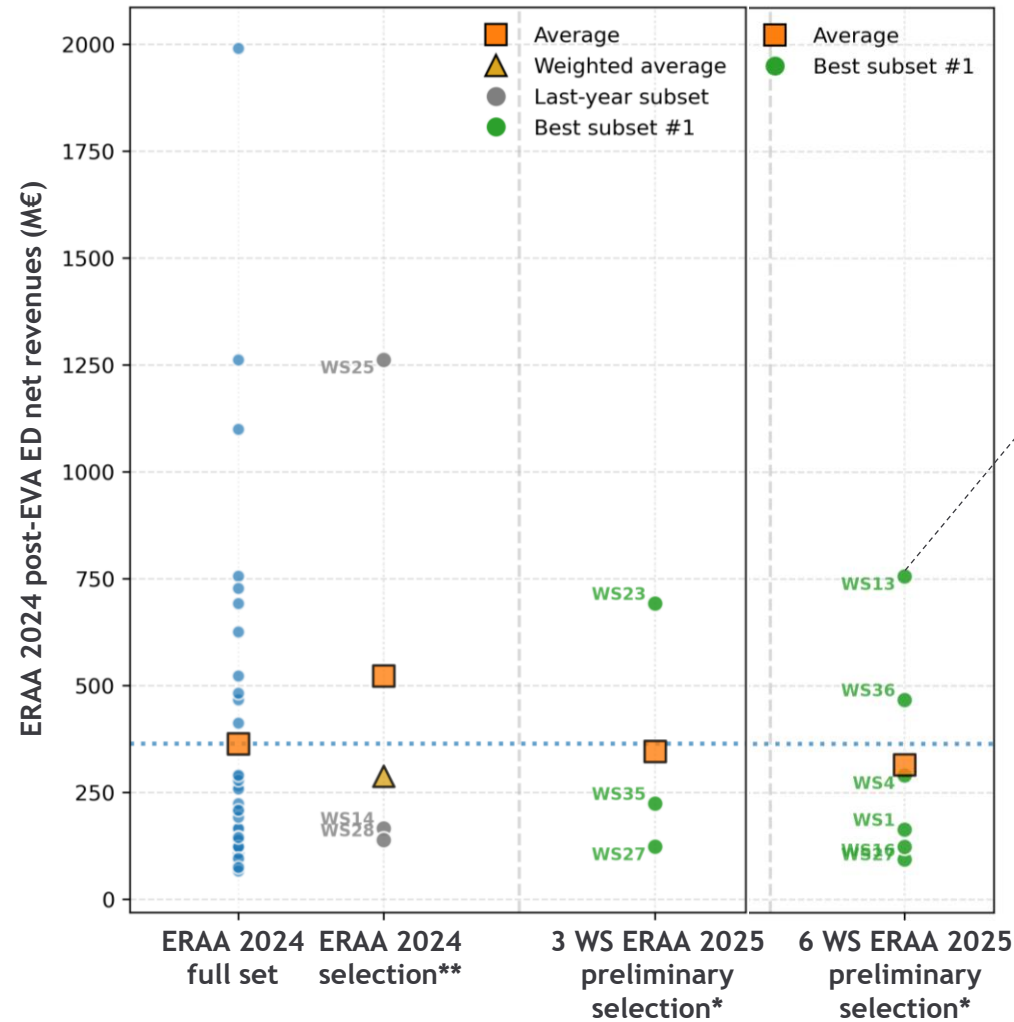
   Post-EVA ED results

2. **All TYs and FO samples** were taken into account to increase representativeness (TYs) and robustness (FOs) of the WS selection.

   All TYs

   All FO samples

Preliminary ERAA 2025 WS selection for EVA

- The **selected 3 and 6 WS subsets are well aligned with the full set of 36 WSs** (considering ERAA 2024 post-EVA ED net revenues).

- **In ERAA 2025 both preliminary selections** (of 3 and 6 representative WSs) **appear more balanced compared to ERAA 2024** (e.g. no extreme WSs selected such as WS25).

  - In ERAA 2024, WS25 was initially not presenting extreme revenues (in pre-EVA ED simulations). Using ERAA 2024 post-EVA ED results for ERAA 2025 WS selection mitigates such risk for ERAA 2025*.

WS13 average net revenues considering:
- 4 target years
- 50 study zones
- 15 forced outage samples

* A calibration of the WS selection may be considered after validating post-EVA ED results of ERAA 2025.
** The weighted sum of revenues of the selected subset of WSs in ERAA 2024 was set to be equal to the arithmetic mean for TY 2035 of the full set of WSs.

Risk aversion

Nils Müller

Market Modelling Advisor, Amprion

Background

Why is the risk aversion implementation in ERAA amended?
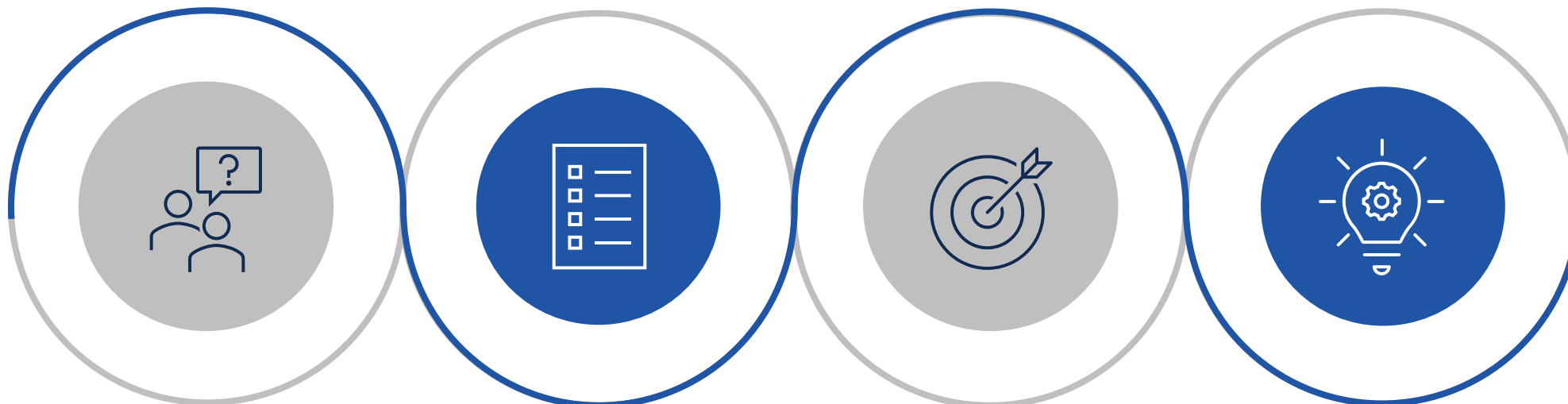
CAUSE

Large expansion in previous ERAA cycles relying on revenues in few scarcity hours. Stakeholders calling to improve appropriate investor behaviour.

CONTEXT

Consideration of risk management towards price spikes (Art. 6.15 of ERAA Methodology)

GOAL

Improvement of appropriate investor behavior in the EVA in particular related to scarcity prices.

APPROACH

Investigate alternatives: (updated) hurdle premiums, establishing revenue cap, and combination of both.

Additional insights on investor behavior

Updating the consideration and probability of occurrence of price spikes is identified as a necessary outcome stemming from the **investor survey*** conducted in the context of the ERAA Methodology Revision.

<u>Objective</u>: Refine the EVA with proper consideration of risk management towards price spikes (Art. 6.15 of ERAAMethodology), currently not captured by hurdle premiums.

Q23: Which approach(es) do you typically use to adjust for price and revenue risk in the investment criteria above when considering entry and exit decisions?

21 responses collected:
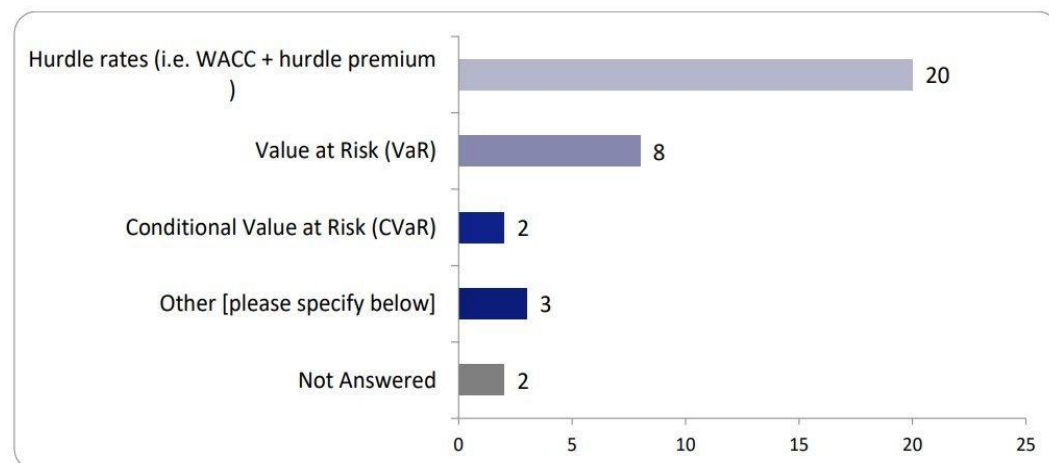
Q25: When evaluating investments in supply-side (generation) assets, how do you account for the potential occurrence of scarcity prices and associated revenues?

20 responses were collected:
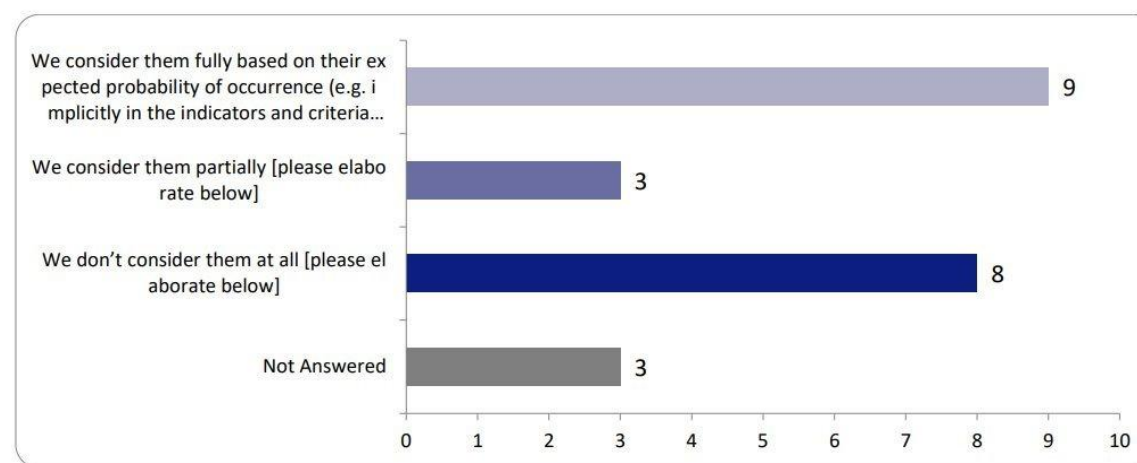
Update of Risk Aversion approaches in EVA: options

(update of hurdle premiums)

1 CARA-Based Risk Premiums

Concept:
A utility-based approach using the Constant Absolute Risk Aversion (CARA) function is implemented. CARA utility function approach is a standard method to include risk considerations in investment modelling, significantly impacting hurdle rates and differentiating technologies like OCGT and CCGT based on their revenue distribution over the full ED weather scenario set.

Process:
Expected utility, certainty equivalents, and risk premiums per MW Have been computed based on ERAA2024 final ED revenue data.

Finalization:
- New hurdle premiums for newly built gas units (OCGT and CCGT) have been identified, extracted, and validated.
- Hurdle premiums for batteries and existing thermal units remain unchanged for now, due to inherent complexity of extending the CARA approach to such capacity type.

Expansion tech.	ERAA 2024 hurdle P.	ERAA 2025 hurdle P.
Gas OCGT New	6 %	9,9%
Gas CCGT New	4,5%	6,9%

2 EVA Revenue Cap Adjustment

Concept:
Analyze available price curves and cluster price cumulated probability of occurrence to extrapolate distribution and appropriate reliable price spike expectations from the perspective of rational investors. In practice, it translates into introducing a reliable revenue cap as seen by investors in EVA.

Process:
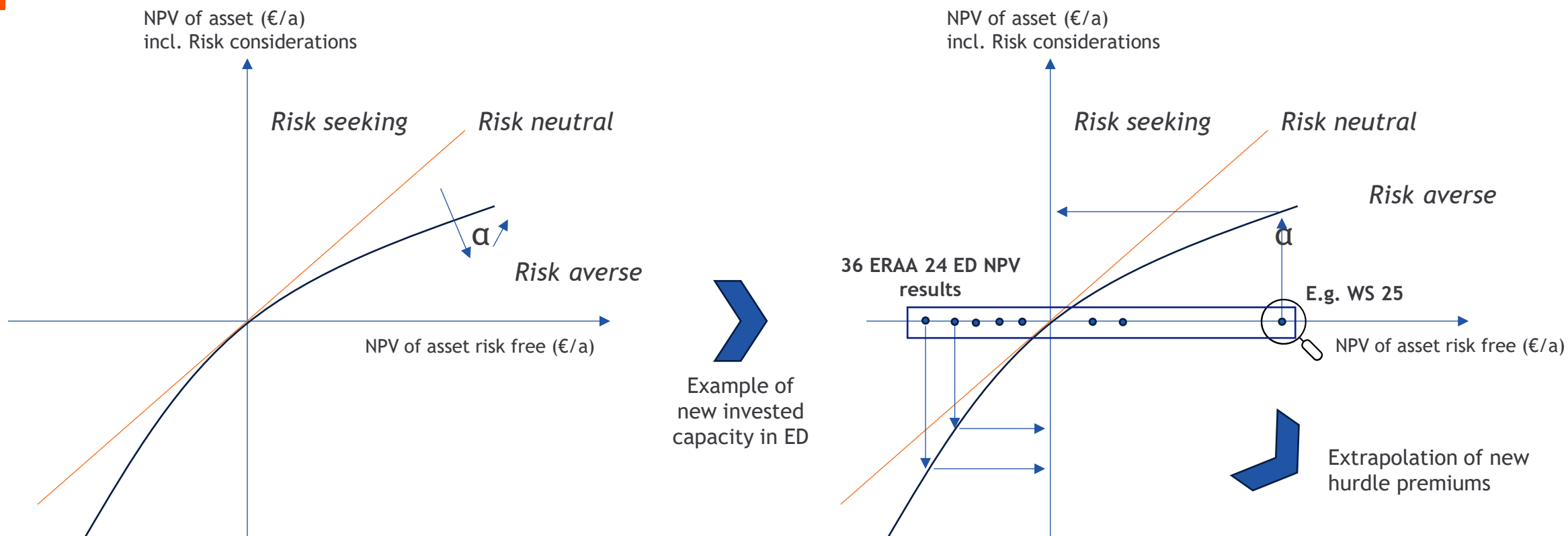Two approaches to determine a reliable revenue CAP were assessed:
1. **Historical price peak analysis** to define a realistic price cumulated probability of occurrence based on observed DA market prices and selecting a percentile of historic prices.
2. **Conditional Value at Risk (CVaR)** simplified methodology, clustering ERAA 2024 ED price time series to define a price cumulated probability of occurrence based on future modelled DA market prices and selecting a percentile of modelled prices.

Finalization:
- Simplified CVaR based on ERAA 2024 ED prices selected (2.)
- Increasing revenue cap value in each TY following same year-to-year percentage increase as the exogenous estimated DA price cap evolution.

Cap €/MWh	2028	2030	2033	2035
DA Market Cap evo.	5500	6500	7000	7500
EVA Revenue cap	1000	1200	1300	1400

Risk Aversion Approach 1: CARA-Based Risk Premiums

NPV of asset (€/a) incl. Risk considerations

Risk seeking   Risk neutral

α

Risk averse

NPV of asset risk free (€/a)

Example of new invested capacity in ED

NPV of asset (€/a) incl. Risk considerations

Risk seeking   Risk neutral

Risk averse

36 ERAA 24 ED NPV results

α

E.g. WS 25

NPV of asset risk free (€/a)

Extrapolation of new hurdle premiums

CARA Utility (Constant Absolute Risk Aversion)

- Typical range for α (alpha):
  - Low risk aversion (risk-neutral to mildly risk-averse): $\alpha \approx 0.0001 - 0.001$
  - Moderate risk aversion (average investor): $\alpha \approx 0.005 - 0.01$ ➡ 0.0075
  - High risk aversion (very cautious investor): $\alpha \approx 0.02 - 0.05$

Simplified description of the methodology: Utility Function for Risk Policy

Risk Aversion Approach 2: EVA Revenue Cap Adjustment

Nodal data from ERAA24 ED model in all TYs and all WSs		
Interval	Number of observations	Cumulative %
0 - 50	3871117	23.515%
50 - 100	6177405	60.754%
100 - 150	5830727	95.903%
150 - 200	580522	99.402%
200 - 250	19480	99.520%
250 - 300	9385	99.576%
300 - 350	5425	99.609%
350 - 400	4001	99.633%
400 - 450	3763	99.656%
450 - 500	3787	99.678%
500 - 550	7688	99.725%
550 - 600	11405	99.794%
600 - 650	1168	99.801%
650 - 700	1022	99.807%
700 - 750	1003	99.813%
750 - 800	783	99.818%
800 - 850	878	99.823%
850 - 900	713	99.827%
900 - 950	728	99.832%
950 - 1000	3228	99.851%
1000 - 1050	633	99.855%
1050 - 1100	655	99.859%
1100 - 1150	518	99.862%
1150 - 1200	357	99.864%
1200 - 1250	390	99.866%
1250 - 1300	411	99.869%
1300 - 1350	272	99.870%
1350 - 1400	285	99.872%
1400 - 1450	1196	99.879%
1450 - 1500	321	99.881%

Analysis based on extracted hourly prices from ERAA 2024 results:

- The cumulated probability of occurrence of prices falling up to a certain interval has been analyzed. The results highlight as suitable option to set the revenue cap at 1000 €/MWh, corresponding to ca 0.15 % Conditional Value at Risk due to price spikes occurrences (statistically speaking price spikes which occur less than 13 hours in a year are reduced).

- This value captures the wide majority of the occurrences while remaining at a reasonable level of risk aversion considering the conservativeness of investors regarding spike prices stemming from the recent investor survey.

- The approach was implemented considering an increasing revenue cap over the modelled horizon. Starting from 1000 €/MWh in 2028, the revenue cap can increase in the following TYs follows the exogenous DA price cap increase estimated based on harmonized market rules applied to the same ERAA 2024 ED prices (same approach as in ERAA 2024):

| TY 2028	TY 2030	TY 2033	TY 2035
1000 €/MWh	1200 €/MWh	1300 €/MWh	1400 €/MWh

- The inclusion of this approach in the EVA requires adjusting the activation prices for the explicit DSR bands above 2000 €/MWh. The objective is to guarantee that they are activated before curtailing load.

- Similar outcomes (with less occurrences of high prices) obtained from analysis based on DA historic prices.

Revenue-based EVA

Oscar Miralles Perez

Adequacy & Market Modelling Specialist, ENTSO-E

Background

What is the revenue-based EVA approach, and why are we testing it in ERAA?
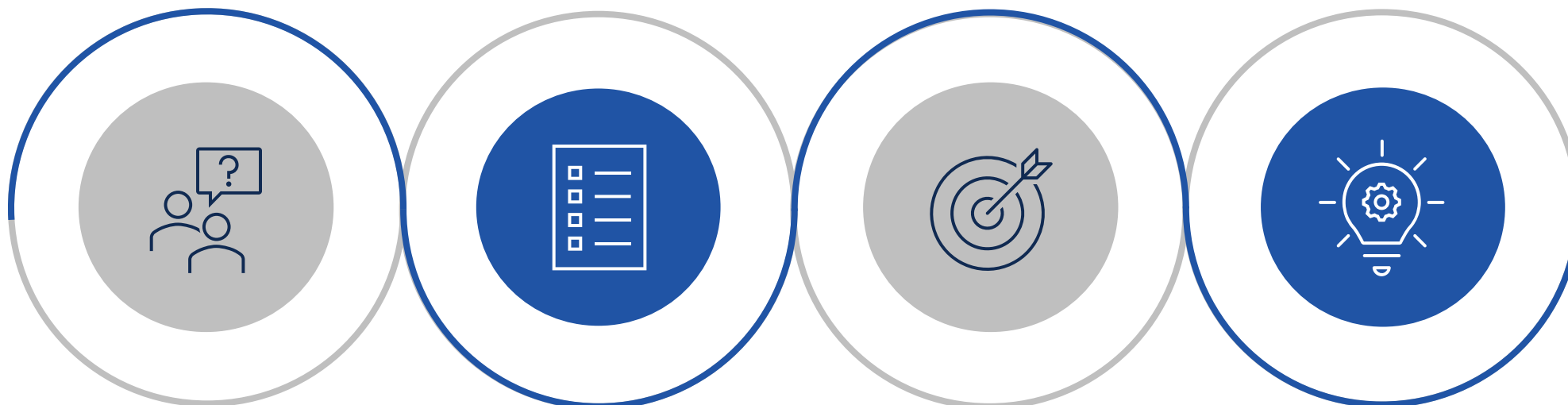
CAUSE

High complexity in overall costs EVA model leads to the introduction of some simplications.

CONTEXT

ERAA methodology (Article 6.2) enables EVA on a "revenue-based" assessment.
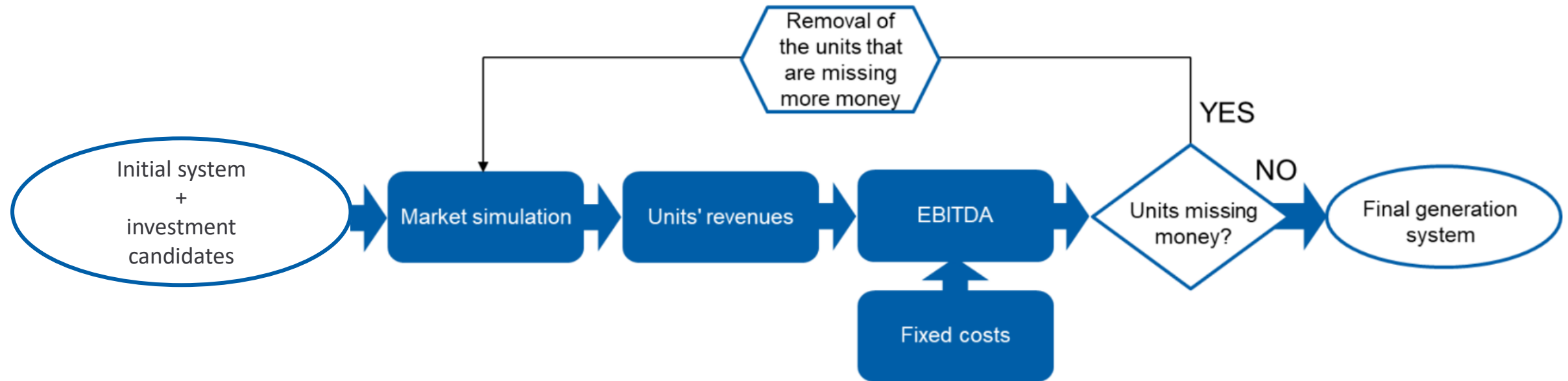ERAA 2024 published case study on revenue-based EVA

GOAL

Reflect on methodological options available and assess computational performance by accommodating elements beyond cost-based EVA (esp. WS count).

APPROACH

Build on ERAA 2024 case study models and establish a revenue-based EVA on the full pan-European perimeter.

Technical implementation

Unit profitability is assessed through **missing money analysis,** an iterative process that aims to identify system equilibrium
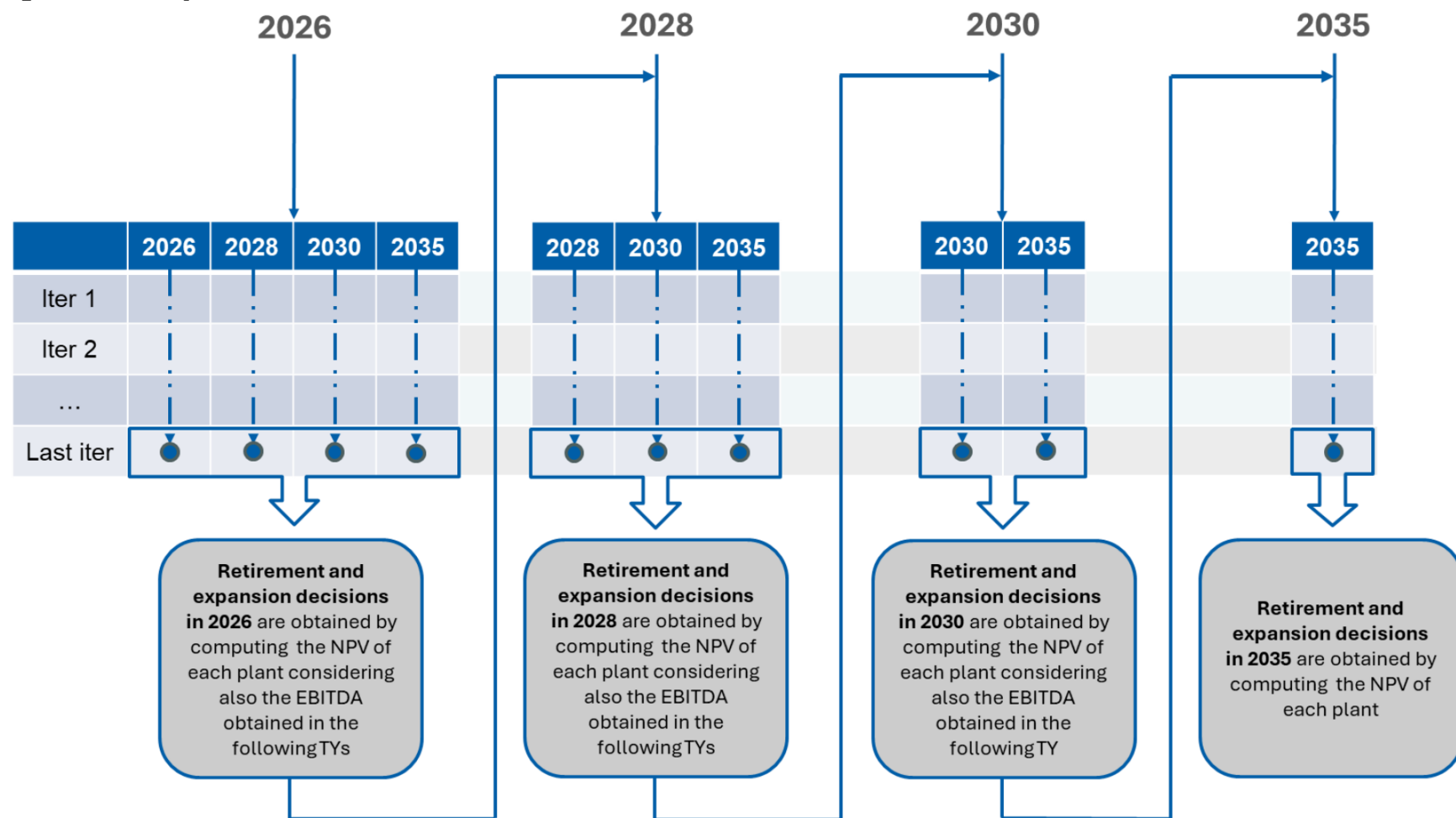
Technical implementation

Unit profitability is assessed through **missing money analysis**, an iterative process that aims to identify system equilibrium

Example based on ERAA 2024 assessed Target Years. ERAA 2025 assesses Target Years of 2028, 2030, 2033 and 2035 instead of above respectively.

ERAA 2025 status on Revenue-based EVA

In ERAA 2025 Revenue-based EVA has been further investigated following case study in ERAA 2024:

- Improve the decision-making logic and review methodological choices to obtain a final system closer to the economic equilibrium;

- Validating computational performance and computational limits of existing infrastructure for an increase of the considered WSs. Additional WSs are run in parallel, hence it is only required additional computational power;

- Assessing existing algorithm iteration settings to reach accurate results in reasonable time and to optimize it for future simulations;

- Ensure consistency of revenue-based EVA and ED models. Validating existing consistency and refining models if some model elements were not considered in case study of ERAA 2024 for computational simplicity.
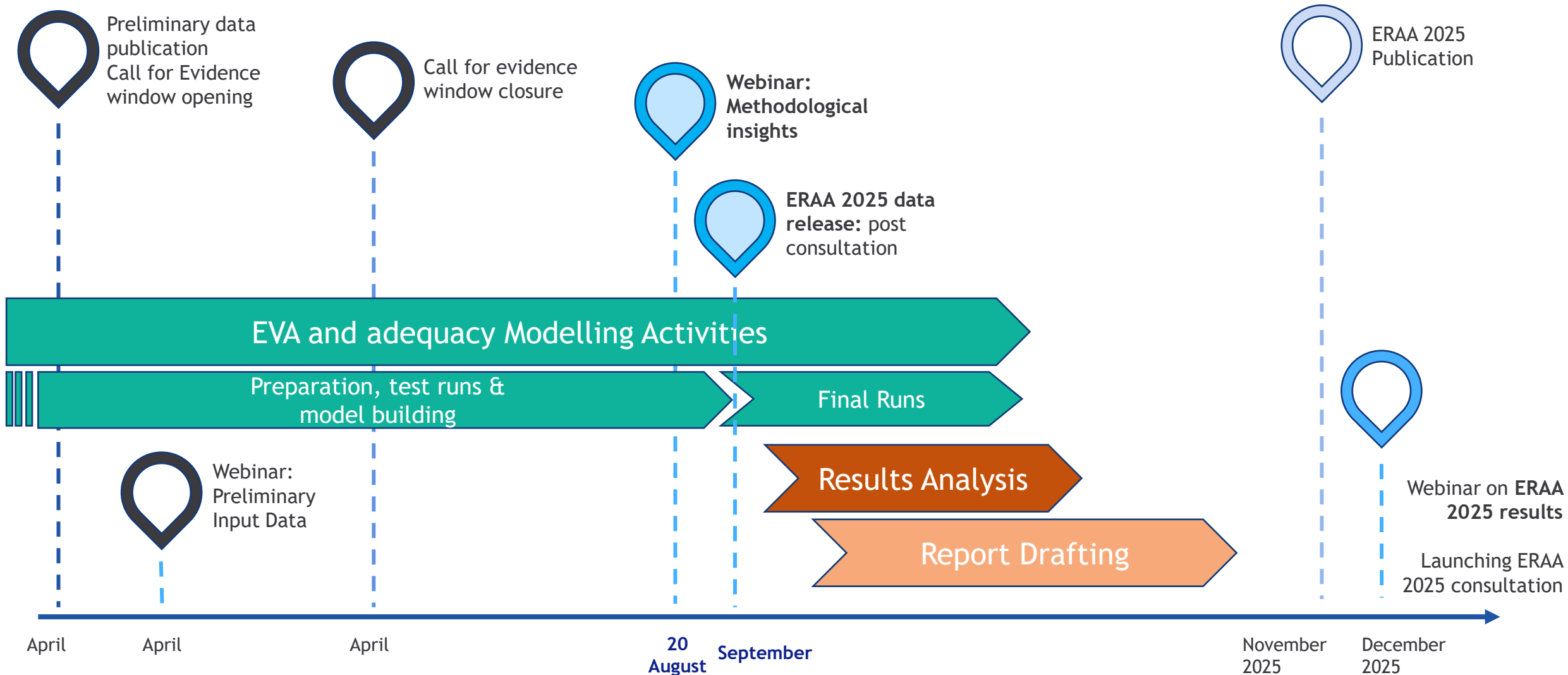
Q&A

Edwin Haesen,
Head of System Development, ENTSO-E

Next steps

Edwin Haesen,
Head of System Development, ENTSO-E

Don't forget to join us for the next public webinar

Preliminary data publication
Call for Evidence window opening

Call for evidence window closure

Webinar: Methodological insights

ERAA 2025 data release: post consultation

ERAA 2025 Publication

EVA and adequacy Modelling Activities

Preparation, test runs & model building

Final Runs

Webinar: Preliminary Input Data

Results Analysis

Report Drafting

Webinar on **ERAA 2025 results**

Launching ERAA 2025 consultation

April — April — April — **20 August** / September — November 2025 — December 2025

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.

ENTSO-E is also developing a revised ERAA Methodology, following ACER's request.

For any questions: info@entsoe.eu