GRIDS & ENERGY SYSTEMS | *Expert Workshop*

Empowering *grids* from Planning to Practice

DAY ONE | 19 NOV
10:00 – 15:30 CET

Enhancing TSO-DSO Collaboration in Planning and Operations

DAY TWO | 20 NOV
10:00 – 15:30 CET

Methodology to Mandate: Implementing the Flexibility Needs Assessments

TenneT Offices
Square de Meeûs 38/40
1000 Brussels

Renewables Grid Initiative

Hosted by TenneT

Co-funded by the European Union

About RGI – Empowering Grids from Planning to Practice

We engage in an energy transition ecosystem of actors and promote **fair, transparent, sustainable grid development** to enable the growth of renewables to achieve full decarbonisation in line with the Paris Agreement.

TRANSMISSIONSYSTEM OPERATORS (TSOS)

50hertz, amprion, elia, EirGrid Group, HOPS, ipto, NESO National Energy System Operator, REN, red eléctrica, Rte, TenneT, Terna, TRANSNET BW, Statnett, swissgrid

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NON-GOVERNMENTAL ORGANISATIONS (NGOS)

Bellona Europa, BirdLife International BirdLife Europe, BIOM Udruga / Association, CAN Climate Action Network Europe, EMBER, Friends of the Earth, Fundación Renovables, France Nature Environnement, Germanwatch, Legambiente, NABU, Natuur & Milieu, RSPB, zero., WWF

SUPPORTING MEMBERS

europacable Try life without us, IUCN, T&D europe

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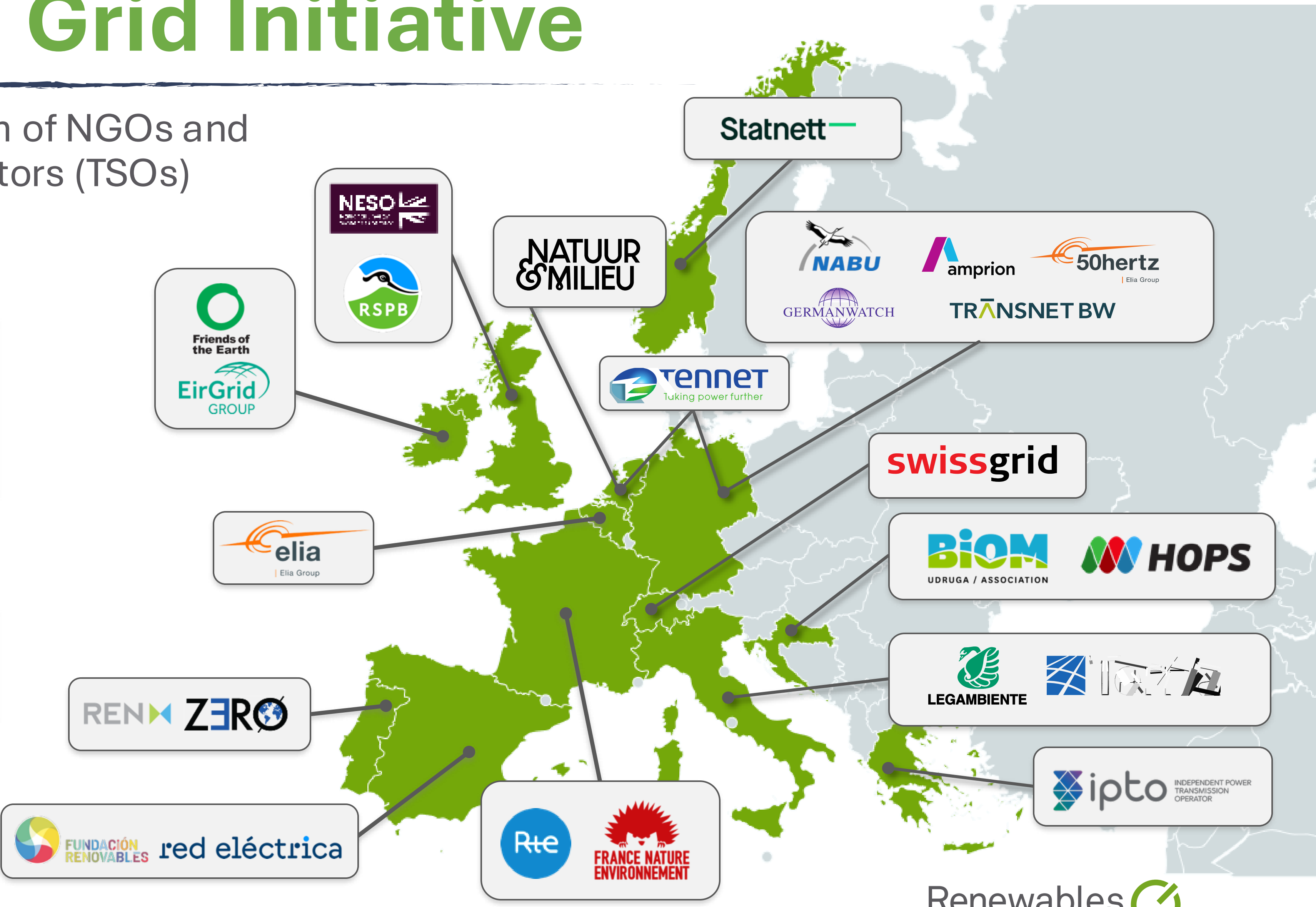
RGI is a unique collaboration of NGOs and Transmission System Operators (TSOs) from **across Europe**

EUROPEAN ORGANISATIONS

CAN Climate Action Network Europe
WWF
BirdLife International – BirdLife Europe
Bellona Europa
EMBER

SUPPORTING MEMBERS

europacable – Try life without us
IUCN
T&D europe



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DAY 2

From Methodology to Mandate:

Implementing the Flexibility Needs Assessments

21 June 2023

11 July 2024

20 Nov 2025

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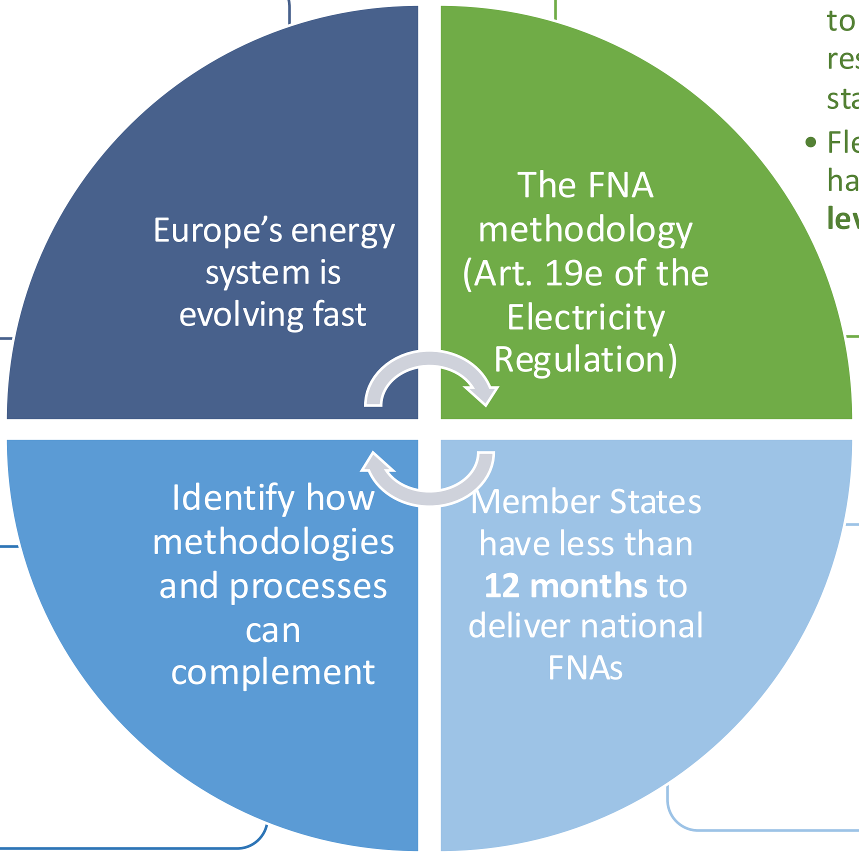
Why Flexibility Matters Now

- Renewables already supply most new generation
- Electrification increases demand variability
- Flexibility is a force that helps manage renewables variability and demand across **time** and **space**.



- FNAs are the first systematic tool to map these needs and support resilient systems at the member state level
- Flexibility potential can be harnessed **across all voltage levels**

- Implementation requires ongoing **exchanges** with relevant actors across the value chain

- RGI's aim is to **facilitate exchanges and bridge technical insights into collective understanding** - supporting effective, transparent, and actionable system planning

Connecting to Day 1: From Collaboration to Implementation


gridX

Yesterday

We explored how stronger collaboration between TSOs and DSOs can support grid planning and operations.

Today

We take that principle, **collaboration**, and apply it to the next layer: **flexibility assessment**

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Objectives

Bridge theoretical concepts with practical applications, fostering a collaborative environment for advancing Europe's energy transition

Analyse the FNA methodology and clarify **how it will be implemented across Europe**

Explore complementarity with adequacy (ERAA) and infrastructure (TYNDP) assessments

Discuss how flexibility resources can be represented meaningfully and realistically **in future planning exercises**

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General information

±15 Minutes Presentations

5 Minutes immediate Q&A

20 Minutes Discussion

We are recording for RGI internal use!

We are under Chatham House rules!

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AGENDA highlights

Renewables Grid Initiative

Session 1 | FNA Methodology deep dive	
10:10-10:40	**Overview of FNA methodology** Mario Sisinni, *ENTSO-E* Daniel Davi Arderius, *EU DSO Entity*
10:40-10:55	**EU Flexibility needs methodology: context and challenges** Daniel Ihasz-Toth and Arthur Lynch, *ACER*
10:55-11:15	**Discussion**
11:15-11:25 | Coffee break	

AGENDA highlights

Renewables Grid Initiative

Session 2 | Complementarity of FNAs with adequacy and TYNDP	
11:25-11:45	**How Open-Source Models Can Support Adequacy, Network Development and Flexibility Assessments** Luciana Marques, Open Energy Transition
11:45-12:05	**Adequacy 2050: Security of supply in the power system** Lorenz Häfele, *TransnetBW*
12:05-12:25	**Scenarios for EU-wide infrastructure planning and adequacy assessments** Paul Brière, *Artelys*
12:25-12:40	**Adequacy and flexibility study for Belgium 2026-2036** Rafael Feito-Kiczak, *Elia*
12:40-13:00	**Discussion**
13:00-14:00 | Lunch	

AGENDA highlights

Renewables Grid Initiative

Session 3 | From potential to practice: flexibility capabilities and enablers	
14:00-14:20	**Unlocking Flexibility through cross-sector links: experience from BeFlexible project** Marco Rossi, RSE
14:20-14:40	**Flexibility, oversight and automation; for lower consumer bills** Bram Claeys, *Regulatory Assistance Project*
14:40-14:55	**RES generation and storage as a service for system value** Catarina Augusto, *SolarPower Europe*
14:55-15:15	**Discussion**
15:15-15:30	**Key takeaways and next steps**
15:30 | End of workshop	

Session 1 FNA Methodology deep dive

Session 1 | FNA Methodology deep dive

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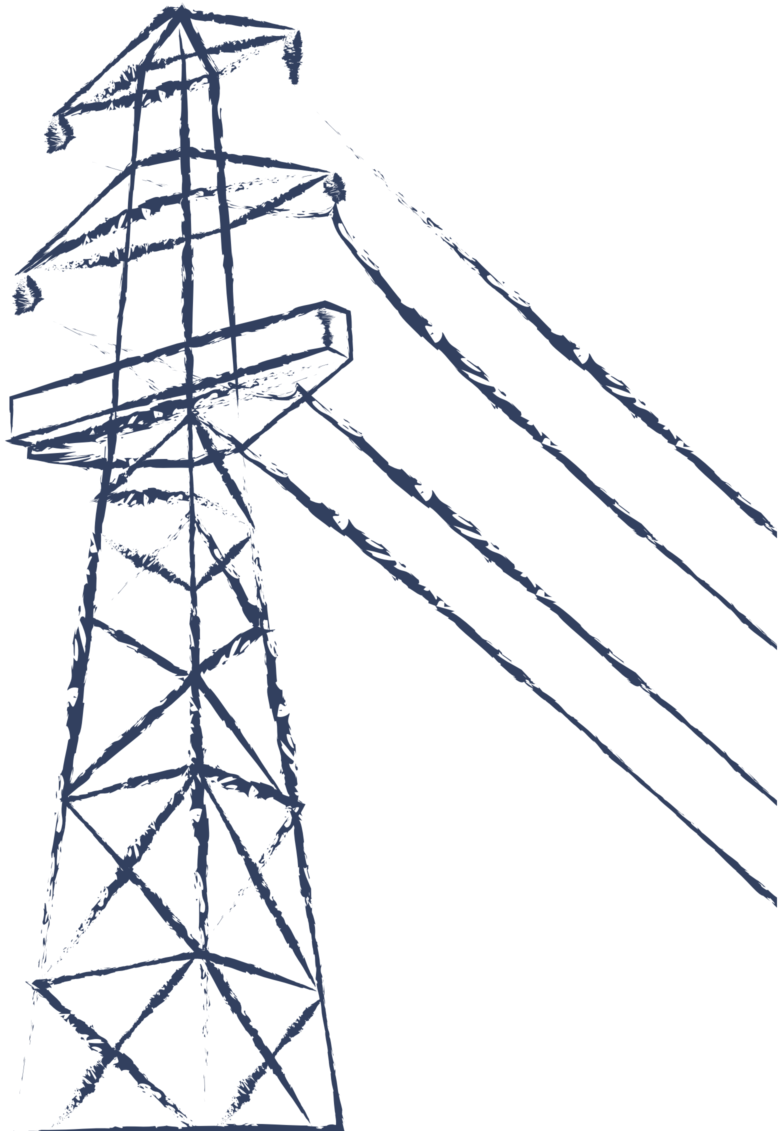
11:15-11:35	**Discussion**

11:50-11:55 | Coffee break



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COFFEE BREAK

10 MINUTES

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Session 2 Complementarity of FNAs with adequacy and TYNDP

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LUNCH BREAK

13:35-14:25

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Session 3 From potential to practice: flexibility capabilities and enablers

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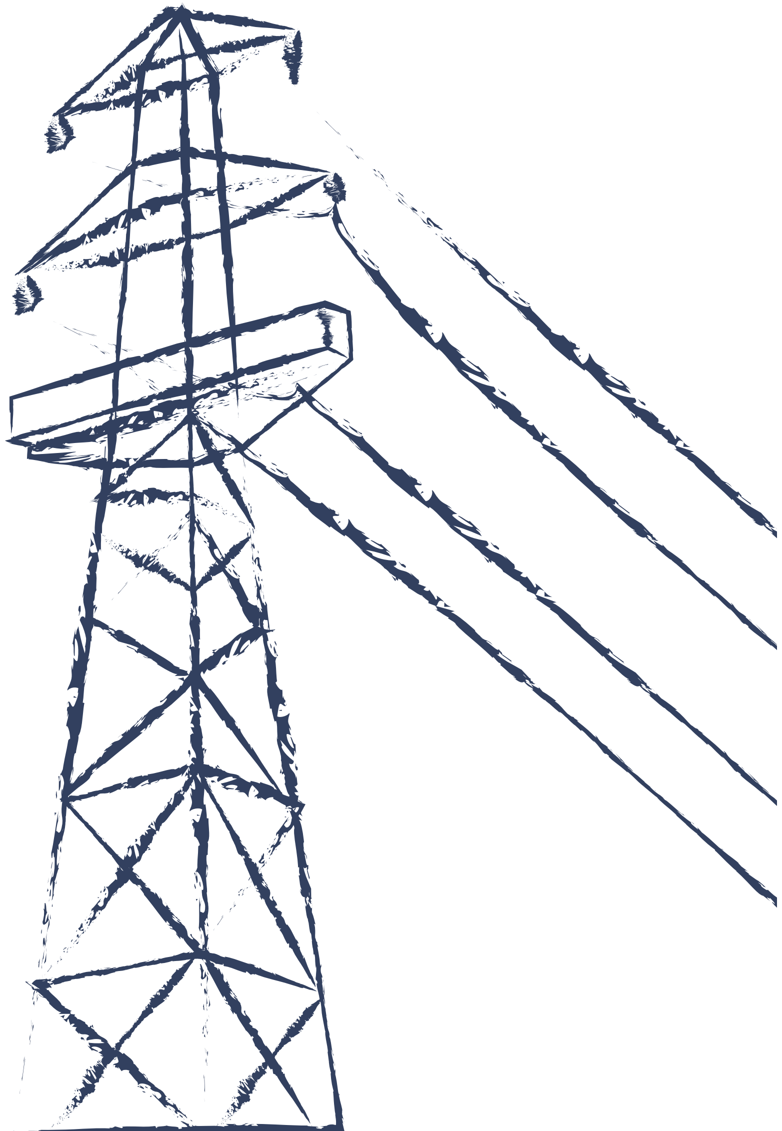

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What comes next?

Nov 2025 — Follow up emails and sharing the (authorised) content presented today

Dec 2025 — Summary report and factsheet presenting the outcomes and main messages from today

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KEY TAKEAWAYS
from those working on FNA

GRIDS & ENERGY SYSTEMS

THANK YOU!

Alexandros Fakas Kakouris
Senior Manager – Energy and Policy systems

Amanda Schibline
Manager – Socio-energy systems

Renewables Grid Initiative

RGI social media: linktr.ee/renewablesgrid

RGI website: renewables-grid.eu

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DSOs FOR EUROPE

entsoe

RGI Expert Workshop Series
Overview of FNA methodology

20th November 2025

Daniel Daví-Arderius
Chair of SG on Monitoring FNA
EU DSO Entity

Mario Sisinni
Chair of FNA Task Force
ENTSO-E

Agenda

1. The FNA methodology: an overview
2. Implementation: the role of DSO Entity and ENTSO-E
3. Monitoring FNA national implementation: how is it going?

The FNA methodology: an overview

Assesment of Flexibility Needs: What is it about?

Legal Basis: *New Provisions of EMDR (EU (2024)1747)*

Methodology Drafting, Review & Approval:
9+3 months (July 2024– July 2025)

Para 3
- DSO Entity & ENTSO-E develop a joint Methodology for Assesment of Flexibility Needs

Para 4
- DSO Entity and ENTSO-E submit the Methodology to ACER (16 April 2025)

Para 6
- ACER review amend and/or approve the Methodology within 3 months of the receipt of the proposal of DSO Entity & ENTSO-E

National Implementation: Assessment & Reporting
12 months (July 2025- July 2026)

Para 3
- DSOs & TSOs implement the methodology and provide data and analysis to the NRA and/or Designated Entity

Para 1& 2
- No later than 12 months after ACER approves the Methodology, NRAs or Designated Entity prepare National Flexibility Needs Assessment Reports

Para 7
- NRA or Designated Entity shall submit the reports to the EC and to ACER and shall publish them

Process based on Article 19e of Electricity Regulation

EU Wide Assessment
12 months (July 2026-July 2027)

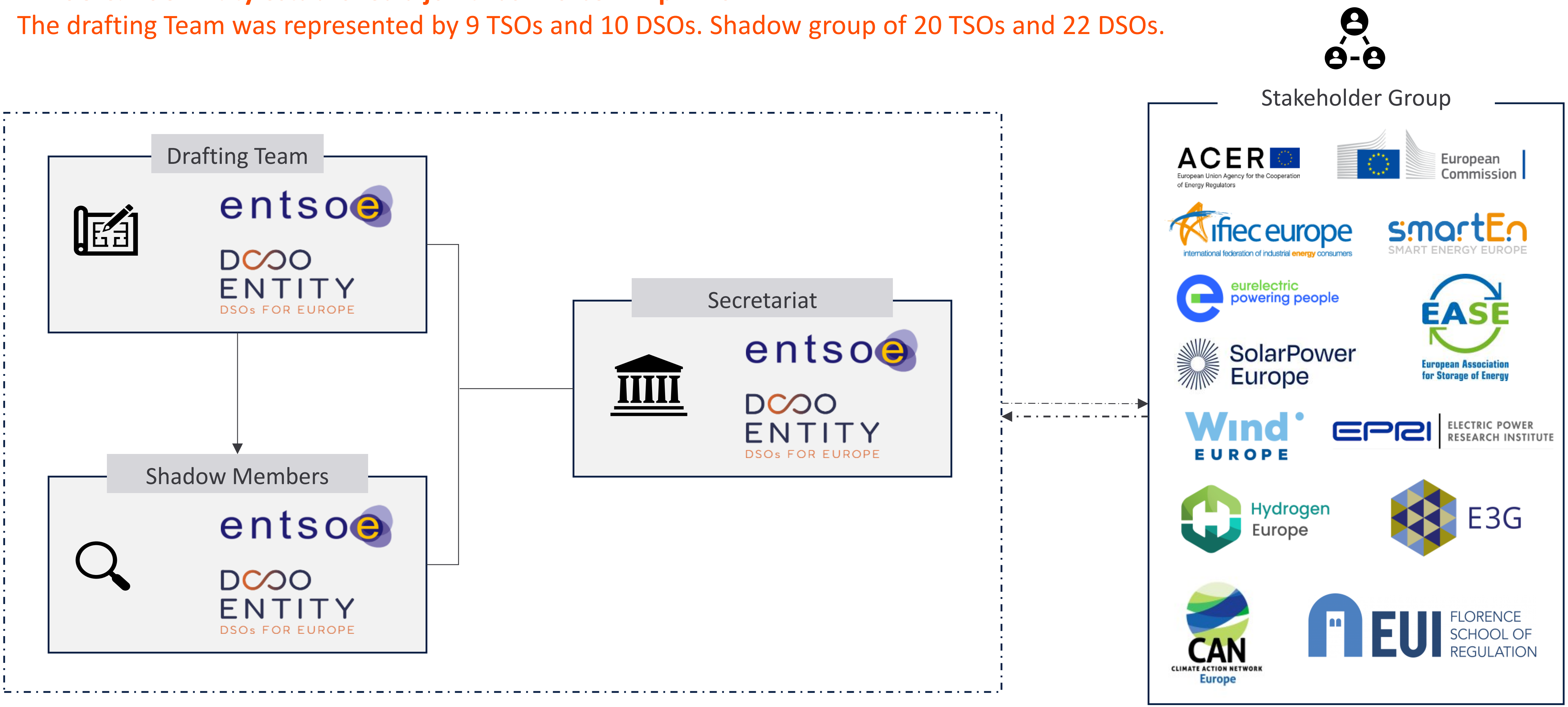
ACER

Within 12 months of receipt of the reports, ACER shall issue an EU wide Assessment Report :
- recommendations on issues of cross-border relevance
- recommendations on removing barriers to the entry of non-fossil flexibility resources.

Drafting Process & Stakeholder Engagement

ENTSO & DSO Entity established a joint Task Force in April 2024.

The drafting Team was represented by 9 TSOs and 10 DSOs. Shadow group of 20 TSOs and 22 DSOs.

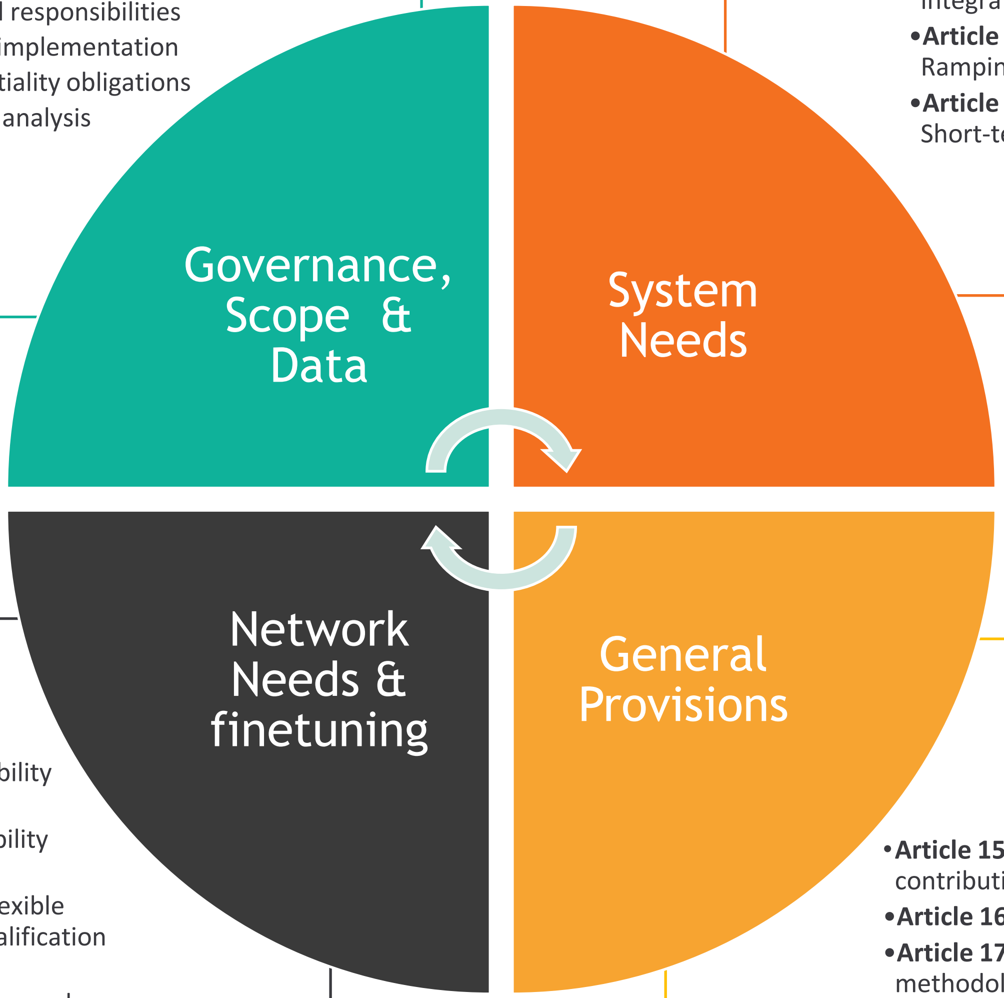


The Task Force engaged with more than 15 selected stakeholders and with the public through dedicated consultation

Overview of FNA Methodology

- **Article 1**. Subject matter and scope
- **Article 2**. Definitions
- **Article 3**. Roles and responsibilities
- **Article 4**. National implementation
- **Article 5**. Confidentiality obligations
- **Article 6**. Data and analysis

- **Article 7**. System needs
- **Article 8**. System needs – RES integration
- **Article 9**. System needs – Ramping Needs
- **Article 10**. System needs – Short-term flexibility needs



ANNEXES

Annex I - TSO Input data to the FNA process - Type and format

Annex II - DSO Input data to the FNA process - Type and format

Annex III - Fine-tuning process

Article 11. DSO network flexibility needs

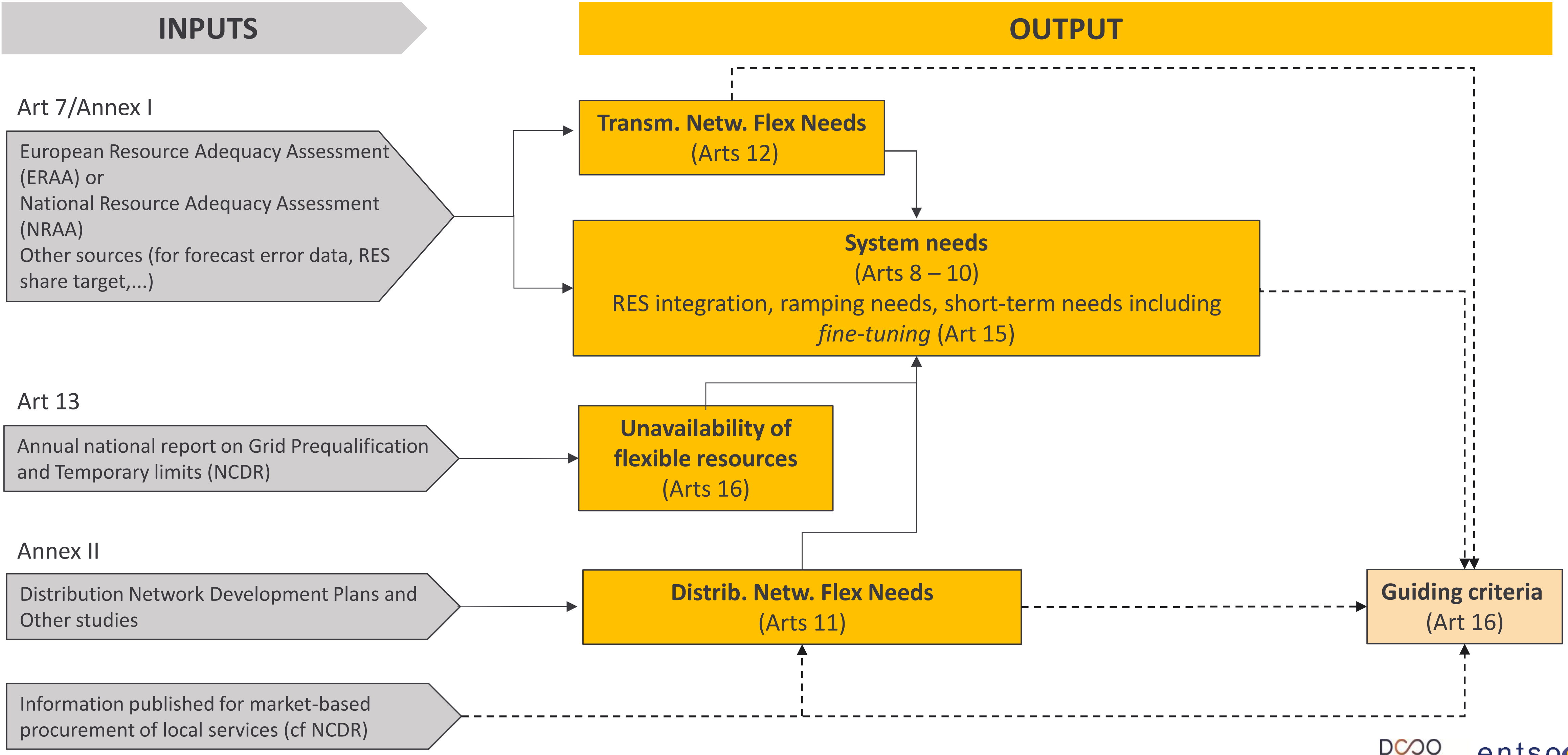
Article 12. TSO network flexibility needs

Article 13. Unavailability of flexible resources due to grid prequalification and temporary limits

Article 14. Fine-tuning system needs with network needs

- **Article 15**. Market Barriers and contribution of digitalisation
- **Article 16**. Guiding criteria
- **Article 17**. Amendments of the methodology
- **Article 18**. Language

Overview of data inputs & needs covered



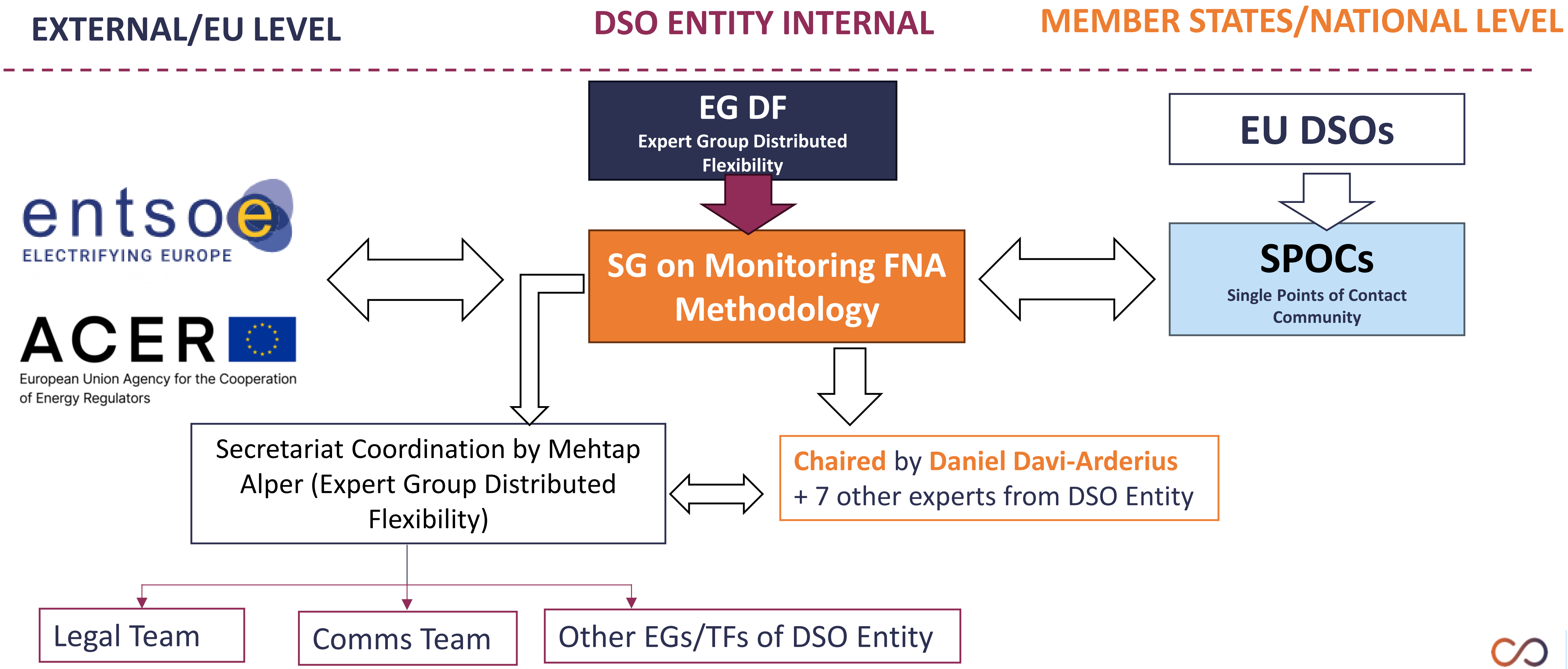
Implementation: the role of DSO Entity and ENTSO-E

FNA: Tasks assigned to EU DSO Entity and ENTSO-E

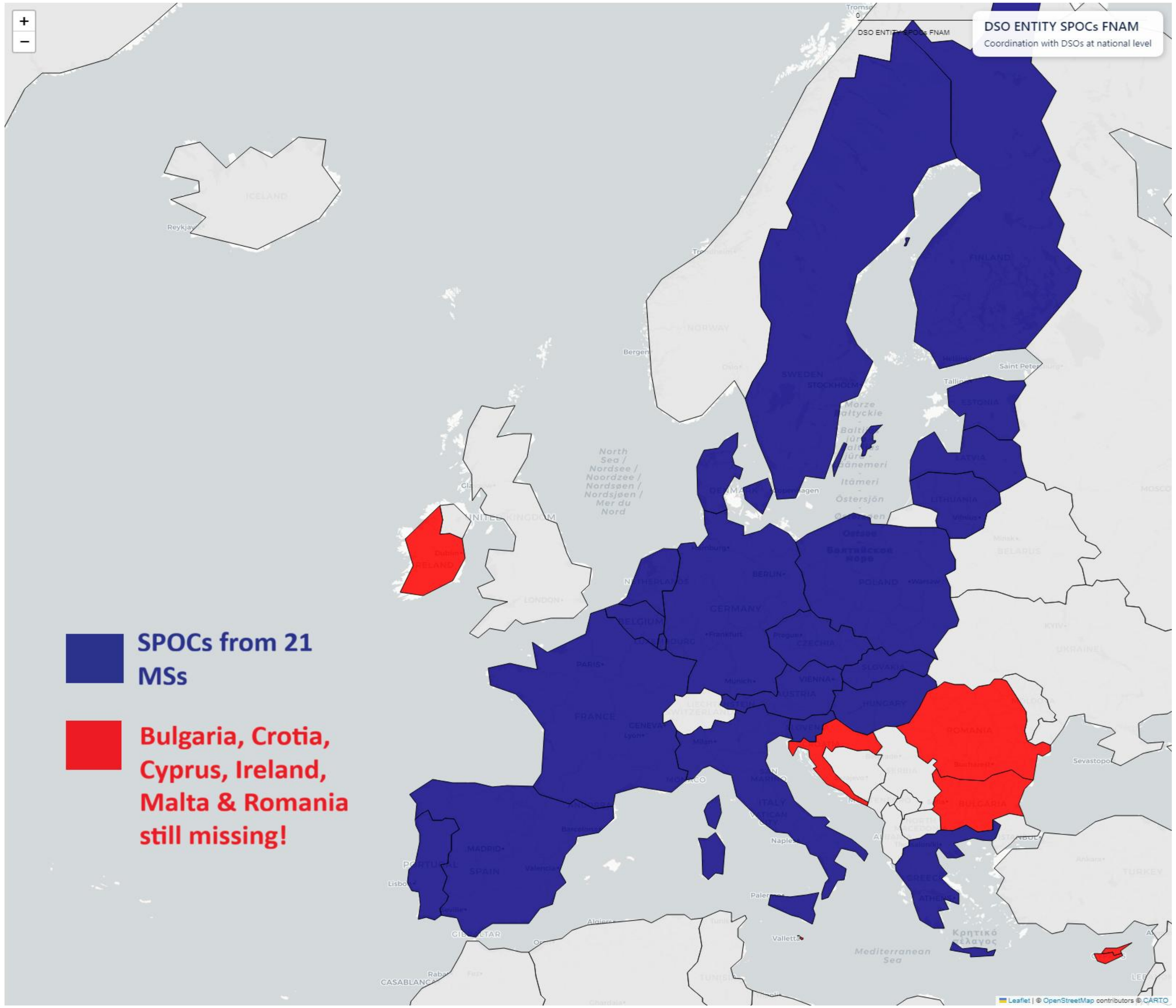
- **Whereas 21** "TSOs and DSOs should use **common NECP targets in their scenarios** to ensure consistency. ENTSO-E, the EU DSO Entity and ACER have a role in **steering the implementation by providing guidance throughout the process."**
- **Article 3** **"ENTSO-E and the EU DSO Entity shall coordinate TSOs and DSOs as regards the data and analysis** to be provided for the preparation of the FNA reports. To this end, ENTSO-E and the EU DSO Entity shall also cooperate closely with each other. This coordination shall include providing the following guidance to TSOs and DSOs within 18 months from approval of the FNA methodology:
  - The **EU DSO Entity shall publish guidance to DSOs** in order to promote harmonisation of the DSO flexibility needs assessment defined under the FNA methodology, as well as to progressively improve their cooperation and coordination under the FNA methodology and the methods used for the analysis of their flexibility needs in a cost-effective manner
  - **ENTSO-E** shall issue and subsequently regularly update a **'Questions and Answers'** document regarding the main and/or recurring implementation challenges related to the system needs assessment raised by TSOs. ENTSO-E shall consult ACER on any question related to the interpretation of the FNA methodology.
- **Article 6.1 "ENTSO-E and EU DSO Entity shall coordinate with each other and with all TSOs and DSOs** in order to **select at least one EU policy target year** in line with targets and objectives specified in Article 19e(4)(b)(iii) of the Electricity Regulation that is assessed by the system operators in all Member States."

Organizational scheme – DSO Entity

DSO Entity established a new **Subgroup on Monitoring FNA Methodology** to steer the implementation of FNA across Member States, ensuring coordination with DSOs where required under FNAM. It also supports the development of Guidance document based on lessons learnt and aligned with DNDP Guidelines, as mandated by FNA.



Single Points of Contact Community (SPOC)



Meeting with DSOs-SPOCs

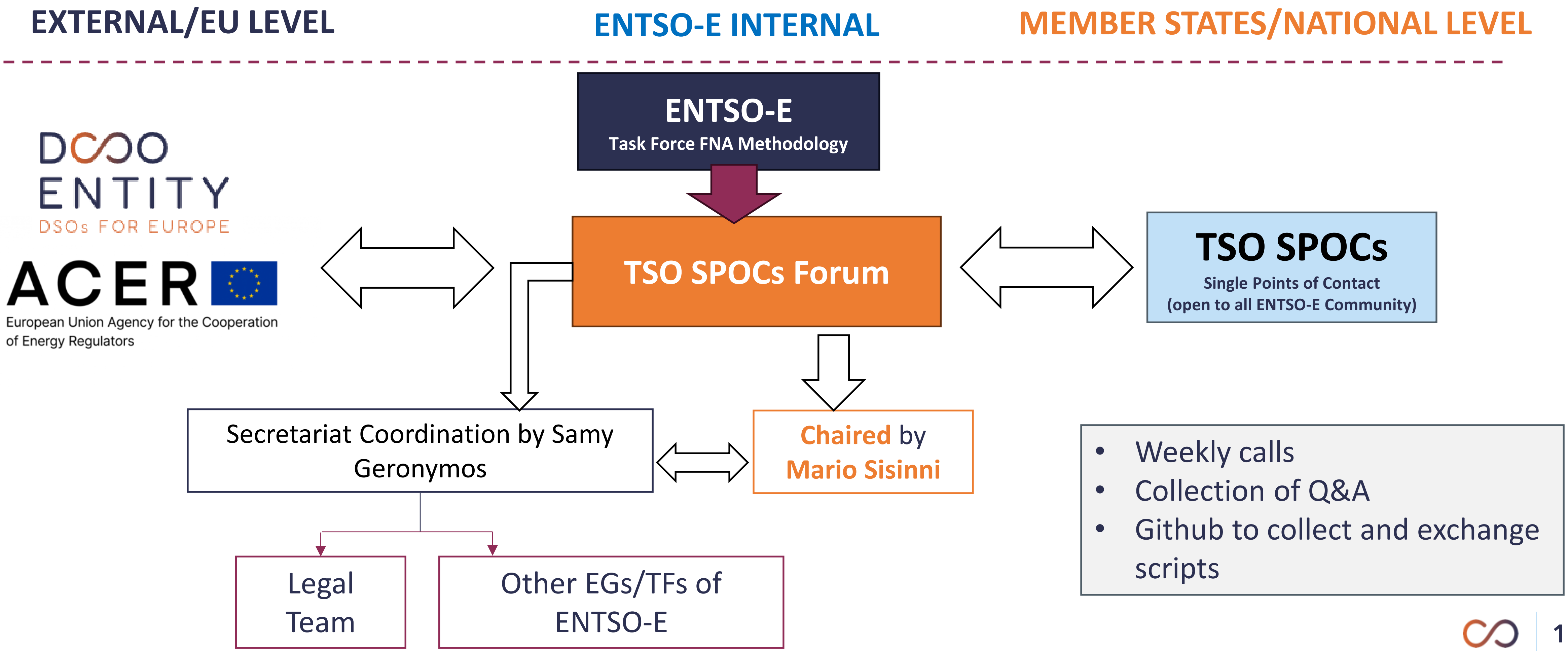
1 October & 5 November

- Timeline and key milestones
- Monitoring the first milestone and Status Check: national organisation—Update from SPOCs

Status on 31st Oct 2025

Organizational scheme – ENTSO-E

ENTSO-E established a forum to facilitate TSOs interactions for the implementation of FNA, script development and exchange and also collect useful input for the preparation of the Q&A document, as mandated by the FNA methodology.



Task 1: DSO Coordination + guidance

- **Article 3 "ENTSO-E and the EU DSO Entity shall coordinate TSOs and DSOs as regards the data and analysis** to be provided for the preparation of the FNA reports. To this end, ENTSO-E and the EU DSO Entity shall also cooperate closely with each other. This coordination shall include providing the following guidance to TSOs and DSOs within **18 months from approval of the FNA methodology**:
  - a. The **EU DSO Entity shall publish guidance to DSOs** in order to promote harmonisation of the DSO flexibility needs assessment defined under the FNA methodology, as well as to progressively improve their cooperation and coordination under the FNA methodology and the methods used for the analysis of their flexibility needs in a cost-effective manner

ACTIONS TAKEN

➔ Collecting Input from SPOCs on the Progress of the FNAM
➔ Collecting Questions from SPOCs & Identifying the Bottlenecks
➔ Organizing SPOCs meeting for Knowledge Sharing
➔ Sub-Group is assigned to Assess Questions and Provide Answers
➔ Collecting Feedback and Suggestions
➔ Exchange with ENTSO-E where/if necessary

Task 1.2: TSO Coordination + guidance

- **Article 3 "ENTSO-E and the EU DSO Entity shall coordinate TSOs and DSOs as regards the data and analysis** to be provided for the preparation of the FNA reports. To this end, ENTSO-E and the EU DSO Entity shall also cooperate closely with each other. This coordination shall include providing the following guidance to TSOs and DSOs within 18 months from approval of the FNA methodology:
  - **ENTSO-E** shall issue and subsequently regularly update a **'Questions and Answers'** document regarding the main and/or recurring implementation challenges related to the system needs assessment raised by TSOs. ENTSO-E shall consult ACER on any question related to the interpretation of the FNA methodology.

ACTIONS TAKEN

- Guidance and support to TSOs:
  - ❑ Explanation of Methodology
  - ❑ Guidance on technical implementation matters.
  - ❑ Consolidation of Q&As for TSOs' reference
- Facilitation of ERAA data and scripts to TSOs
- Events and workshops
- Interactions with DSO Entity/ACER

Task 2: Selection of EU Policy Target Year

Why?	**Reference Article(s) FNAM** • **Whereas 21** "TSOs and DSOs should use common **NECP targets in** their scenarios to ensure consistency. ENTSO-E, the EU DSO Entity and ACER have a role in steering the implementation by providing guidance throughout the process.“ • **Article 6.1** "ENTSO-E and EU DSO Entity shall coordinate with each other and with all TSOs and DSOs in order to **select at least one EU policy target year** in line with targets and objectives specified in Article 19e(4)(b)(iii) of the Electricity Regulation that is assessed by the system operators in all Member States."
What?	DSO Entity and ENTSO-E Joint Task Force discussed with technical and legal experts: **Conditions set out under FNAM:** ➢ At least 1 target year (TY) needs to be selected in coordination of Associations will be common across EU. This needs to be an **ERAA TY** and **EU Policy Year**. ➢ According to Article 19e(1) of the Regulation (EU) 2019/943, national FNA reports must cover a period of at least **the next 5 to 10 years.** Consequently, the two selected target years needed for the first submission should fall at least within the 5-to-10-year timeframe According to the conditions for selecting the common target year for all TSOs and DSOs across Member States, as set out in Article 4(1)(d) and Article 6(1) of the FNA methodology, as well as Article 19e(4)(b)(iii) of the Electricity Regulation, only the years **2030** and **2050** qualify as binding EU policy years under the FNA methodology. By contrast, 2035 and 2040 are not recognized as binding policy years under Regulation (EU) 2021/1119.
Result	* DSO Entity & ENTSO-E aligned on **selection of one policy target year (Art. 6.1.)**→ **2030!**

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Monitoring FNA National Implementation: how is it going?

FNAM Timeline & Key milestones - First cycle

Step 0
25.07.2025
ACER adopts the FNAM

ACER

Done

Step 1
National Entity is designated

Step 2
25.11.2025
TSO DSO agree on national implementation

Step 3
25.11.2025
TSO and DSO collect data and analysis

Step 4
25.05.2026
TSOs and DSOs submit data and analysis to the Designated authority or entity

Step 5
25.07.2026
Member States submit the national report to ACER and the European Commission

1st Milestone-Art 4.1 FNA

Article 4. National implementation

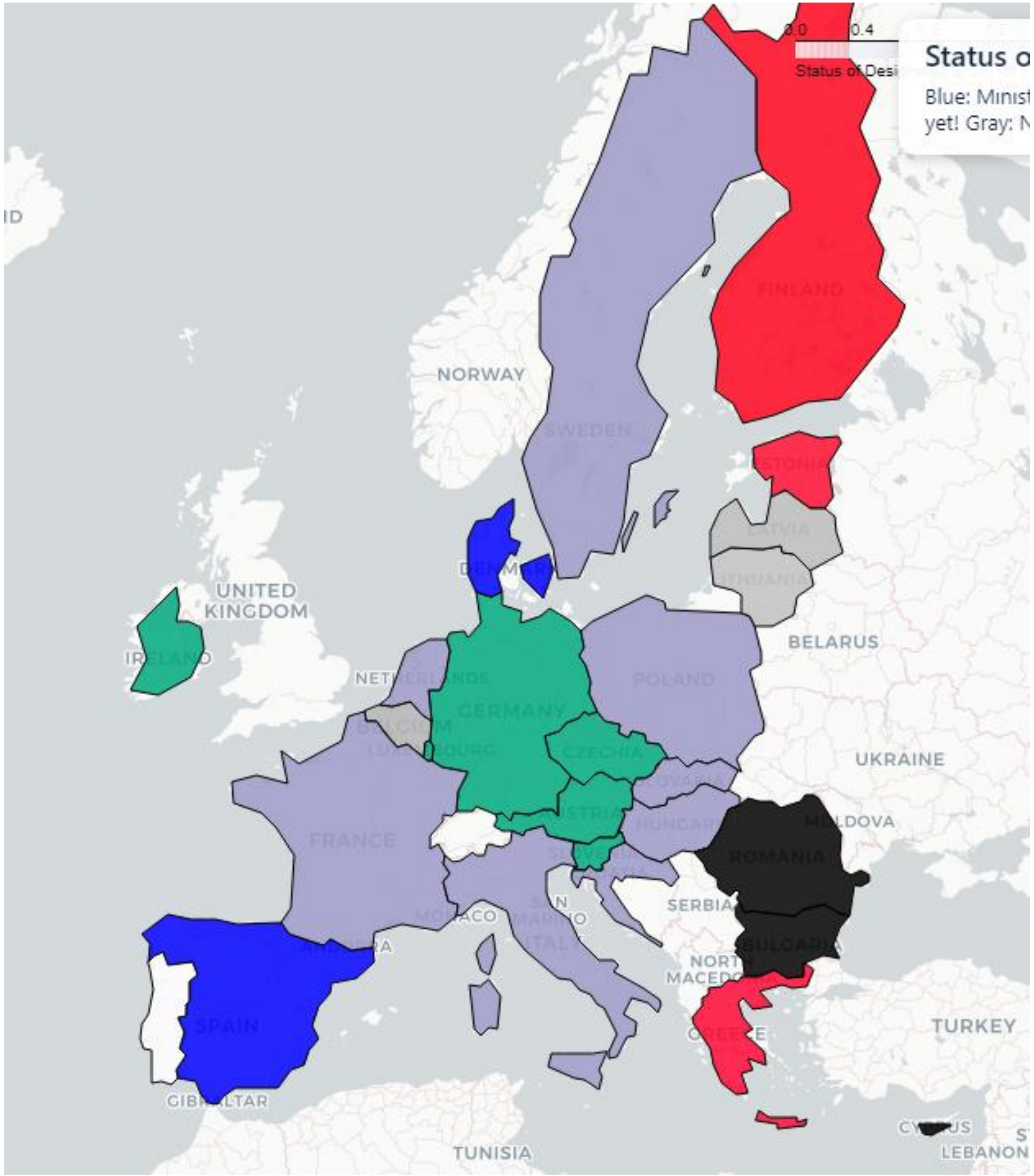
1. Within four months of ACER's approval of the FNA methodology, TSO(s) and DSO(s) within each Member State shall agree with each other and with the respective designated authority or entity and, where an entity is designated, also with the regulatory authority:
   a. The exact scope of data and analysis the TSOs and DSOs intend to provide at national level;
   b. Their respective roles and responsibilities in providing the data and analysis;
   c. Estimated timeline for the exchange of data;
   d. Common target years for the purpose of data and analysis pursuant to Article 6(1), and Article 6(2) if applicable;
   e. In case of multiple TSOs within one Member State, their respective contributions to the provision of data and analysis, as agreed between them;
   f. Temporal, spatial and voltage granularity of DSO data pursuant to Articles 6 and 11;
   g. Data to be provided, where relevant, for the purpose of evaluating the barriers for flexibility in the market and the contribution of digitalisation pursuant to Article 15;
   h. Any additional DSO inputs and justifications for those inputs pursuant to Article 6(7);
   i. Any additional data and analysis according to Article 1(6). Any additional data or analysis required from the DSOs to perform additional changes proposed by TSOs shall be duly justified and agreed by DSOs and vice versa.

Designated Entity

Who Adopts National Flexibility Assessment Reports?*

- Ministry
- NRA
- TSO
- No decision yet!
- No information from SPOCs
- No SPOCs

Not sure all Designated Entities will be formally nominated before 25th November



*Based on the latest info received from SPOCs by 1st November

Article 4.5. Delegation of DSO responsibilities

5. A DSO may delegate all or part of its responsibilities under the FNA methodology to one or more DSO(s), an organisation representing the DSOs, a TSO, or a third party. In this case, the delegating DSO shall:
   a. retain responsibility for ensuring compliance with the obligations set forth in the FNA methodology;
   b. notify the designated authority or entity, and where an entity is designated also the regulatory authority without delay;
   c. where applicable, ensure that the suitable confidentiality agreements with the other party have been put in place prior to the delegation pursuant to Article 5.

At this stage no final decision- Cooperation/meetings are on-going between DSOs-TSOs and representing organisations.

Topics to be agreed at national level are often still under discussion!

- **Exact scope of data & analysis for SOs:** Still under discussion in many countries
- **Type of values:** MW and/or MWh
- **Time block:** annually or where applicable seasonally (summer/winter)-still under discussion
- **Voltage level** of congestion or voltage issue: High Voltage-under discussion
- **Data Sources:** So far, often DNDPs-still under discussion
- **Target years: so far,** recurrent years under discussion **2030 and ?**

EU DSO Entity has provided guidance on SPOC about all these topics (last meeting on 5th Nov)

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Thank you!

Back-up

Coordination role of EU DSO Entity

What is the **meaning of the coordination task to EU DSO Entity** as defined in Art. 3?

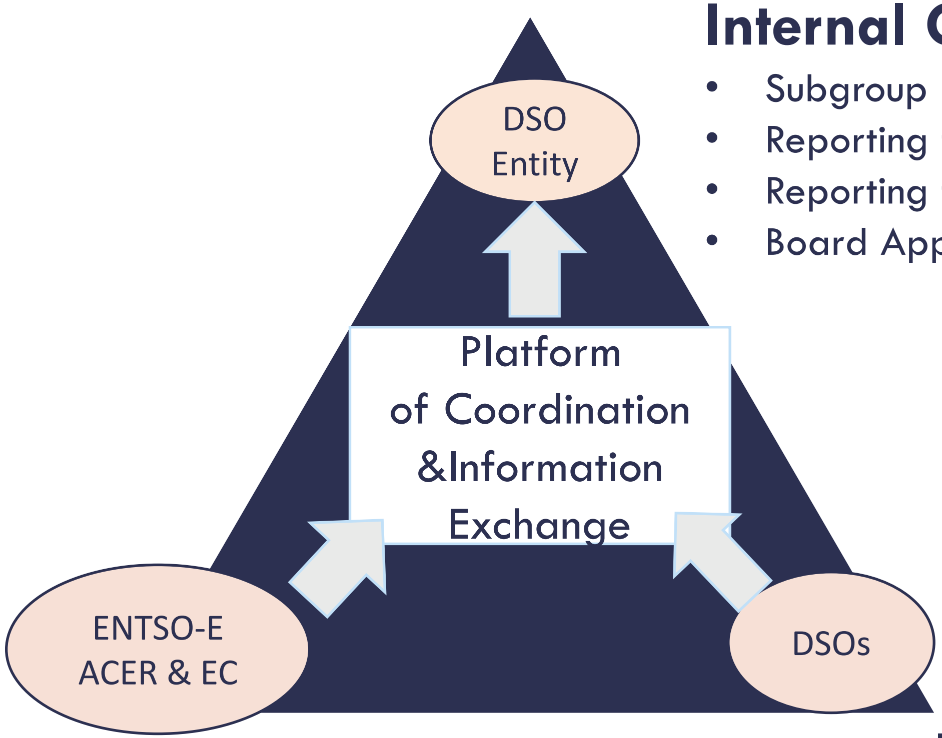
- DSO in each MS starts the process and ‘data and scenarios’ are agreed at national level.
- DSO Entity collects national practices and support questions from DSO

To do so, we have created a

- **Single Points of Contact Community (SPOC)** where we can coordinate and/or exchange information when necessary and
- (New) **Sub-Group on Monitoring FNA** under EG DF to follow up on the questions, provide support to DSO and collect input to establish the Guidance.

New information exchange platform

Regular & ad-hoc meetings to ensure internal & external coordination



Internal Coordination (DSO Entity)

- Subgroup Regular Coordination Meetings (monthly)
- Reporting to EG DF (monthly)
- Reporting to Board (where necessary)
- Board Approval (where necessary)

National Level-SPOCs (DSO/DSO)

- Common Excel File for Queries
  - Q&A
  - Lessons Learned
  - Amendment Proposals
- Monitoring the Status
- Regular Meetings

EU Coordination (ENTSOE/DSO Entity)

- Coordination of EU Policy Target Year
- Coordination of Q&A and Lessons Learned (when/if necessary)
- Coordination of potential Amendments/Updates

ACER

European Union Agency for the Cooperation of Energy Regulators

Flexibility Needs Assessment Methodology: context and challenges

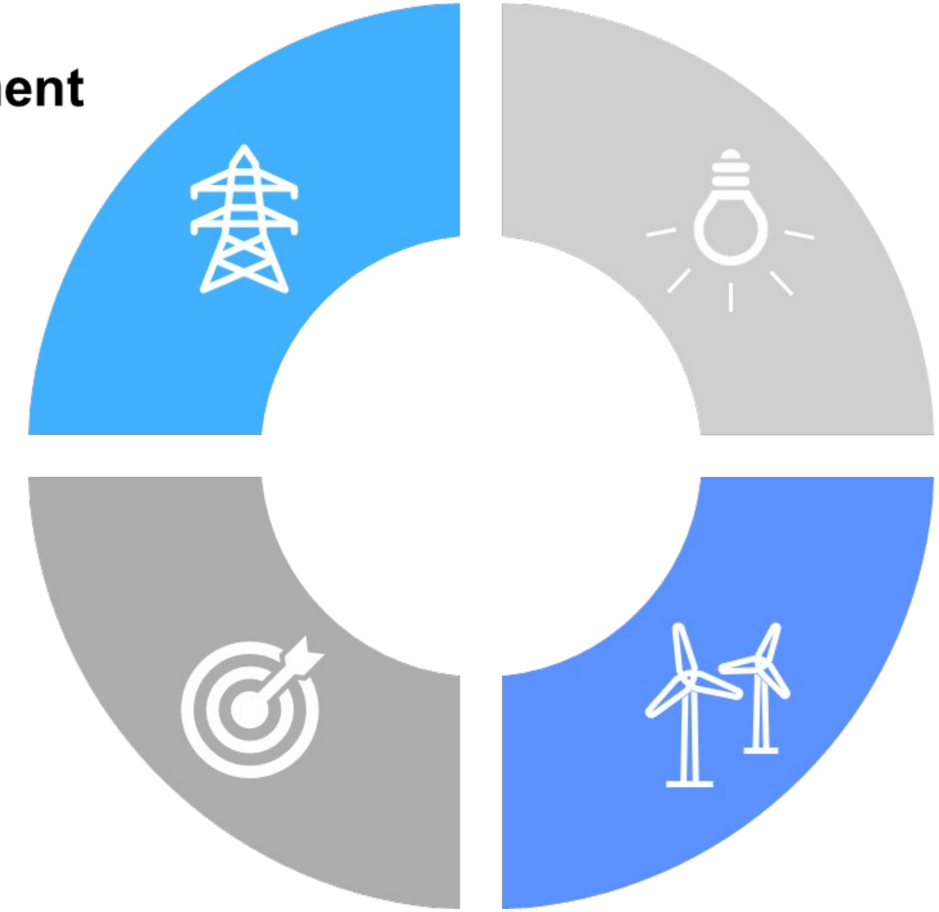
RGI workshop

20/11/2025

The context of the FNA

Network development
- TYNDP
- NDPs

Security of Supply
- ERAA
- NRAAs



Climate targets
- NECPs

Flexibility
- National flex assessments
- EU-wide assessment

[Related Reading: Improving EU scenario development to meet future energy needs]

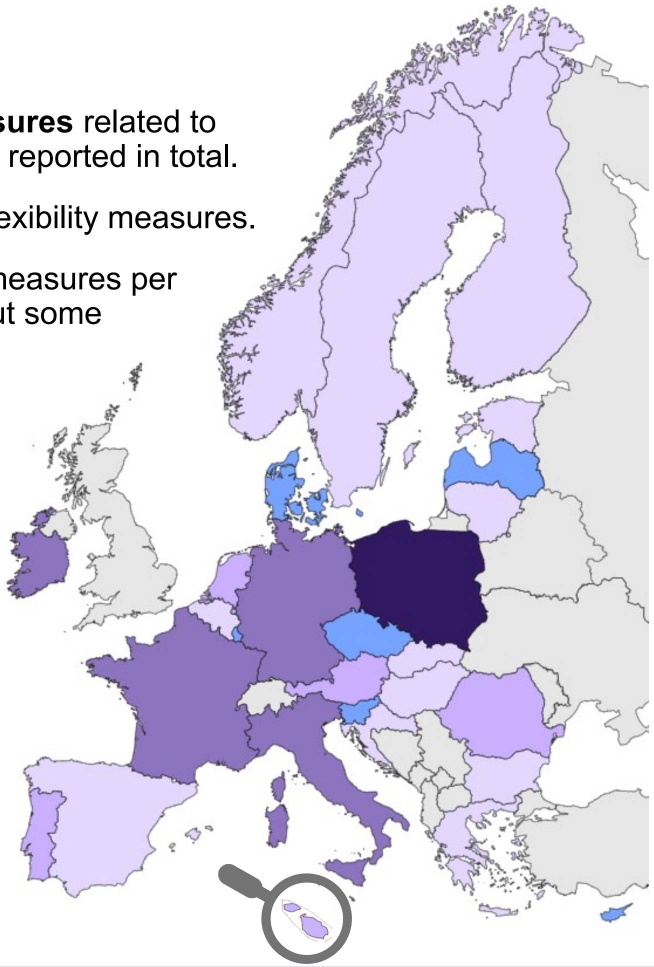
Various measures proliferate, risking overlaps

ACER
European Union Agency for the Cooperation of Energy Regulators

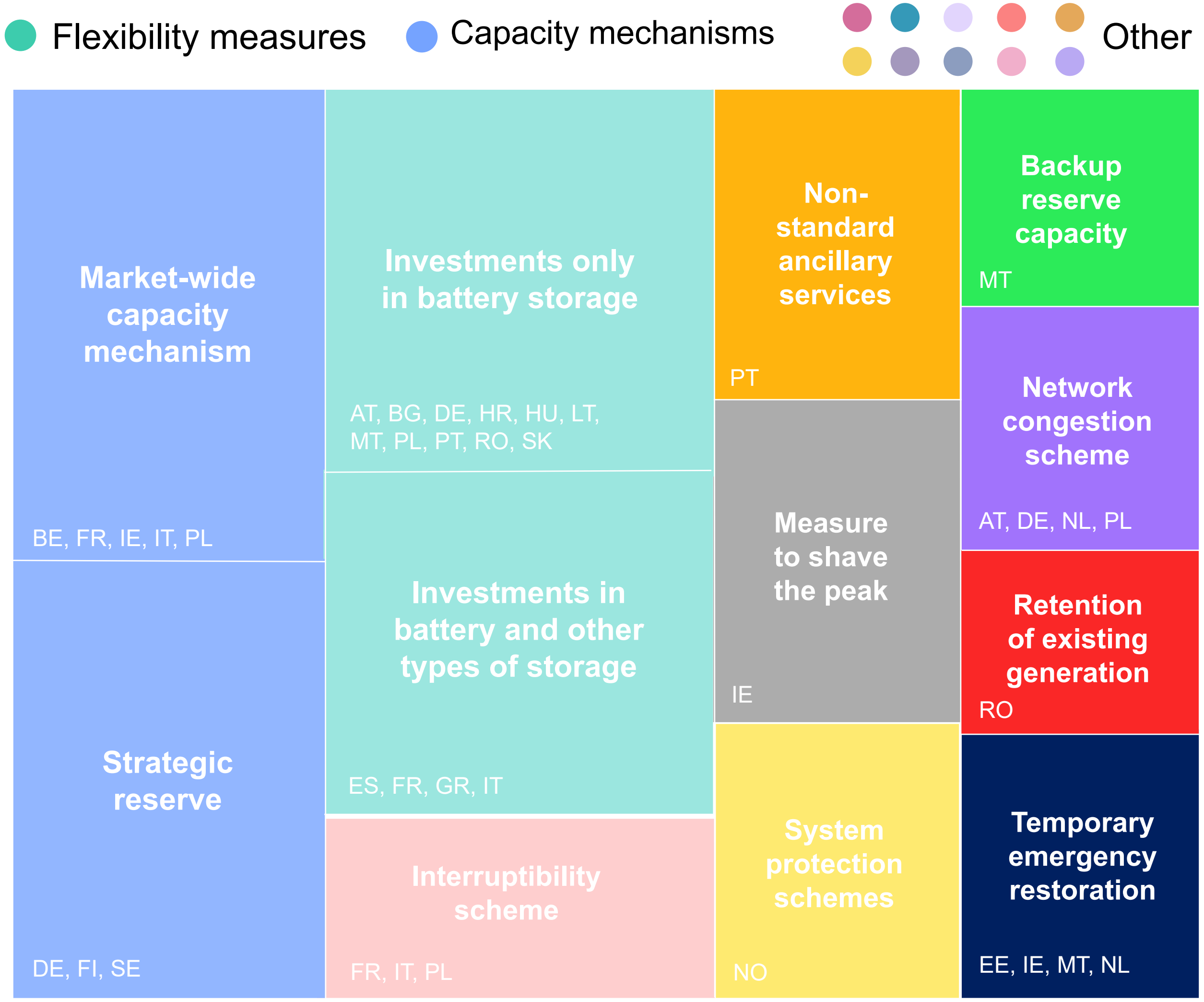
Support measures piling up within countries

Number of security of supply measures, EU-27, 2024

- **39 support measures** related to security of supply reported in total.
- 15 of which are flexibility measures.
- On average 1.4 measures per Member State, but some have more than 3 measures.



Number of measures
0 1 2 3 4



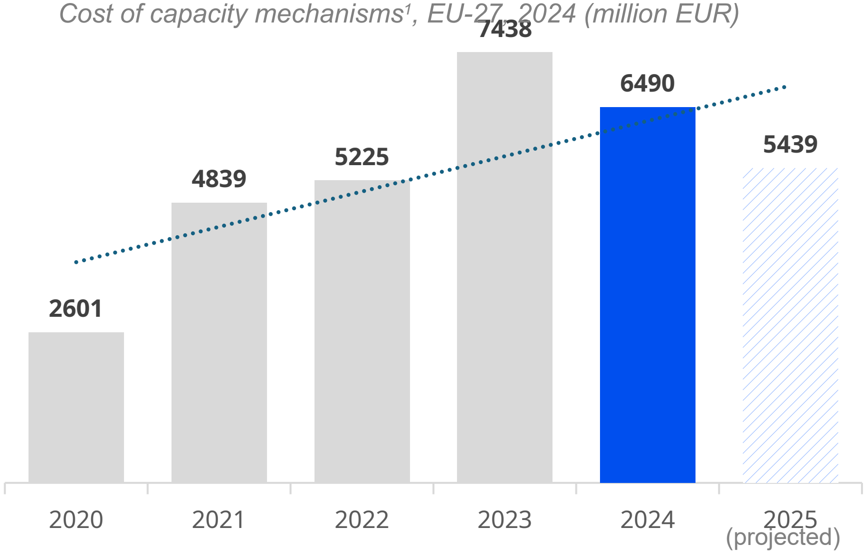
Source: ACER based on NRA data

EU pays almost 11bn EUR for a plethora of measures

- **Costs of capacity mechanisms** in the EU have followed a steady upward trend over the years peaking in 2023.
- **Flexibility measures** represent less than 5% of all support costs today but are projected to grow in the coming years.

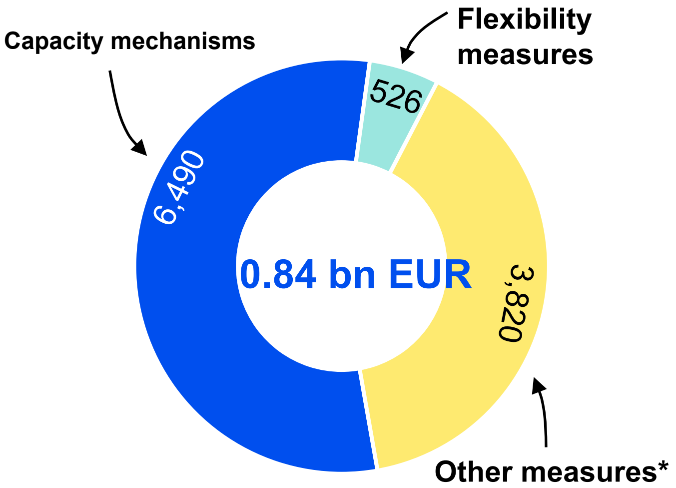
Increasing costs of capacity mechanisms

Cost of capacity mechanisms[1], EU-27, 2024 (million EUR)



Support measures are costing the Member States a pretty penny

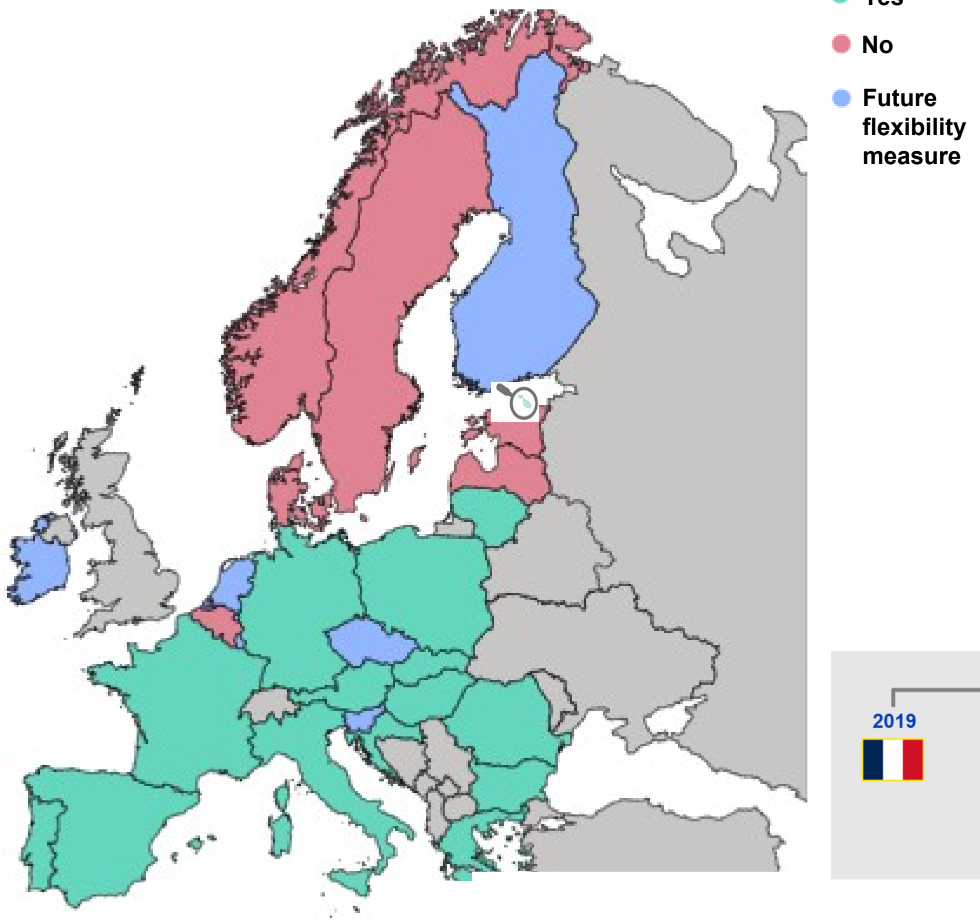
Cost of all support measures, EU-27, 2024 (million EUR)



Sources: ACER based on NRA data, Estonian market reform plan, Spanish updated market reform plan, amendment of the Czech energy law.
*Other measures refer to support schemes that do not fall under the categories of 'capacity mechanisms' or 'flexibility measures'. These are defined as initiatives that relate directly or indirectly to security of supply and provide remuneration to market participants for capacity outside of balancing mechanisms.
[1] For cost calculation assumptions see note (2) in *Annex II*

Flexibility measures proliferate across Europe

More than half of Member States had a flexibility measure in place in 2024



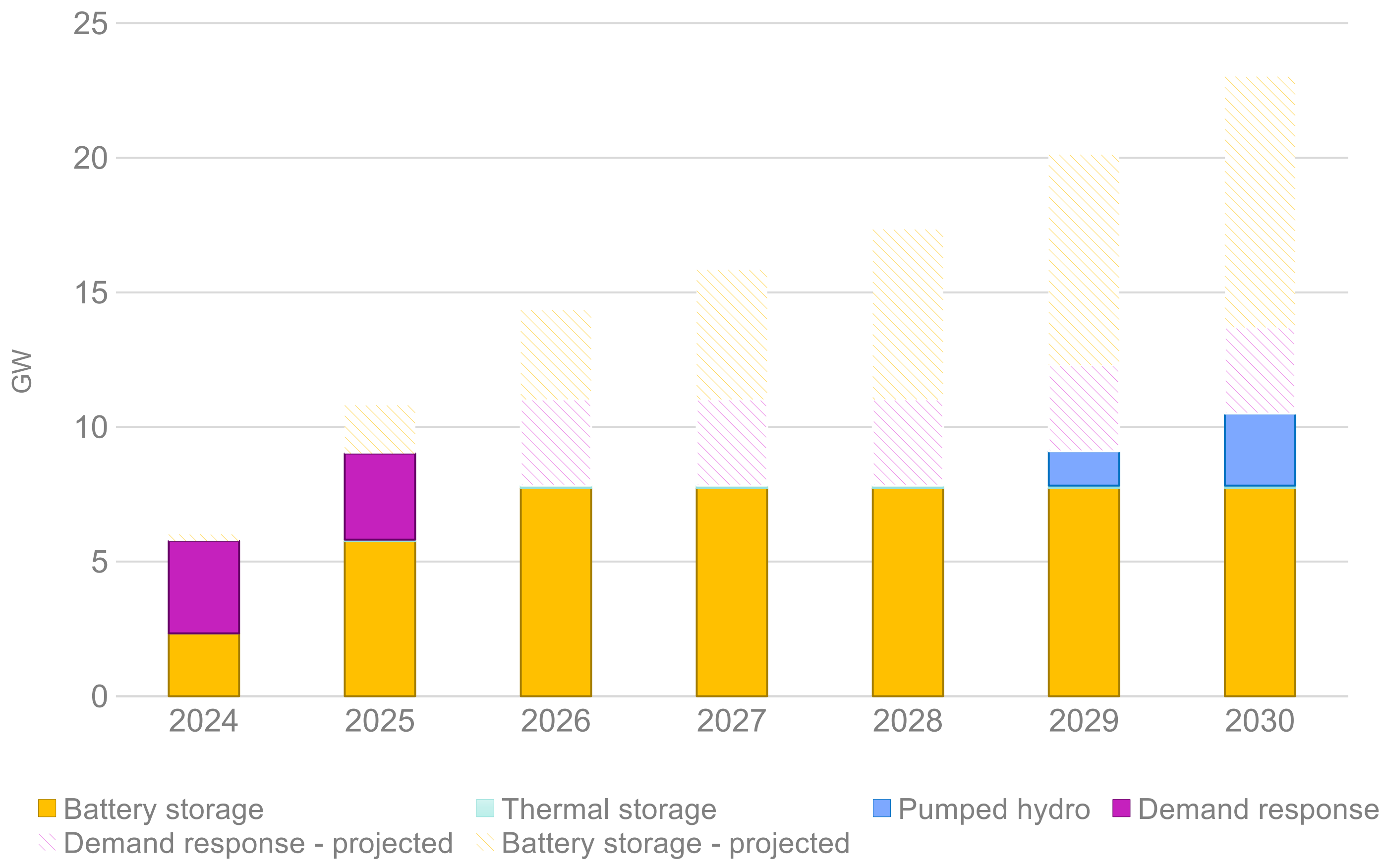
- Within Member States, there is big variability regarding the stage of development of future flexibility measures.
- CZ, HR, IE, MT and NL have introduced new flexibility measures in 2025.
- ES, FI, LU and SI have plans to implement new flexibility measures, but they are still in the preparatory phase.

Subsidy mechanism that aims at incentivising the deployment and utilisation of non-fossil flexible resources, such as demand response, battery storage and pumped hydro storage. Future flexibility measure" refers to Member States that will or intend to have one (or more) flexibility measure(s) in future years.

Grid-scale battery storage is the main beneficiary

- Out of 15 Member States with flexibility measures, 8 are remunerating grid-scale batteries.
- 42% of total remuneration is directed to grid-scale batteries.
- Minimum duration requirement was set for storage in 13 out of 15 schemes: two hours was the most common.

Installed capacity (cumulative) of non-fossil flexibility assets

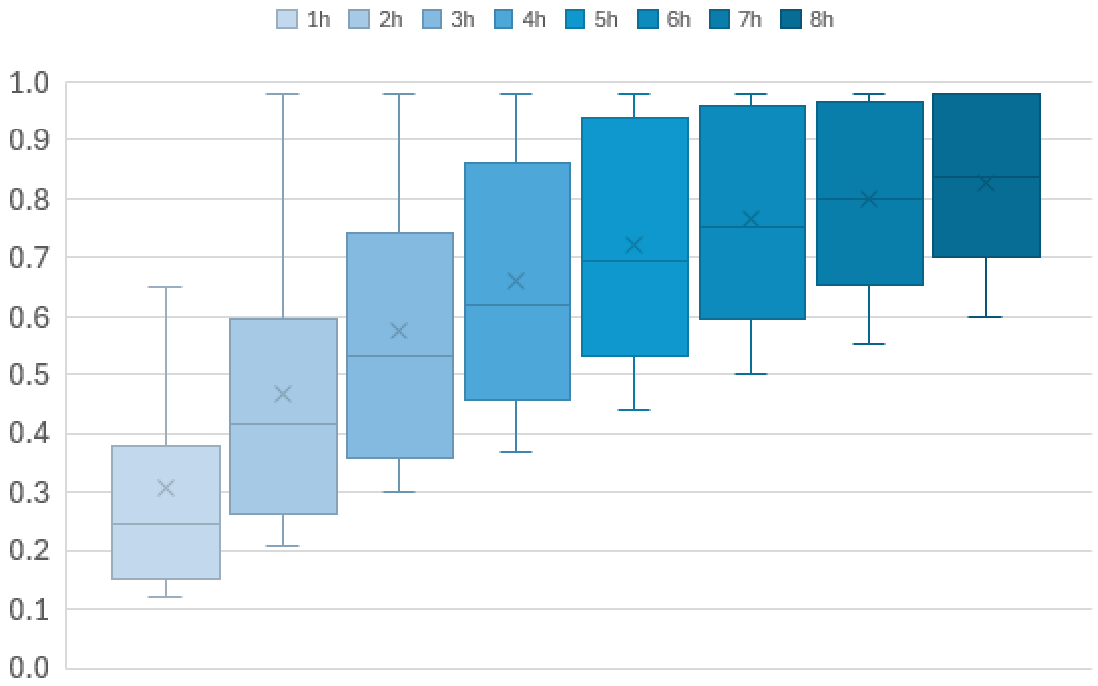


Installed capacity of supported flexible assets in EU-27, cumulative, in GW. *Note: the plot is made with data available as of mid 2025. The projections shown are therefore limited and do not encompass all flexibility asset additions that are expected in the [2024-2030] period.*

Adequacy and flexibility should be co-optimised

Scarcity duration expands with the energy transition

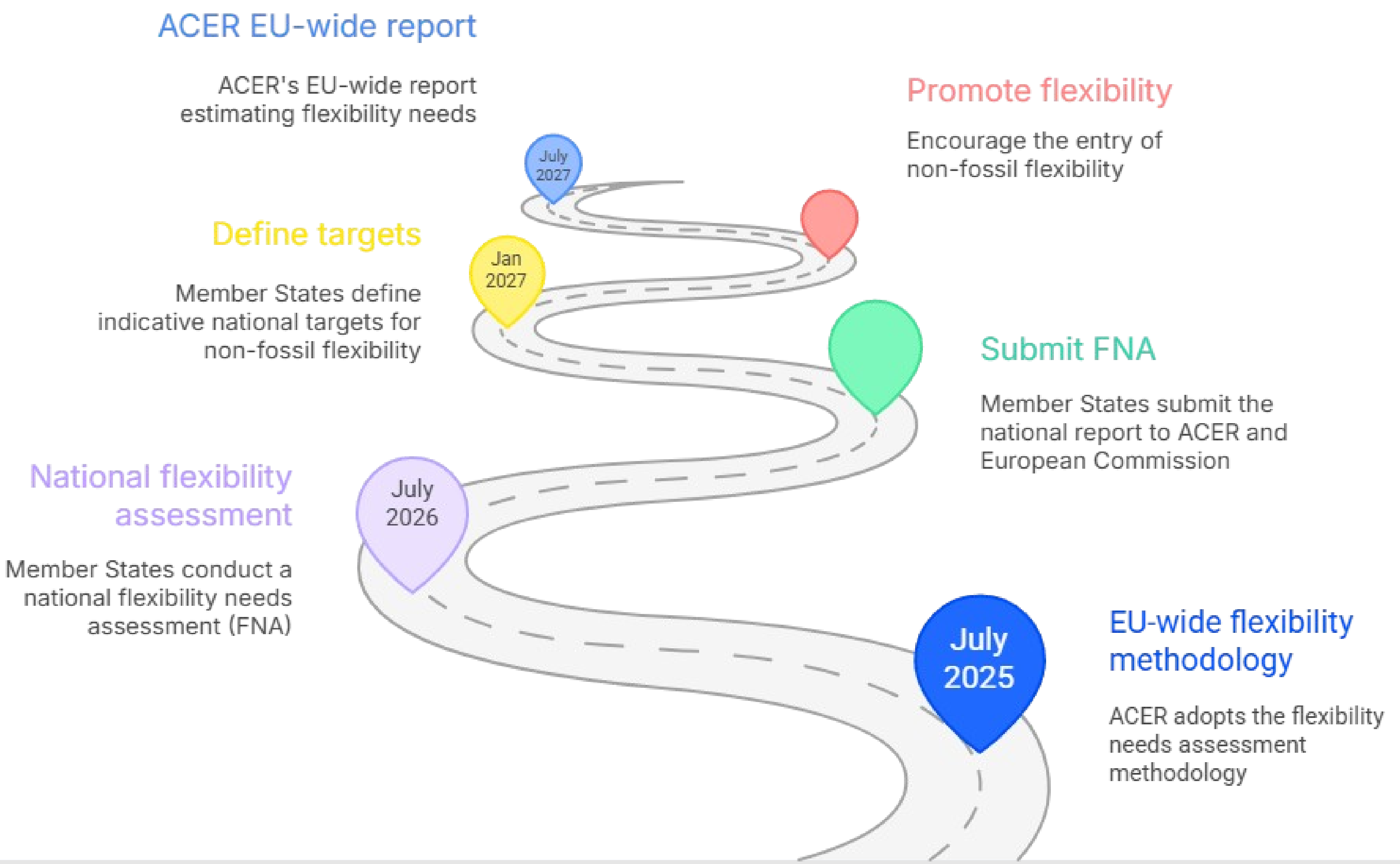
Derating factors for batteries[1] of various sizes, EU-27, target year 2035



- **There is interdependence between flexibility and adequacy decisions.**
- For instance, a flexibility measure might identify 2-hour batteries as the most cost-effective option for addressing short-term flexibility needs. However, this choice could still require additional resources to ensure adequacy.
- Adequacy and flexibility procurement should be co-optimised rather than assessed in isolation.

Source: ACER based on ERAA 2024 data
[1]The Derating Factor per bidding zone is estimated for a 1 MW battery, indicating how much such a battery contributes to reducing unserved energy in the ERAA 2024 edition.
*See Article 19g of Regulation 2019/943

Flexibility in the EMD framework



- → Deployment of renewables calls for **flexibility solutions** to ensure their integration in the grid.
- → To foster non-fossil flexibility, **assessments of flexibility needs** (bi-annually - National and European level).
- → Assessments are based on the input of TSOs & DSOs and a common **European methodology**.
- → Where national non-fossil **flexibility objectives are not met by market-only mechanisms**, Member States **may introduce flex schemes.**

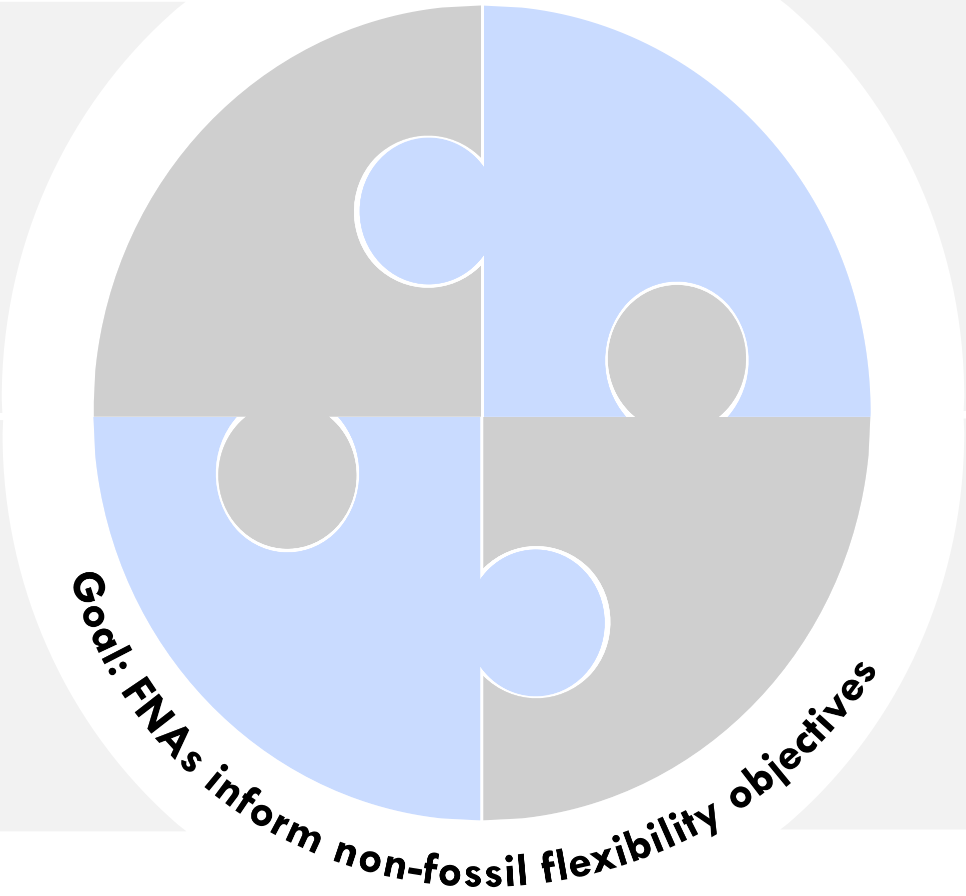
Note: the timeline is dependent of the time of the approval of the FNA report by the NRA in case it is drawn up by a designated entity e.g. the TSO.

ACER
European Union Agency for the Cooperation of Energy Regulators

Guiding criteria: useful information to support policymaking

Characterisation of needs, interpretation of the results

Assess technical capability of different sources to meet flexibility needs



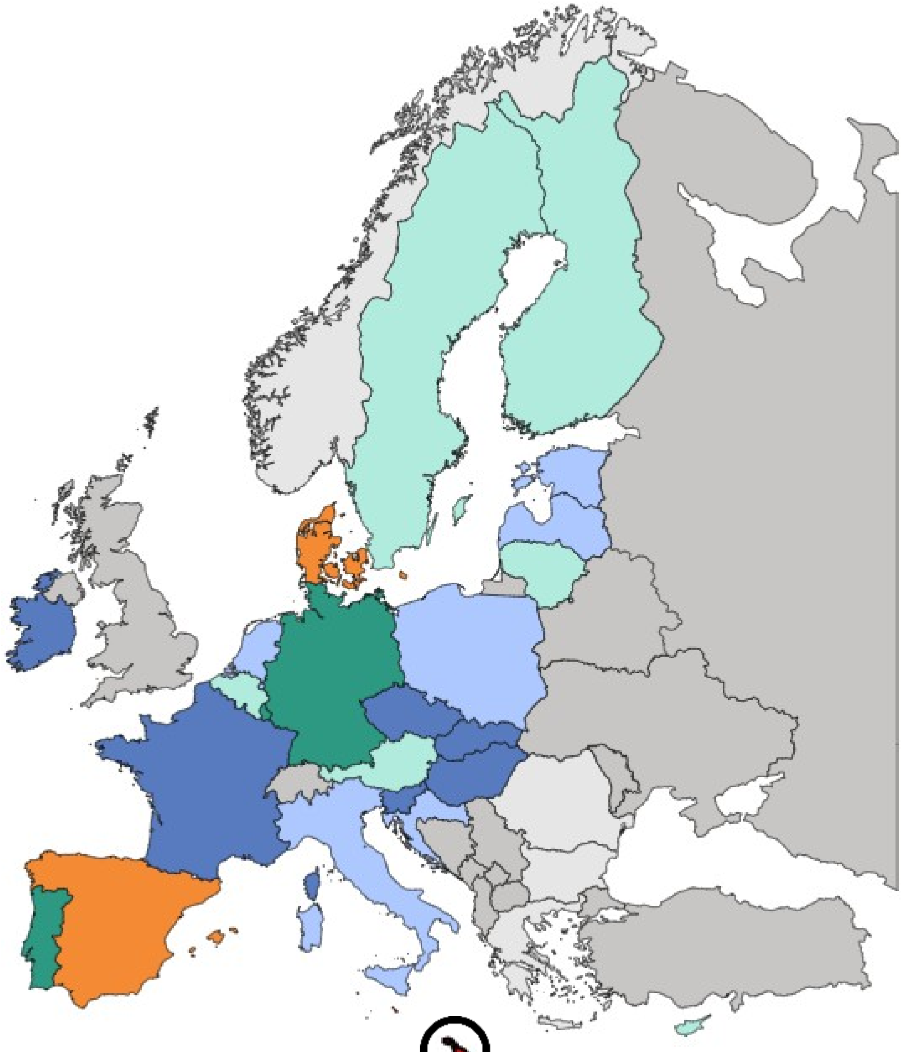
TSOs to analyse interdependencies among the needs

Possibility to assess other cost-effective solutions to meet goals

Who adopts the Flexibility Needs Assessment Report

- The first Flexibility Needs Assessment has to be adopted by all Member States by July 2026 according to Article 19e of the Electricity Regulation.

- The report can be adopted by the NRA, a Designated Entity (e.g. the TSO) or a Designated Authority (e.g. the Ministry of Energy).



NRAs from Member States without were asked about their expectation. These Member States are marked with the tag "expected" on the map.

Thank you!

How Open-Source Models Can Support Adequacy, Network Development and Flexibility Assessments

Luciana Marques
Open Energy Transition (OET)

RGI Expert Workshop Series: Empowering Grids from Planning to Practice
19 November 2025

Open Energy Transition in Numbers

OET is a **non-profit company** that is focusing open energy planning solutions to accelerate the **clean energy transition**

2023

Founded by Dr. Max Parzen & Dr. Martha Frysztacki

50+ TEAM SIZE

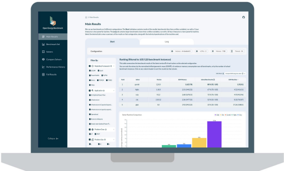
24+ PhDs, 100% Remote, 20+ countries

100% FOCUS

on adding value with **open-source** software, **open data** and **open collaboration**

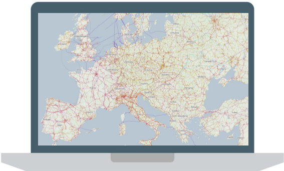
SOFTWARE DEVELOPMENT

Custom software, off-the-shelf solutions, etc.



DATA WRANGLING

Open data (grids/demand), benchmarks, automation, quality

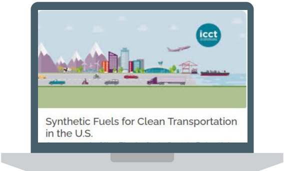


SERVICES AND TRAINING

24/7 support, optimization, AI, business knowledge, etc.

STUDIES

Trusted studies, fully reproducible and transparent



Different Assessments, Different Goals

	🎯 Core Question	🧩 Focus	📊 Results
Resource Adequacy Assessment (RAA)	*Do we have enough capacity to avoid shortages?*	Supply–demand balance, peak loads, stress events	LOLE, EENS, Firm capacity, Risk metrics
Flexibility Needs Assessment (FNA)	*Can the system handle variability & uncertainty?*	Ramping, reserves, storage, DSR, local flexibility	Network & system flex needs (congestion, RES integration, ramping, short-term)
Network Development Plans (NDP)	*Do we have the grid needed for the future system?*	Expansion, congestion relief, RES integration, interconnections	System Needs, Infrastructure Gaps, Grid projects, Cost Benefit Analysis

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Investment Model (EVA) + Market Model (ED or UCED)

Investment Model (Capacity Expansion)

What sort of questions can we ask an energy systems model?

<table>
<tr><th></th><th>Real-time Models</th><th>Market Models</th><th>Investment Models</th></tr>
<tr><td>Applications</td><td>Operational feasibility, reliability and power quality assessments.</td><td>Production cost optimization, market simulation, resource adequacy, flex assessment</td><td>Investment decisions, technology assessment, resource adequacy, decarbonization pathways.</td></tr>
<tr><td rowspan="2">Tools (proprietary)</td><td></td><td colspan="2">e.g., PLEXOS</td></tr>
<tr><td colspan="2">e.g., PowerFactory, PSSE</td><td></td></tr>
<tr><td rowspan="3">Tools (open-source)</td><td></td><td colspan="2">e.g., PyPSA, GenX, Calliope</td></tr>
<tr><td></td><td></td><td>e.g., OSeMOSYS, TIMES</td></tr>
<tr><td colspan="2">e.g., PowSyBl, pandapower, Sienna</td><td></td></tr>
</table>

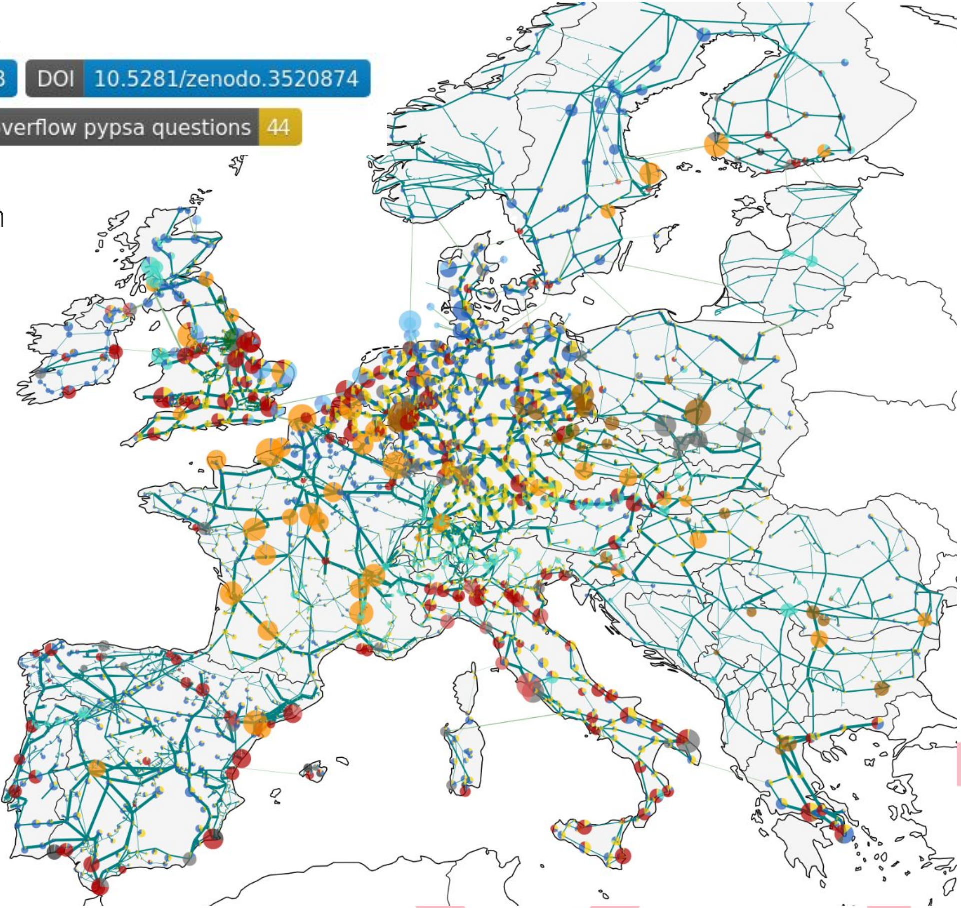
Open source tools have models to run economic dispatches and inform RAAs and FNAs, as well as to perform cost-benefit analyses of network investments options to inform NDPs

PyPSA-Eur: A Sector-Coupled Open Optimisation Model of the EU Energy System

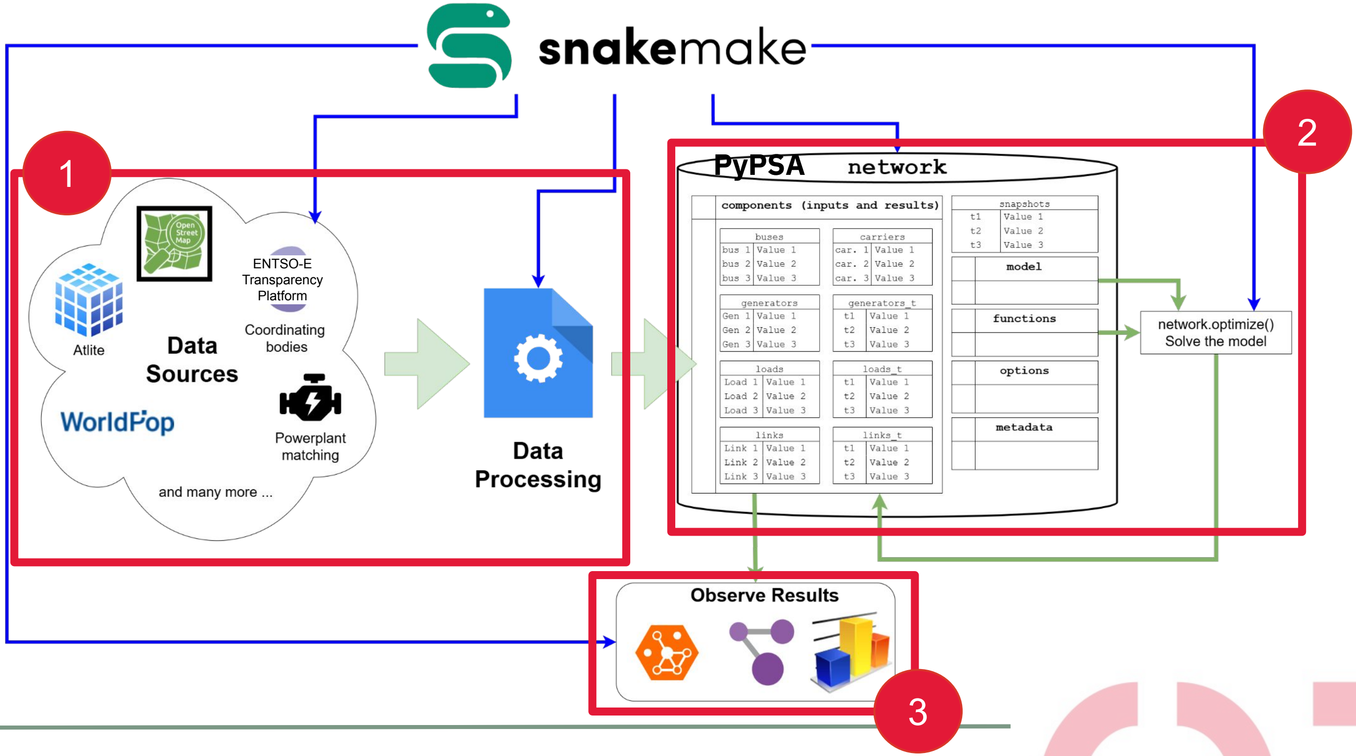
release v0.13.0 | Test workflows passing | docs passing | repo size 109.3 MiB | DOI 10.5281/zenodo.3520874
DOI 10.5281/zenodo.3938042 | snakemake ≥8.14.0 | REUSE compliant | stackoverflow pypsa questions 44

Automated workflow to build European PyPSA networks from open data. The network includes:

- all AC lines at and above 220 kV, substations and (planned) HVDC links + gas pipelines.
- a database of existing power plants
- time series for electrical demand
- time series for wind/solar availability, and geographic potentials
- methods for model simplification
  - temporal: hourly (default), sub-hourly, multiple hours
  - spatial: substation level + aggregation methods



PyPSA Workflow Automation
-> Run 100 scenarios with one click, manage & explore scenarios

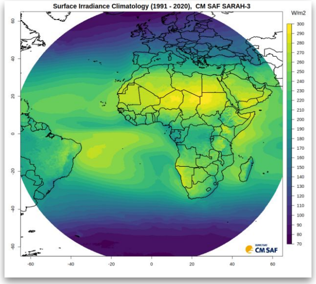


1 What open data sources are available?

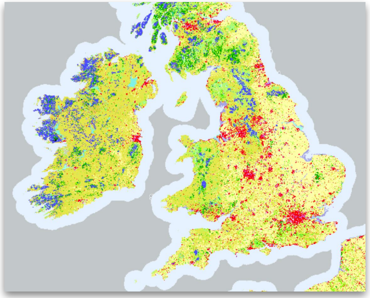
https://pypsa-eur.readthedocs.io/en/latest/data_sources.html

WDPA

SARAH-3

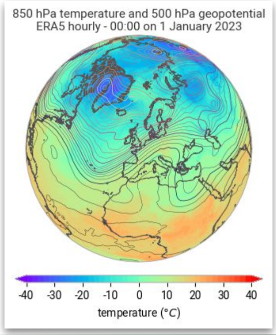


CORINE

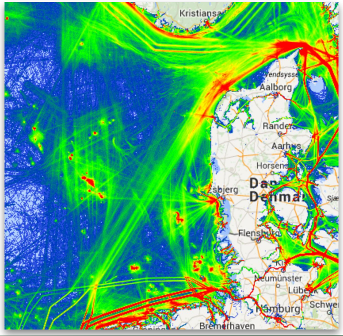


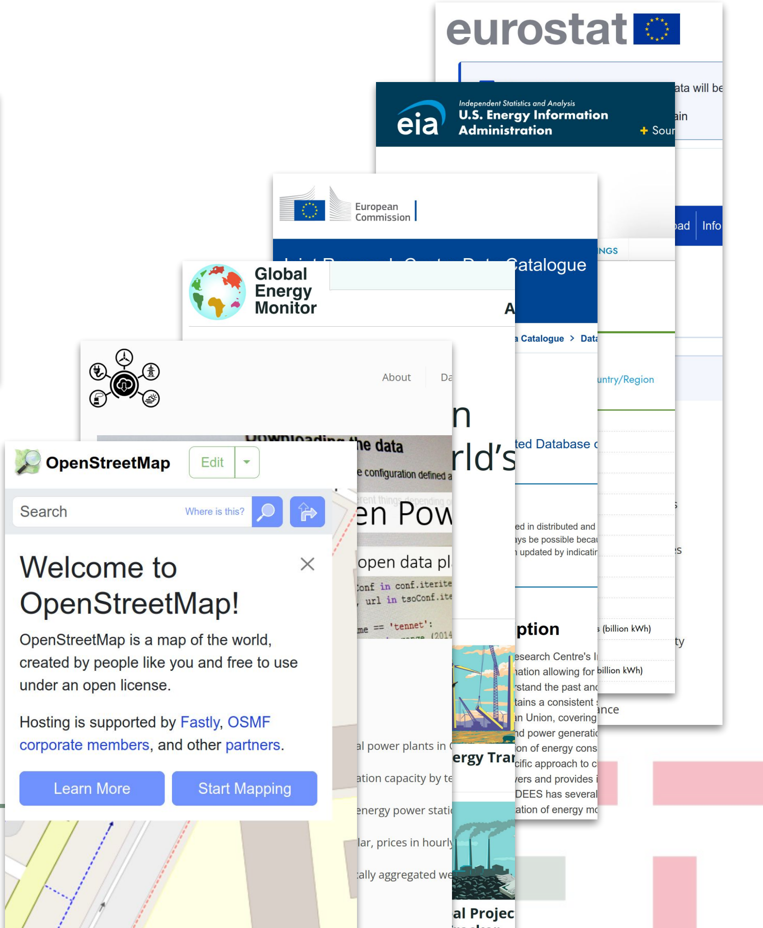
GEBCO

ERA5

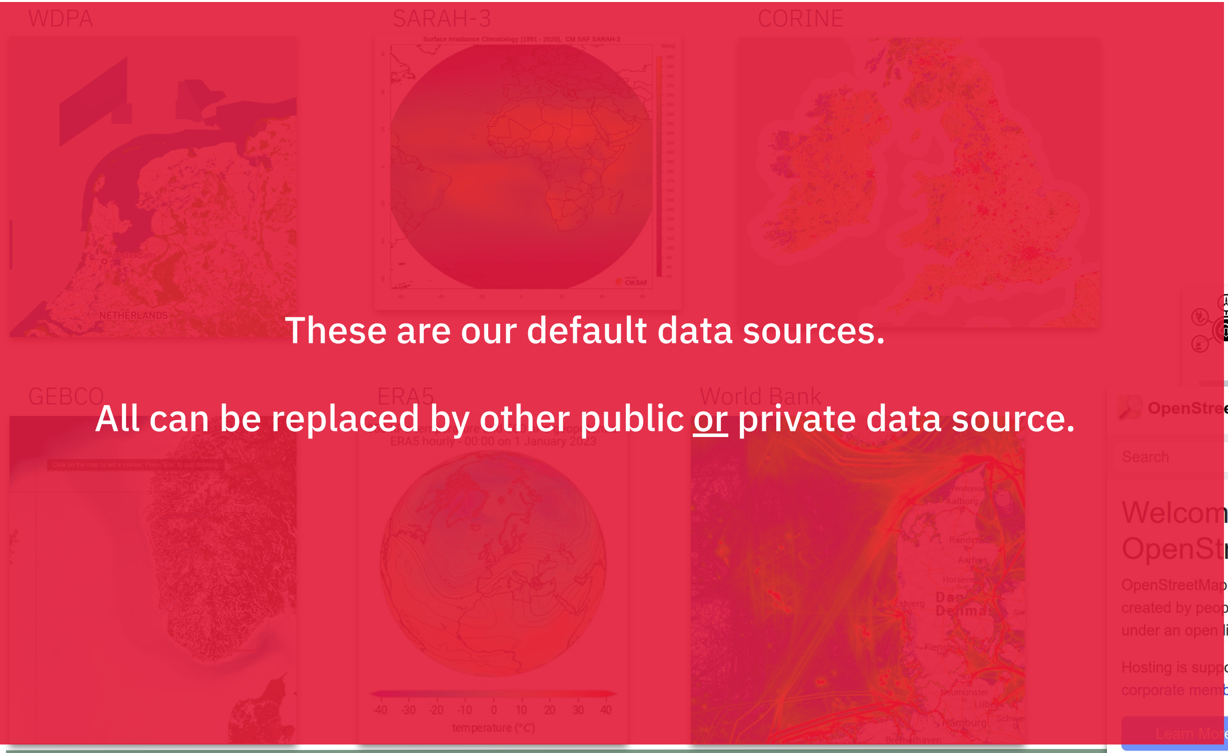


World Bank





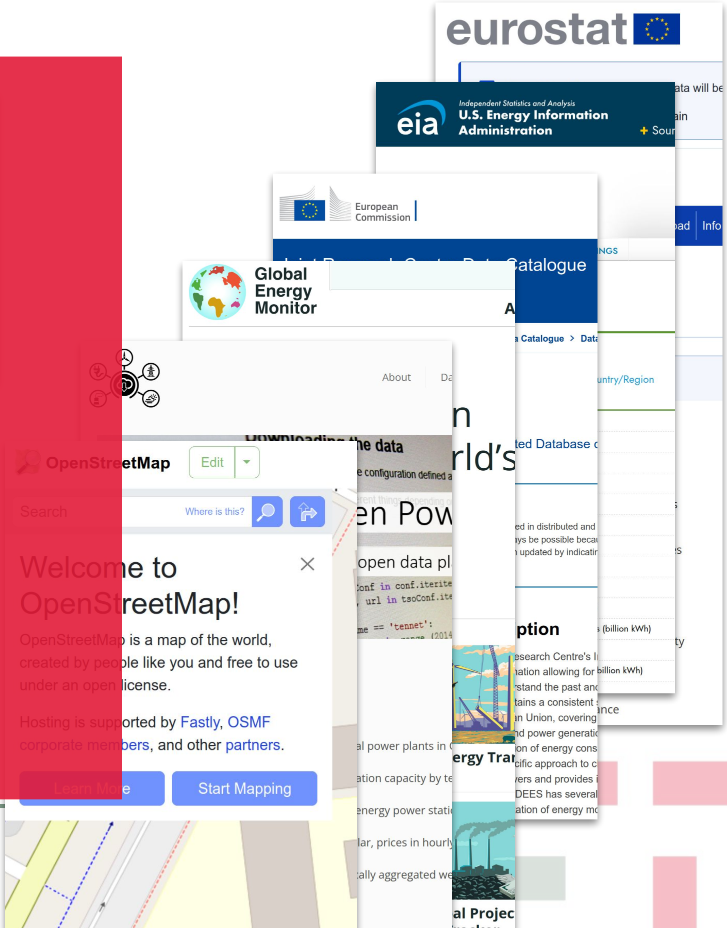
1 What open data sources are available?



These are our default data sources.

All can be replaced by other public or private data source.

https://pypsa-eur.readthedocs.io/en/latest/data_sources.html



2 What models are available in the PyPSA ecosystem?

Optimization Problems

Capacity expansion (linear)
- Marginal cost + capital cost
- Transmission, generation, or integrated

Market Models (linear)
- Marginal cost-based
- Linear optimal power flow (LOPF)
- (UC) Economic Dispatch & redispatch

Solving options:
- Single-horizon, multi-horizon or rolling horizon
- Include uncertainty with multi-stage stochastic planning, Monte Carlo simulation or Modeling to Generate Alternatives (MGA)

+

Components

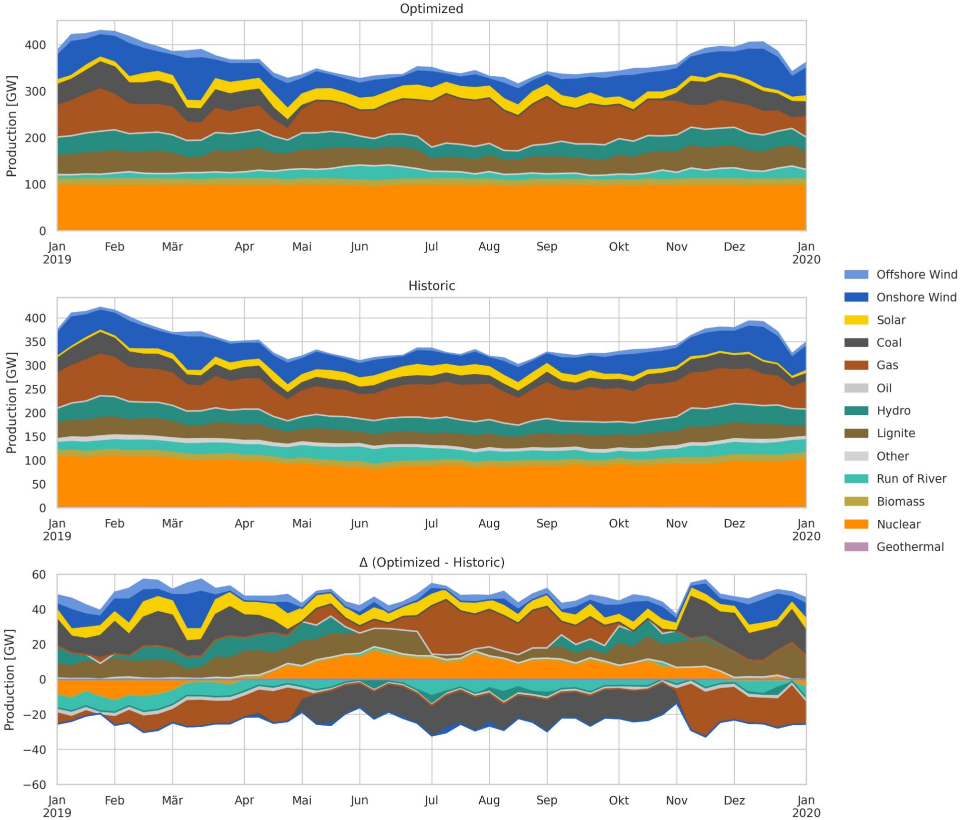
- **Generators:** with unit commitment, all operational constraints, and customizable availability time series
- **Transmission**: Meshed AC-DC networks
- **Demand**: Endogenous demand from industry, transport, heating
- **Storage**: Includes efficiency losses and inflow/spillage for hydro
- **Conversion** between energy carriers & materials (enables PtX, CHP, BEV, DAC, CO2 networks, material/data flows, ...)

3 What results can be retrieved?

Marginal prices of bidding zones, Dispatches of different technologies, Cross-border exchanges, Optimal capacities, Procurement costs, CO2 emissions, etc.

Over different simulated scenarios

Can be used to calculate LOLE, EENS, flexibility needs, ramping needs, etc.



Open-TYNDP

Open-source TYNDP

Client:	Breakthrough Energy, European Climate Foundation, TransnetBW
Service:	Software development
Goal:	Creating a PyPSA-based open-source workflow that can be used to replicate ENTSO-E TYNDP scenario building and cost-benefit analysis processes.
Tools:	Custom PyPSA-based UCED and capacity expansion models with data pipelines and user interface.

https://github.com/open-energy-transition/open-tyndp

FNA

Flexibility needs assessment

Client: ACER
Service: Software development, training and capacity building
Goal: Building a modeling toolset that can be used for assessment of flexibility needs in Europe.
Tools: PyPSA-based custom tools

NESO

Open Market Model

Client: NESO
Service: Software development
Goal: Evaluate best open-source options, developing open market model which the SO and developers can use to test scenarios.
Tools: PyPSA (others reviewed)

🚀 Benefits of Open-Source Energy Modelling

Pan European Market Modelling Database (PEMMDB)

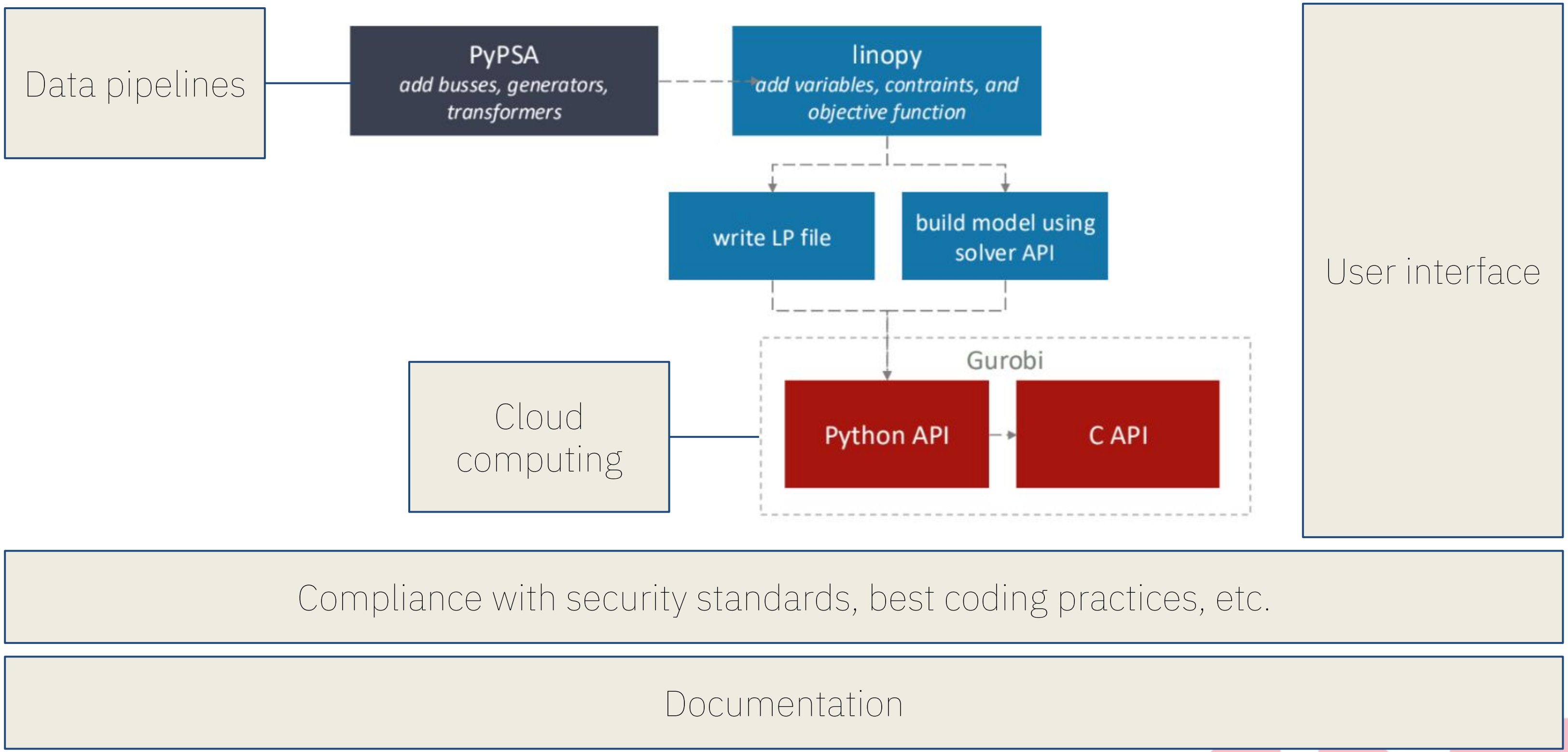
- Collaborative Development:
  - Multiple stakeholders (TSOs, DSOs, academia, industry) co-develop shared tools → **reduced duplication with shared open building blocks (ERAA & TYNDP & FNAs)**.
- Full transparency:
  - Open methods & data → traceable assumptions, easier validation.
  - Lower reliability/dependency on "black box" softwares.
- Fast Innovation:
  - Smooth transition from theory → implementation.
  - Rapid iteration enabled by open communities.
- Reproducibility:
  - Open codebases and data allow consistent, repeatable results.
- Equal Access:
  - Models & datasets available to all → supports fair scrutiny, capacity building & policy alignment.

⚠️ Methodological Gaps in Open-Source Energy Models

- Market coupling mechanisms missing:
  - FBMC not integrated
  - Risk: major impact on prices, flows & adequacy results.
- Incomplete market timeframes:
  - DA → ID → Balancing not fully modeled
  - Risk: oversimplified dispatch & unrealistic system behavior
- Regulatory Methods Not Covered
  - Economic Viability Assessment (EVA) not readily available
  - Risk: capacity expansion (required for ERAA & FNAs) not covered

Gaps may lead to biased adequacy, misestimated flexibility, and incorrect network needs if not properly closed

Don't focus on models alone



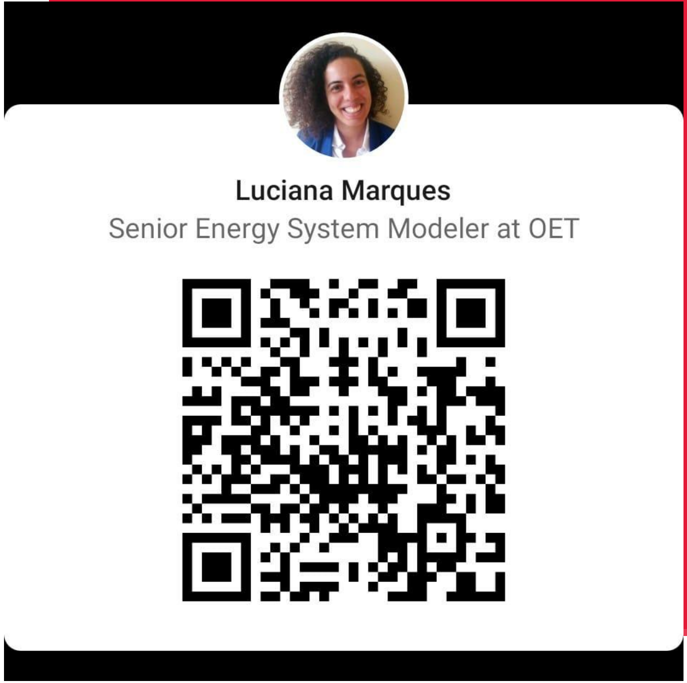
⚠️ Open Modelling Also Brings New Challenges

- Model proliferation → fragmentation risk
  - Over 200+ open-source energy models exist;
  - Aligning efforts and avoiding duplication becomes difficult.
- New procurement pathways
  - Open-source tools don't fit traditional procurement;
  - Organizations need to adapt internal processes and governance.
- "Free" ≠ free to operate
  - Open models still require maintenance, documentation, long-term support, and community care.
- Dependencies remain
  - Even open ecosystems typically rely on commercial solvers, proprietary cloud services, or licensed datasets.

TO DOs

- Bring **advanced methods** to energy system models. It takes far too long now (PyPSA just got two-stage stochastic programming!)
- Most open-source models still miss some **features** (e.g., cascading hydro) for global adoption
- Improve code quality (incl. modularity) and **user-friendliness**
- Decrease runtimes for simple models, including with **open-source solvers** and decomposition methods
- **Data standards** and **metadata standards** (incl. ontologies) would make life much easier for everybody
- **Interoperability** with proprietary software helps adoption
- **Open datasets** that are enterprise-grade

Thank you!



Questions?

Luciana Marques

Open Energy Transition (OET)

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TRANSNET BW

ADEQUACY 2050

Security of supply in the power system

LORENZ HÄFELE

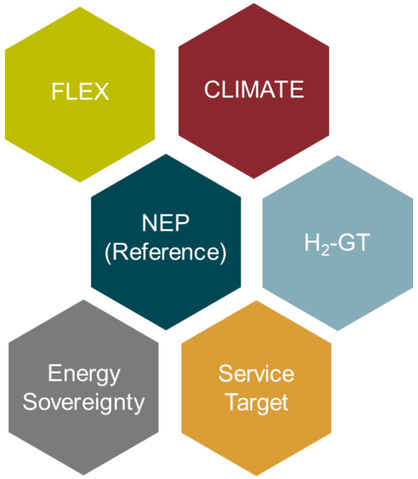
Brussels, 20.11.2025

RGI EXPERT WORKSHOP SERIES

EMPOWERING GRIDS FROM PLANNING TO PRACTICE

TRANSNET BW

ADEQUACY 2050 – OVERVIEW



Energy System Model	Market Model	Grid Model
Determines capacities and investments in renewable energy and flexibilities (including thermal power plants)	Detailed dispatch in the electricity sector (in a resolution compatible with the network model)	Overload energy in the transmission grid
Determines the level of sector coupling	Determines electricity market prices	Evaluation of NEP2023 measures
Calculates optimised electricity time series for sector-coupled technologies	Determines ENS and ENS-sharing among bidding zones	Redispatch calculations

- **Reference Scenario**: German National Grid Development Plan (NEP 2023), Scenario B
- **Goal: Robustness Analyses** of the Reference Scenario
- Methodologically novel **Adequacy Assessment** with sector-coupled optimization
- **Focus**: Flexibility Technologies (FLEX) and Weather / Climate Change (CLIMATE))
- **System Adequacy**: combined assessment of Resource Adequacy and Transmission Adequacy in climate-neutral energy systems

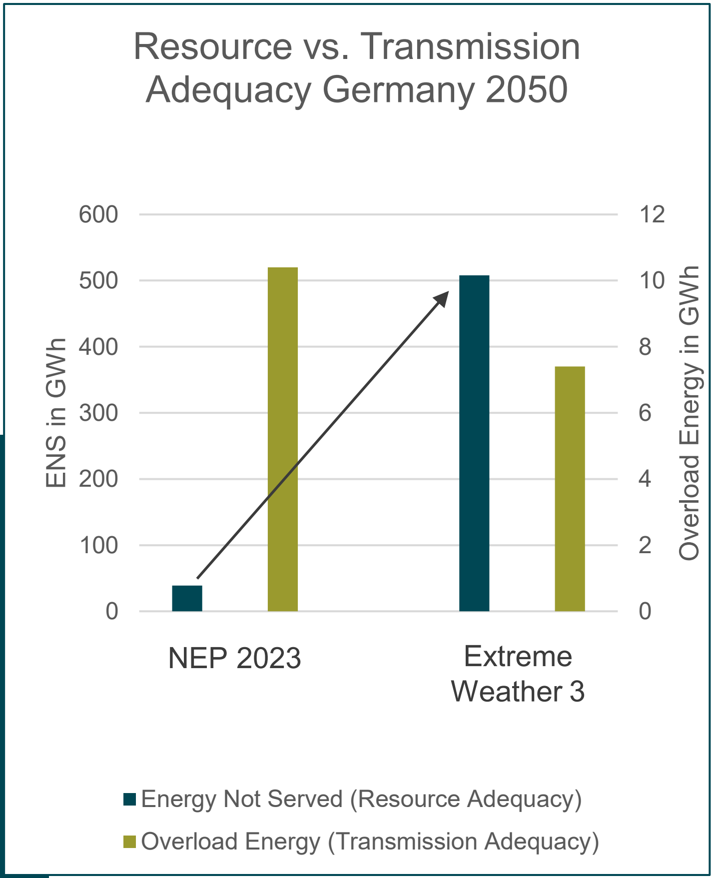
Key Message #1

TRANSNET BW

PLANNING OF CLIMATE-NEUTRAL SYSTEMS MUST INCLUDE WEATHER VARIABILITY AND CLIMATE CHANGE IMPACT, NOT JUST HISTORICAL AVERAGES

- German National Grid Development Plan uses average meteorological year 2012
- **Max. annual historical generation variability: ± 15 %** **± 5 %**
- For Germany (Ref. Scenario, 2050): up to ca. 150 TWh/y (~12 % of the annual demand)

- We analysed meteorological projections.
- We selected a “new average” scenario and 3 extreme meteorological years:
  - Extreme Weather 1 → Overall low renewable yields in Europe
  - Extreme Weather 2 → An exceptional cold winter
  - **Extreme Weather 3** → A particular high number of hot summer days paired with low renewable yields



EUROPEAN INTERCONNECTIVITY LAYS THE GROUNDWORK FOR A MORE EFFICIENT ENERGY SYSTEM

18 billion € / year cost reduction
is possible, when we plan with higher interconnection targets (Europe, 2050)

76 to 81 GW interconnection capacity around Germany
(NEP23: 49 GW), which aligns with BMWK-Langfristszenarios

Deep **European cooperation** regarding energy infrastructure is also necessary in the field of **green hydrogen imports**.

- Year-to-year weather variability also impacts European green hydrogen production
- European green hydrogen import shares vary greatly between 20% (380 TWh) and 50% (820 TWh)
- European system design needs to also account for an **adequate hydrogen supply infrastructure**

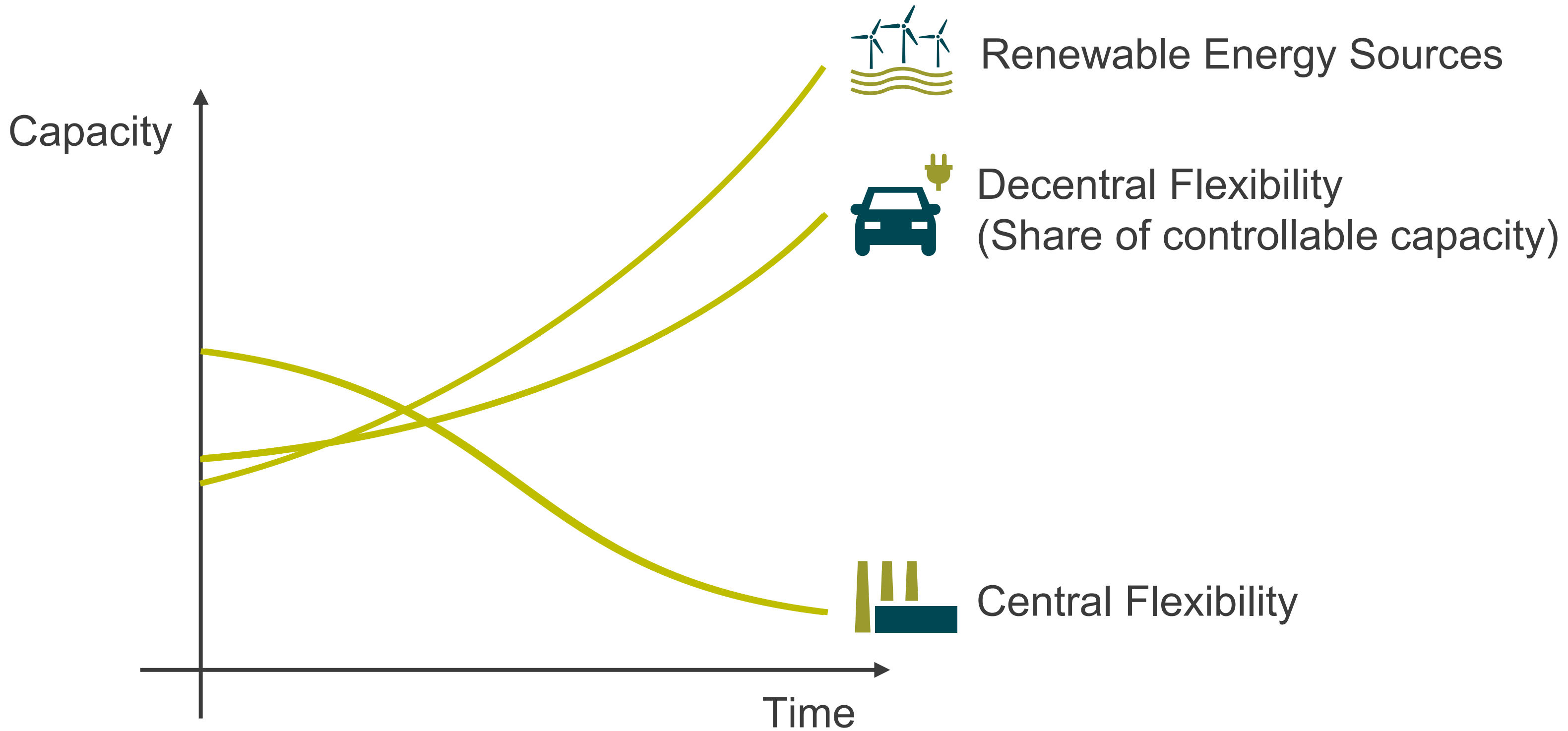
HYDROGEN POWER PLANTS ARE ESSENTIAL – ESPECIALLY WHEN FLEXIBILITY FALLS SHORT

- Flexibility from **hydrogen power plants** is much more **expensive** than flexibility from market-oriented prosumers
- **BUT ONLY** for an **average meteorological year** and under **perfect market** conditions
- A **stress test** (Decentral Flex 50%; Low-RES) shows:
  - on **168 h electricity demand will not be fully satisfied** (2,77 h is the benchmark for an adequate system), this corresponds to a shortfall of 1,2 TWh of electricity

If we design our system to be **resilient against loss of 50% market participation** of prosumer **by investing in 9 GW** more central capacities, then **AUTOMATICALLY** it is also **much better suited** for the shown stress test (**only 5 hours of loss of load; - 97%)**

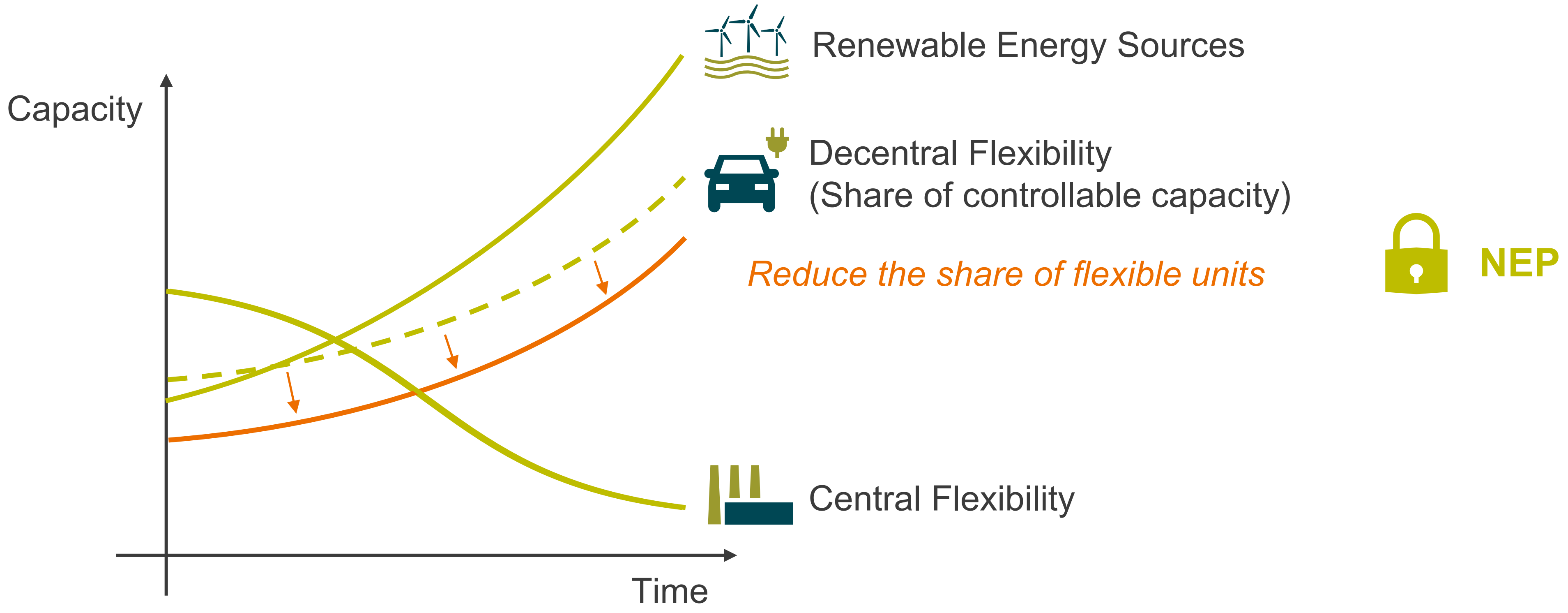
	NEP system	System with add. 9 GW capacities
Normal conditions Weather: 2012 Decentral Flex: 100%	✓	✓
Stress Test Weather: Low-RES 2050 Decentral Flex: 50%	1.208 GWh ENS 168 h LoL	1 GWh ENS 5 h LoL

PRINCIPLE OF “LOW FLEX” METHOD

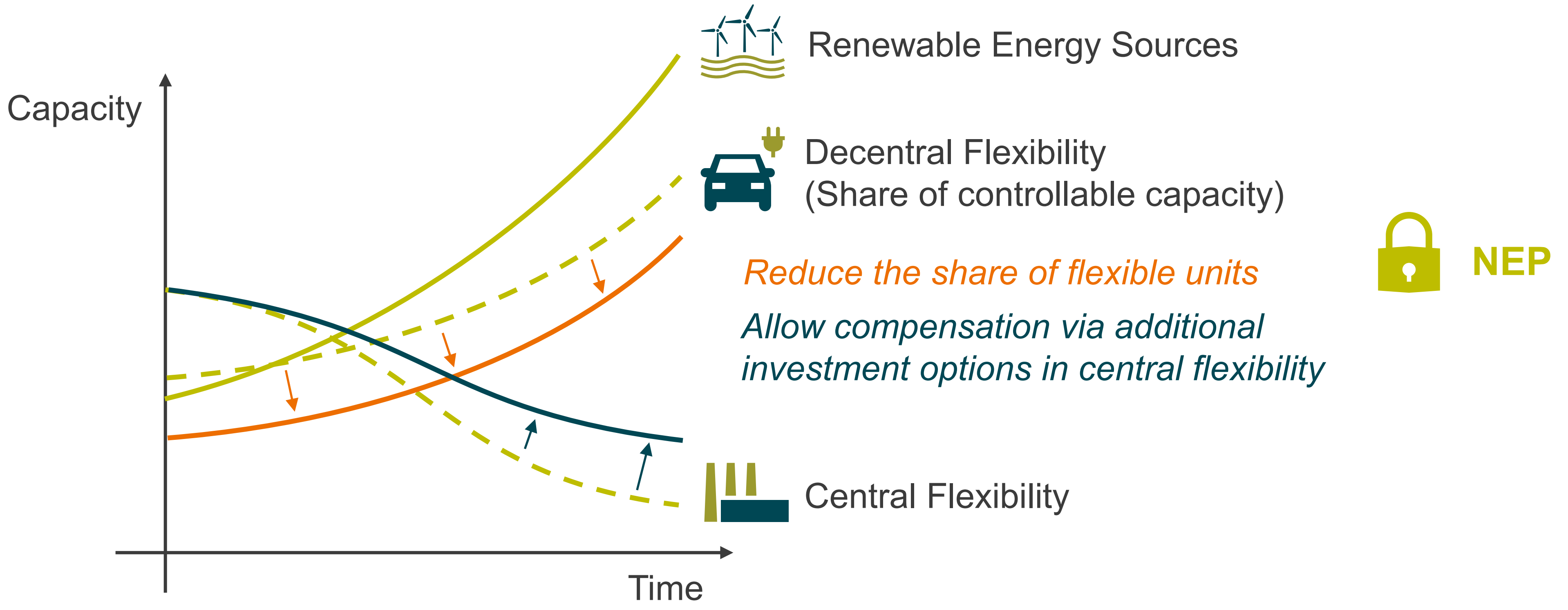


NEP

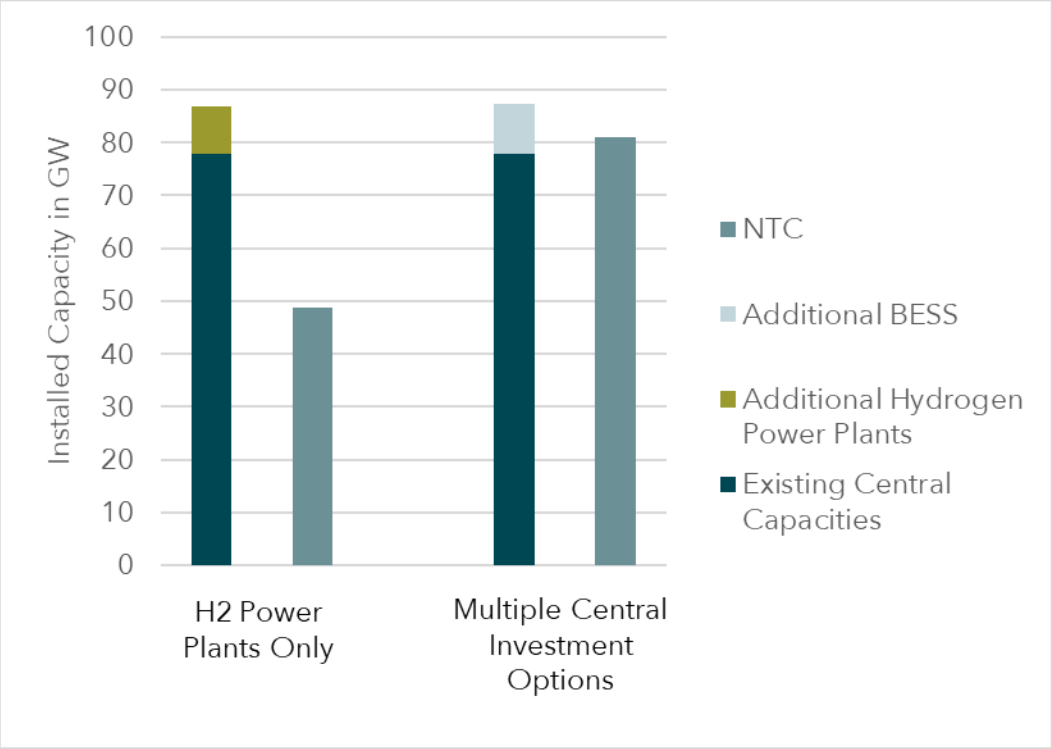
PRINCIPLE OF “LOW FLEX” METHOD



PRINCIPLE OF “LOW FLEX” METHOD



TRADE-OFFS IN CENTRAL FLEXIBILITY TECHNOLOGIES GERMANY - 2050



Weather: 2012
Decentral Flex: 50%

- **Additional 9 GW** hydrogen power plants are necessary, if market-orientation of prosumers is only 50%
- Central Flex Technology trade-off:
  - **additional 9,5 GW** large scale storage batteries and
  - **additional 32 GW** interconnection capacity for Germany can substitute 9 GW additional hydrogen power plant investment
- The alternative solution is economically more attractive but maintains the **weather-dependency**. However, multiple scenarios – even the stress scenarios - showed a clear trend of interconnection expansion coupled with additional battery and RES investments.

TRANSNET BW

UNLOCKING SMART DECENTRAL FLEXIBILITY POTENTIALS IS ESSENTIAL FOR THE AFFORDABILITY OF THE ENERGY TRANSITION

-11
Bn. € / year
(EU)

/ **SMART**
/ **FLEXIBLE**
/ **MARKET-ORIENTED**

Prosumers **which follow dynamic price signals** have the potential to reduce 11 billion € / year costs in Europe in 2050.

For Germany (2050):

investments of 9 GW additional hydrogen power plants are avoided

-1.5
Bn. € / year
(DE)

Keys to achieve this reduction:

Active market participation of prosumers (either directly or via aggregators)

Smart meters, smart electric vehicles & wall boxes, smart heat pumps and more

Market design which encourages flexibility on all scales

FLEXIBILITY TECHNOLOGIES ARE KEY – AND THEY MUST BE BOTH CENTRAL AND DECENTRAL.

Decentral flexibilities

/ Huge **leverages on electricity market prices**

/ Present in masses and with comparable cheap flexible operation

Central flexibilities

/ Dispatchable **independently** from weather

/ Provide **resilience against**

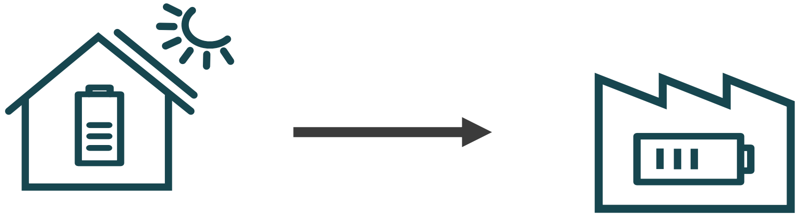
  / **forecast errors** of RES,
  / overall **low renewable electricity yields,**
  / of demand assumptions

Electricity interconnection capacities

/ Europe has a **diverse mix of weather**

/ Interconnectors “tap” the **different weather profiles** of Europe and “pipe” them to where demand is high

! **Smart** is not enough, **market-oriented** is necessary:



0 % market-oriented, 100 % optimized for self-consumption

+ 60 % large-scale BESS

*same effect, if no dynamic price tariffs

THANK YOU FOR YOUR ATTENTION

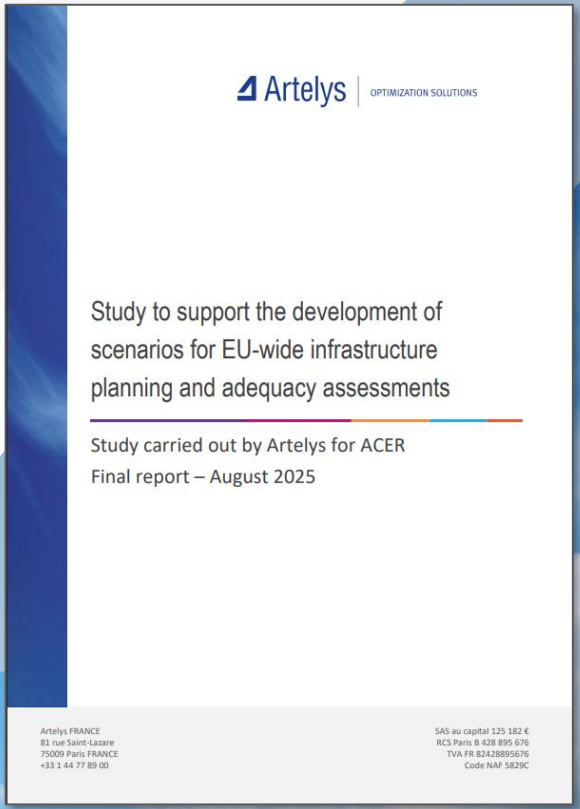
TRANSNET BW

Artelys | OPTIMIZATION SOLUTIONS

Convergence between the different EU-wide planning exercises: the ERAA-TYNDP perspective

Paul Brière, Artelys

RGI Expert Workshop Series: Empowering Grids from Planning to Practice, 20th November 2025


Artelys | OPTIMIZATION SOLUTIONS

Study to support the development of scenarios for EU-wide infrastructure planning and adequacy assessments

Study carried out by Artelys for ACER

Final report – August 2025

Artelys FRANCE
81 rue Saint-Lazare
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SAS au capital 125 182 €
RCS Paris B 428 895 676
TVA FR 82428895676
Code NAF 5829C

www.artelys.com

Artelys – In a nutshell

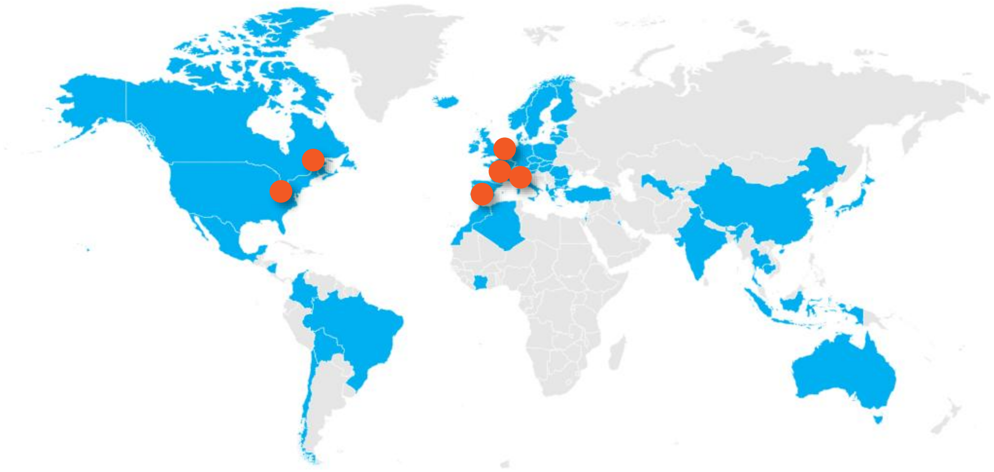
Artelys is an **independent** company, founded in 2000, specialised in **decision support**, **modelling** and **optimisation**

2000
Founded by
Arnaud Renaud

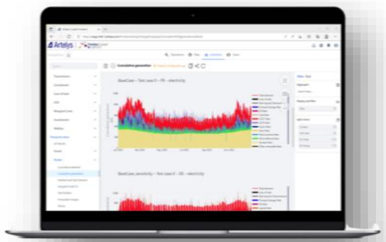
15% of
continuous annual growth, 300+ clients in 40+ countries

170+ STAFF
Highly skilled engineers and doctors

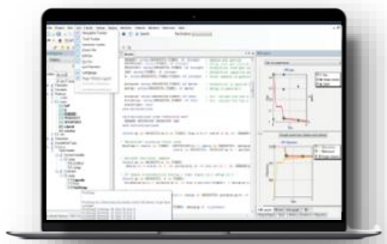
25% to 35%
of our activity dedicated to R&D



SOFTWARE SOLUTIONS
Tailor-made solutions, off-the-shelf software, numerical solvers



CONSULTANCY SERVICES
Combining our quantitative skills with business expertise, notably in the energy sector



STUDIES
For an efficient energy transition

Artelys key references

Adequacy

Flexibility

Infrastructure planning

Planning

Software: Artelys Crystal Super Grid delivered to conduct adequacy and infrastructure planning studies.

Artelys Crystal Super Grid

swissgrid

Study: National Resource Adequacy Assessments (NRAA) and Flexibility Needs Assessments (FNA).

Litgrid

Study: CBA and CBCA of interconnection projects

AST elering

Operations

Software: Market clearing algorithm for capacity markets.

European TSO

Software: Market clearing algorithm for local flexibility markets.

epexspot

Software: contributions to PowSyBl (open-source load flow algorithm)

LF ENERGY POWSYBL

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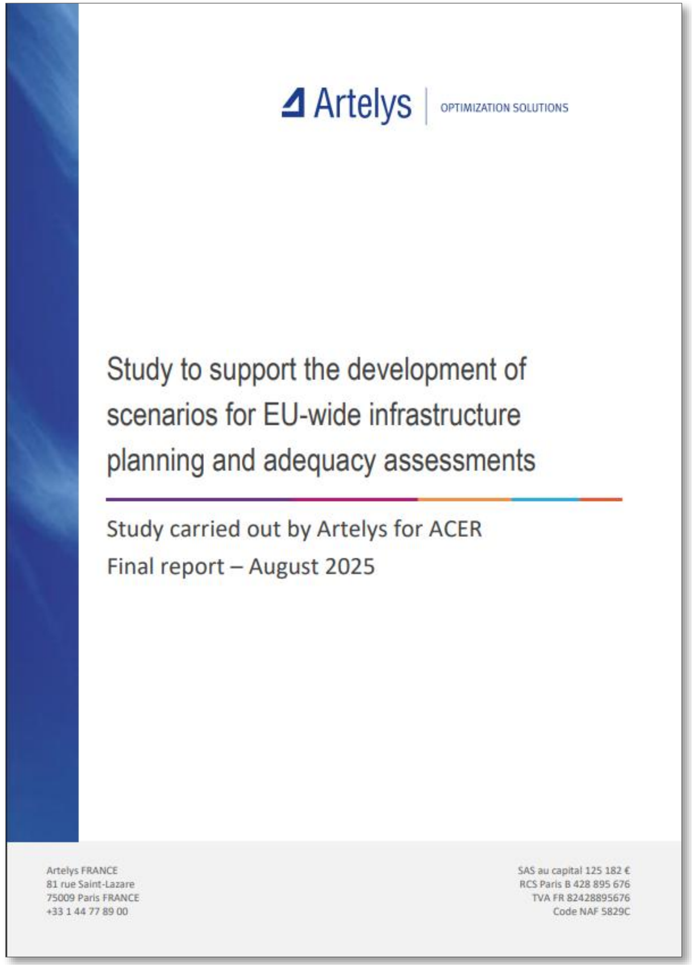
Context of the presentation

Artelys completed this summer a **consultancy study** for **ACER** on ERAA and TYNDP scenario development processes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https://www.acer.europa.eu/news/acer-consultancy-study-recommends-improvements-eu-scenario-development

Introduction: EU-wide infrastructure planning and adequacy assessments

European Resource Adequacy Assessement (ERAA)

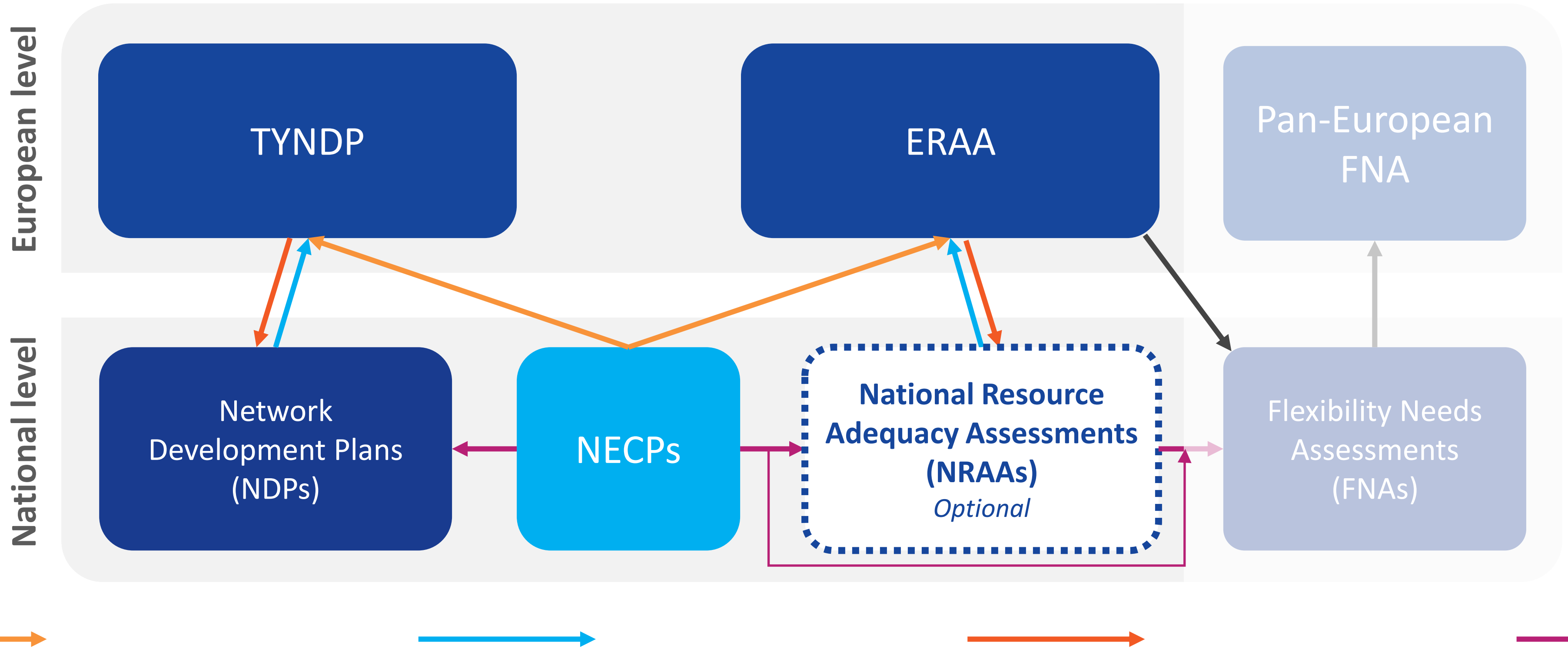
- Developed **annually**
- Developed by **ENTSO-E**
- **Objective**: Probabilistic assessment of electricity resource inadequacy risks
- ~10 years ahead
- Central scenario based on National Energy and Climate Plans (**NECPs**)

Ten-Year Network Development Plan (TYNDP)

- Developed **biennially**
- Developed by **ENTSO-E** and **ENTSOG** (and **ENNOH** in the future)
- **Objective**: Identification of **investments needs** and of the **cost & benefits** of **electricity** and **hydrogen infrastructure projects**, with a focus on projects with a cross-border impact
- Up to 2050
- Central scenario (National Trends) **based on NECPs**
  Scenario variants (new in 2026)

Interlink between TYNDP, ERAA and national instruments

ERAA and TYNDP are European scenarios which are **strongly interlinked** with **national exercises**.



ERAA and TYNDP assumptions are based on the NECPs

NRAAs and NDPs are often used as an alternative source of information by the TSOs

TYNDP and ERAA are often used as a source of data for developing NDPs and NRAAs

NDPs and NRAAs are based on NECPs

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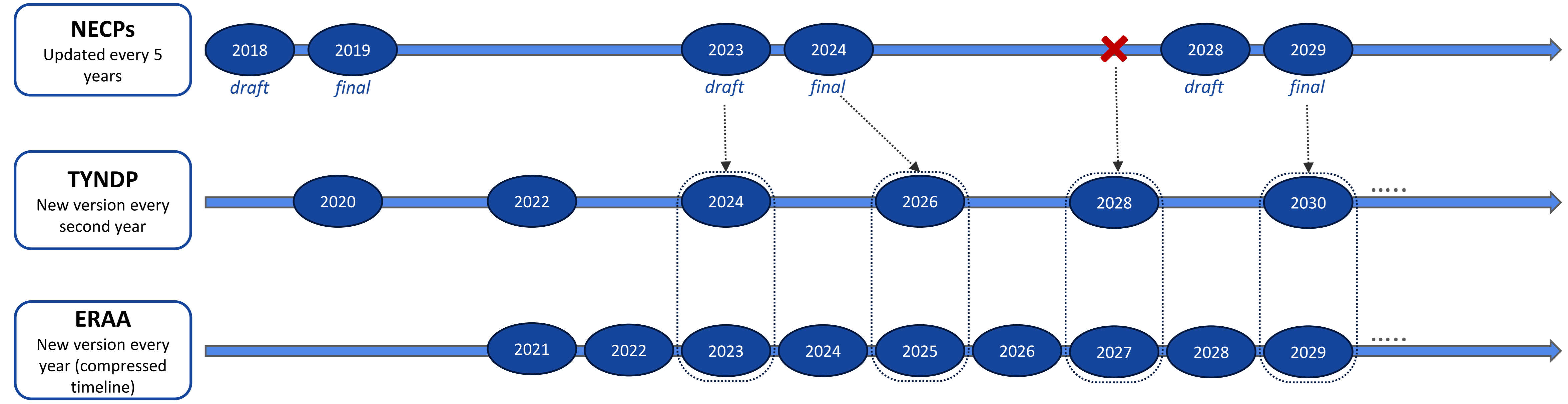
Challenge IV – Temporal misalignment between planning processes



Challenges

- **Temporal mismatch between ERAA and TYNDP** → difficulties to align processes (in particular data collection).
- **ERAA compressed timeline** forces ENTSO-E and TSOs to carry out all steps in a timely manner, which is a challenge. The delays are often **at the expense of stakeholder engagement**.
- Some TYNDP and ERAA cycles occur **without NECP being updated**.
- Delays in NECPs submission can impact ERAA and TYNDP timelines, slowing the entire chain.

Recommendations

- Consider moving **ERAA** from annual to **biennial basis**.
- Align data collection timelines (especially **data cut-off dates**):
  - National assumptions from TSOs should be **aligned by default**, with deviations only if documented & validated.
- **Anchor TYNDP and ERAA timelines to NECPs.** Between NECP updates, changes in assumptions should be justified and validated.
- **Increase NECP frequency** → consider shifting from 5-year to 4-year cycles.

Challenge V – Input data misalignment between ERAA and TYNDP

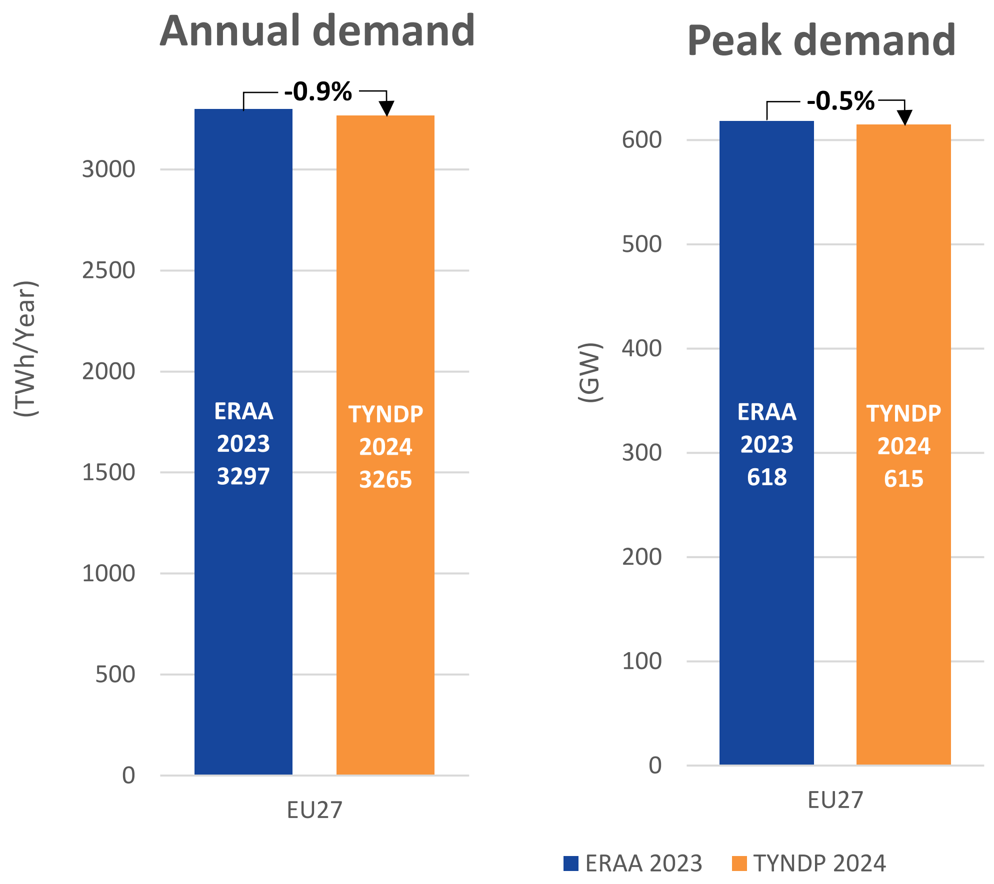


Figure – Comparison of electricity demand assumptions between ERAA 2023 and TYNDP 2024
(EU27 – horizon 2030 – climate year 2009)
***Source*: Artelys, based on data published by ENTSOs and ENTSO-E**

Reasons

These deviations can be explained by:

| Different **data collection timelines** between ERAA and TYNDP

| Different **tools** or **processes** used for data collection

| Some TSOs also reported **voluntary reporting different input data** for ERAA and TYNDP.

Recommendations

| Align data collection **timelines** and **processes** (e.g. tools used for the data collection) between both exercises.

| The general rule should be to use the **same national input data** for both exercises.

| If specific situations in certain MSs require some TSOs to provide different inputs into the ERAA and TYNDP processes, these should be **justified** and **validated** (e.g. by NRAs).

Key takeaways

Challenge #1

Translation of NECPs into scenarios national assumptions

- **Harmonise NECP** formats
- Increase **transparency** from TSOs
- Establish a validation role for **NRAs**

Challenge #2

Process to ensure compliance of scenarios with EU targets

- Improve the gap-filling methodology for **larger gaps**
- **EC** and **ACER** to provide stronger **guidance**
- **Align** between EU targets compliance verification between EC and ENTSOs

Challenge #3

Stakeholder engagement process

- Extend **SRG** to **ERAA**
- Extend consultation to the **entire** set of assumption data

Challenge #4

Temporal misalignment between TYNDP, ERAA and NECP processes

- Consider reducing **ERAA** frequency to **biennial**
- **Align** data collection **timelines** between ERAA and TYNDP
- **Anchor** TYNDP and ERAA timelines to **NECPs' timelines**

Challenge #5

Input data misalignment between ERAA and TYNDP

- Align national input data between ERAA and TYNDP
- In case of exceptional deviations, **justify** and **validate** (e.g. by NRAs)

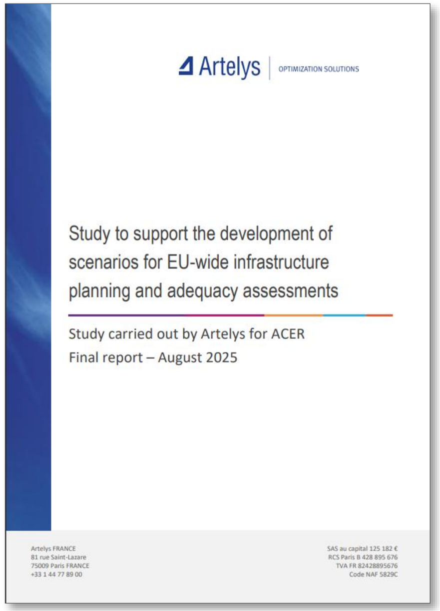
For further information

Additional challenges and recommendations not presented today

- On the current processes:
  - Transparency
  - Alignment between ERAA and TYNDP
  - Use of the **ETM tool**
  - Etc.
- Proposals of **TYNDP scenario variants** methodology and **ERAA additional scenario** based on current trends.
- Methodology proposal to transparently report **how scenario assumptions are chosen** and compare to other sources from the literature.

https://www.acer.europa.eu/news/acer-consultancy-study-recommends-improvements-eu-scenario-development

- **Report**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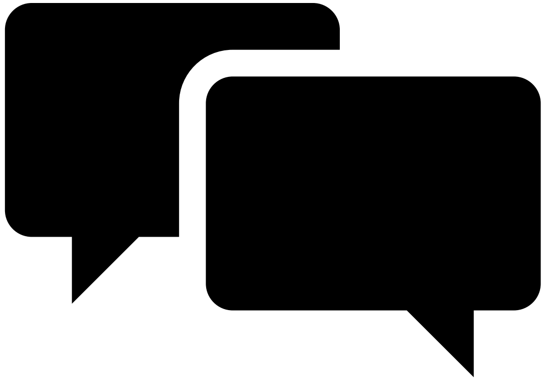
- **Annexes**

Annex I
Benchmark results

Annex II
Inputs table

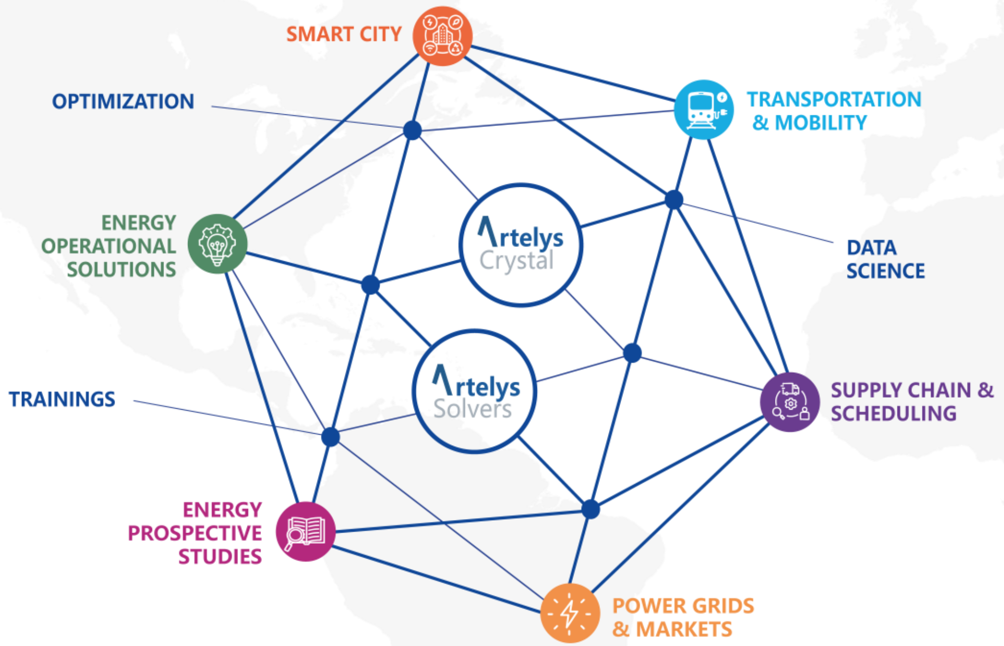
Annex III
Validation of scenarios inputs

Questions?



Thank you for your attention

Contact



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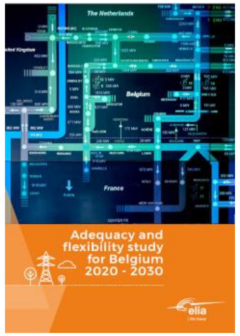
Adequacy and flexibility study for Belgium

2026-2036

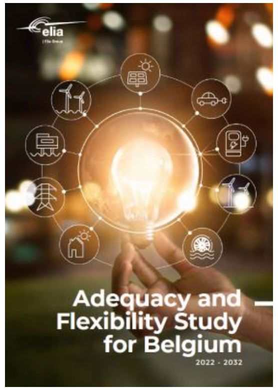
Rafael Feito Kiczak
Head of Scenarios, Market & Adequacy studies @Elia

Elia has built extensive experience with conducting adequacy and flexibility studies

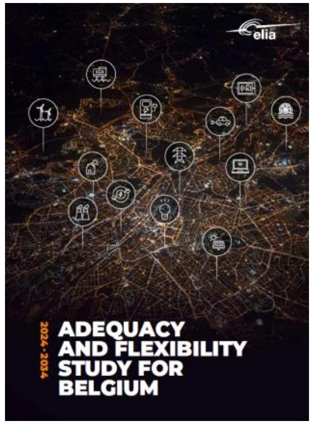
2016



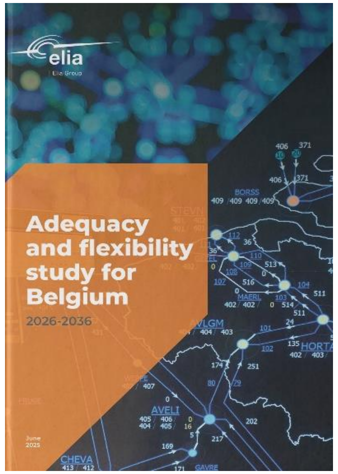
2019



2021



2023



June 2025

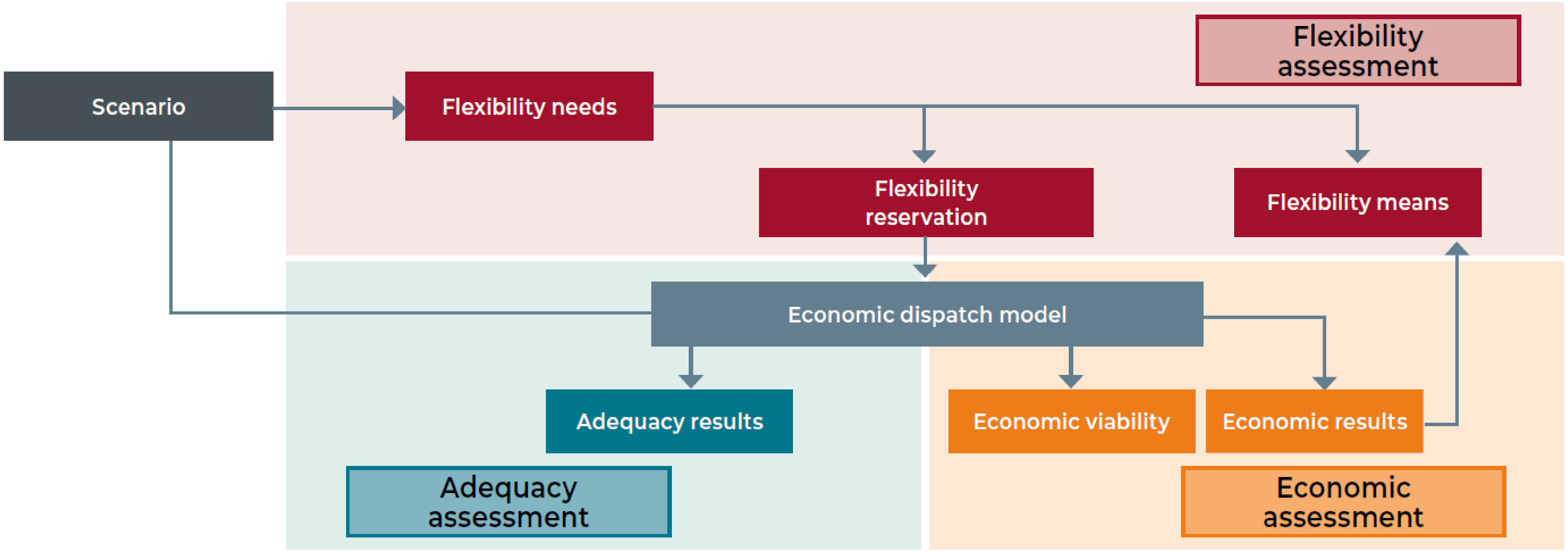
- Elia's first Flexibility Needs Assessment (FNA)
- With scenarios are based on Adeqflex'25

Summer 2026

- **Elia is integrating flexibility in its adequacy studies since 2016**
- **Focus on fast variations and prediction errors to complement adequacy studies**
- **Methods are improved and trough several iterations and consultations**
- **Legally binding study including process**

Allowed Elia to leverage experience in the development of the FNA method

The study looks at adequacy, economic viability and flexibility for the next 10 years



Full aligned with ERAA methodology with several key improvements:

- **11 target years** modelled for **all EU27 +UK/NO/CH**
- **Forward looking climate DB** (200 CY based on Meteo France)
- **Revenue-based EVA** for all even target years and Monte Carlo years
- **Full flow-based** Core across all simulations (including advanced hybrid coupling)
- **Extensive DSR** modeling (e.g. 24 ways of charging EVs, industrial flex per process)

Three scenarios are assessed (quantified for all Europe), together with additional sensitivities at EU and Belgian level

Current commitments & ambitions (CC)

Announced targets and policies and official projections (Bureau du Plan, NECP, latest government agreements, industry electrification plans).

Constrained transition (CT)

Additional constraints (supply chain and policy delays) hinder grid and renewable projects, slowing electrification, wind development, and flexibility compared to the CC scenario

Prosumer power (PP)

Accelerated electrification of end-users (electric vehicles and heat pumps) & massive uptake of PV and more end-user flexibility compared to CC.

- Three scenarios quantified for Belgium and the whole of Europe
- Multiple views on the future electricity system
- Based on input from stakeholders, public consultations
- >100 of sensitivities performed at Belgian and European level

Both EU-BASE and EU-SAFE scenarios are simulated on the three scenarios

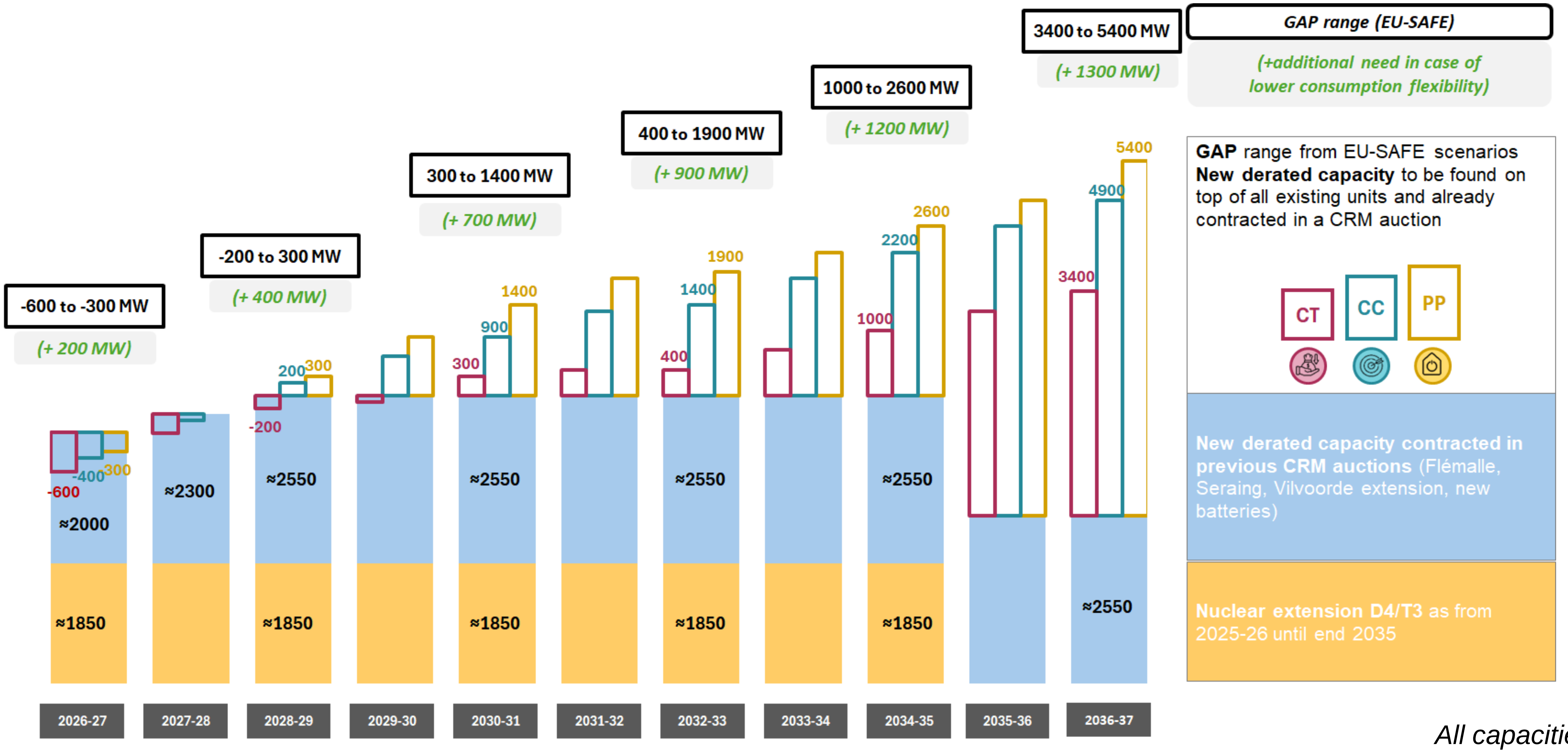
Some key results of our previous study

Adequacy – EVA – flexibility needs and means

The nuclear extension and CRM has developed enough capacities for the coming three years however new requirements emerge from 2028

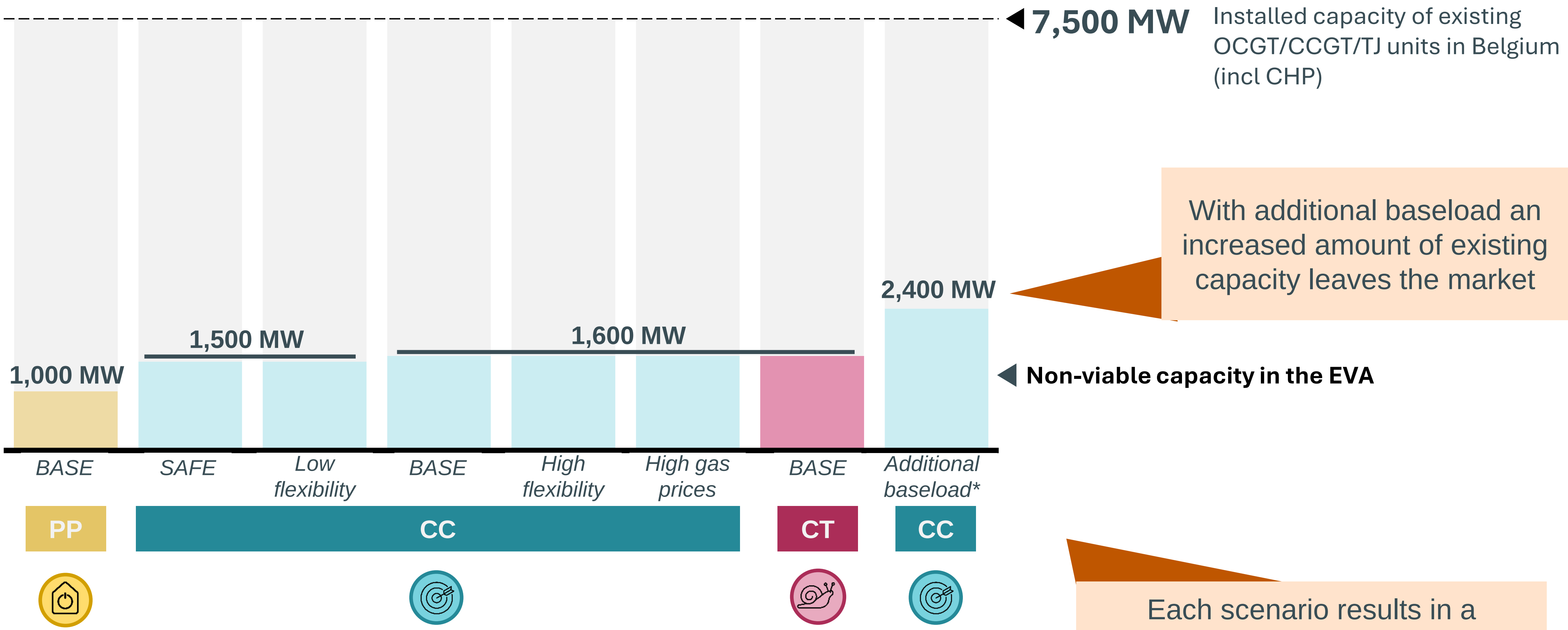
If slower flexibility uptake if assumed, additional capacity needs to be found

New capacity requirements (GAP) assuming all existing capacity remain in the EU-SAFE scenarios



All capacities in derated MW

Results of the economic viability assessment for different scenarios highlight capacity at risk of leaving the market



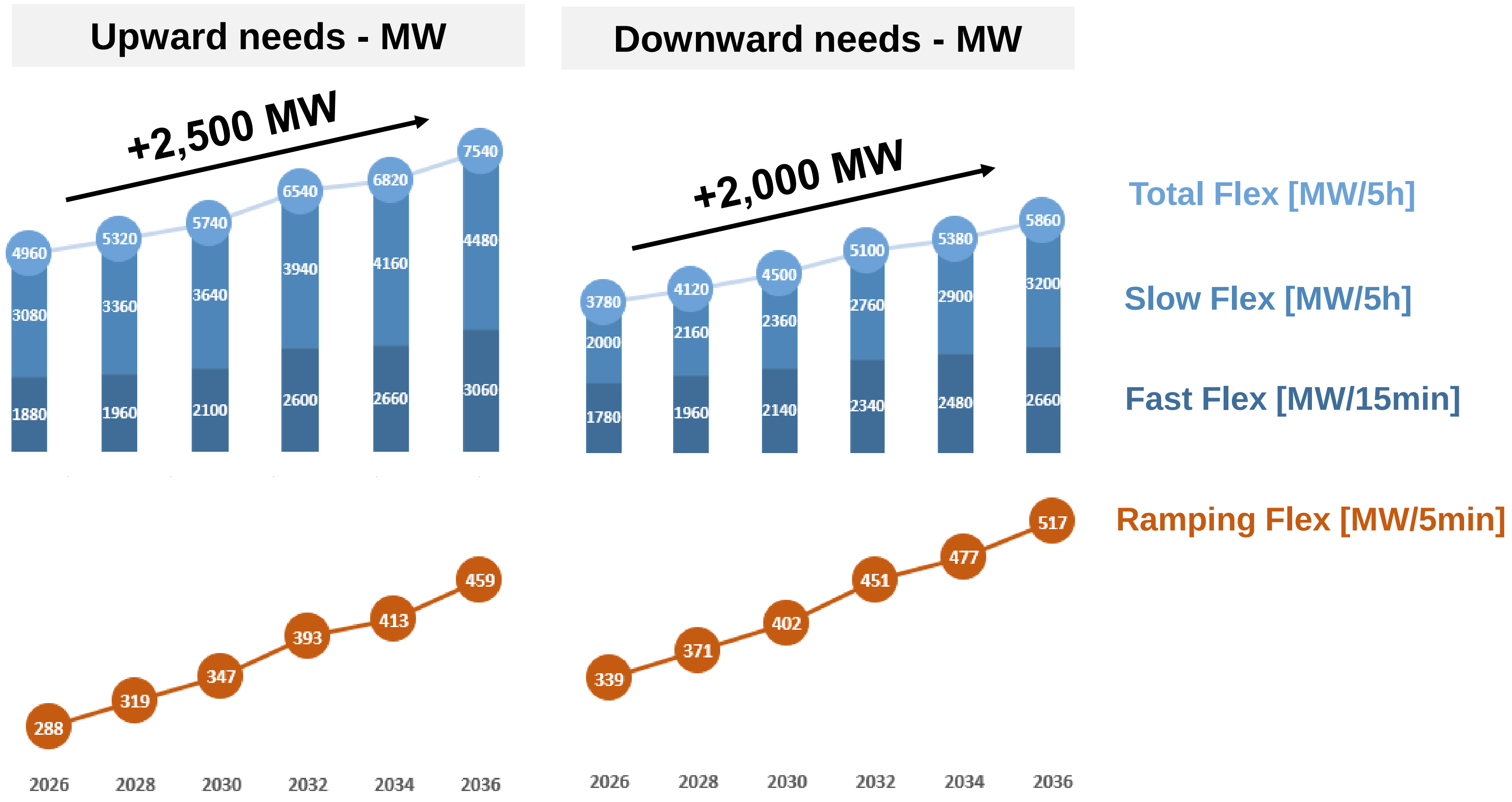
With additional baseload an increased amount of existing capacity leaves the market

Each scenario results in a non-viable GAP

*Extension of Tihange 1 is taken as additional baseload

Flexibility needs assessments enable a better view on the challenge – expected increase for Belgium

➢ *These result in flexible needs to manage prediction errors of renewable capacity in intra-day and real-time. Without action, the share to be covered by the TSO through reserve capacity will increase proportionally.*

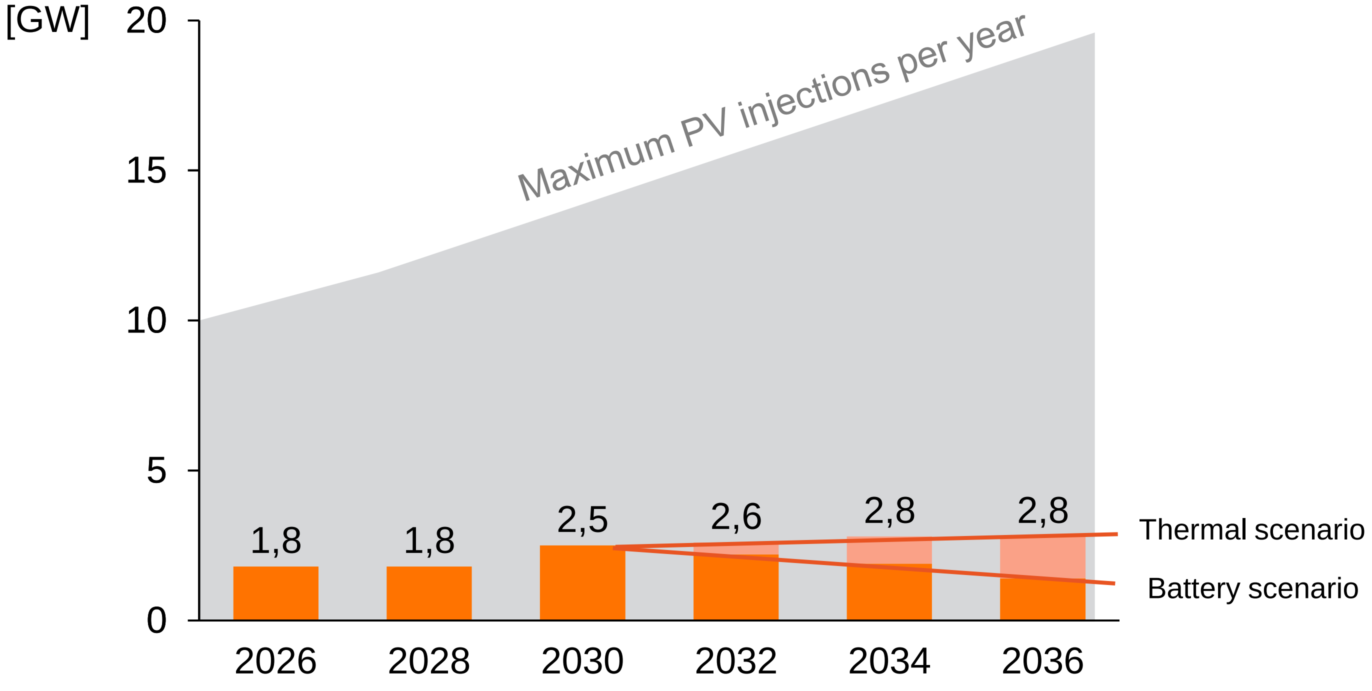


By 2036, the Belgian system will require

- **6 - 7 GW of flexibility** in the last hours before real time,
- of which **3 GW needs** to be able to **react in the last quarter hours**,
- and up to **0.5 GW needs** to **react within 5 minutes**.

Additional flexibility from decentralized assets is required to keep the system in balance

Additional efforts needed on unlocking decentralized solar power or consumer flexibility to keep the system in balance during excess energy periods



- From **300 hours** (in 2026) towards **300-600 hours** (in 2036) with risks of not covering all flexibility needs
- An additional effort of **1,8 GW** (in 2026) to **2,5 GW** (in 2030) of decentralized solar power or consumer flexibility is needed to react in the market to manage system imbalances

Results represent minimum flexibility needs under an optimistic scenario including all flexibility options of batteries, end-user flexibility, large-scale RES, cross-border flex under the Current Commitments scenario with a battery-gap filling scenario while accounting the contributions of decentralized wind power

End-users can benefit from making their production and consumption devices flexible and also contributing to cover the flexibility needs

	Assumption	Benefits from optimising my devices based on a **capacity tariff** and a **dynamic contract**	Source of the benefit
No injection when negative prices	4kWp PV installation	**40 to 250 €/year**	Benefits from avoiding negative prices
Optimising my vehicle charging	EV with 60kWh battery	**170 to 530 €/year**	Benefits from: peak shaving, energy arbitrage, increasing self-consumption
Optimising my heat pump usage	4kW HP	**20 to 70 €/year**	

Ranges provided are based on availability of the asset, different scenarios, weather years and future years.

Potential **additional** revenues could be gained from **short-term flexibility**

- *Benefits are express as a delta for a dynamic contract, do include the benefits from capacity tariffs as set today in Flanders but exclude additional benefits from providing ancillary services.*
- *Benefits are not necessarily cumulative for the 3 categories as synergies exist.*
- *Benefits including grid fees, taxes and levies*

Flexibility from end-users is lagging behind, however between 350 and 500 M€/year of system operation costs be potentially saved if unlocked

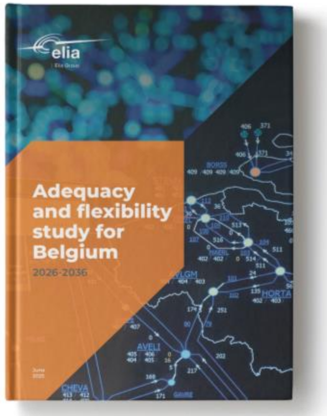
- An update of the value assessment of flex re-confirmed the value of developing end-user flex
- Observations yet show that the development still lags behind (cf. slow uptake of dynamic contracts)
- Additional efforts are needed to bridge barriers and enable solutions

	2030	2036
Balancing savings	≈ 125 M€/year	≈ 260 M€/year
+		
CRM costs savings	40-120 M€/year	90-240 M€/year

350 – 500 M€ per year
of system gains of unlocking additional end-user flex towards 2036 without accounting potential gains of optimizing grid investments

Want to know more ?

- **Adequacy & Flexibility study 2026-36 (June 2025)**



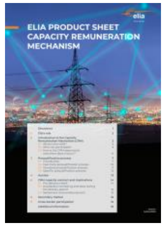
[Full study] online (>500 pages)

[Extended presentation to stakeholders]

[Assumptions workbook]

- **Interested in more ?**

[Blueprint study]: 2035-2050 study (multi energy European study with focus on energy mix choices, flexibility, adequacy, affordability/costs...)

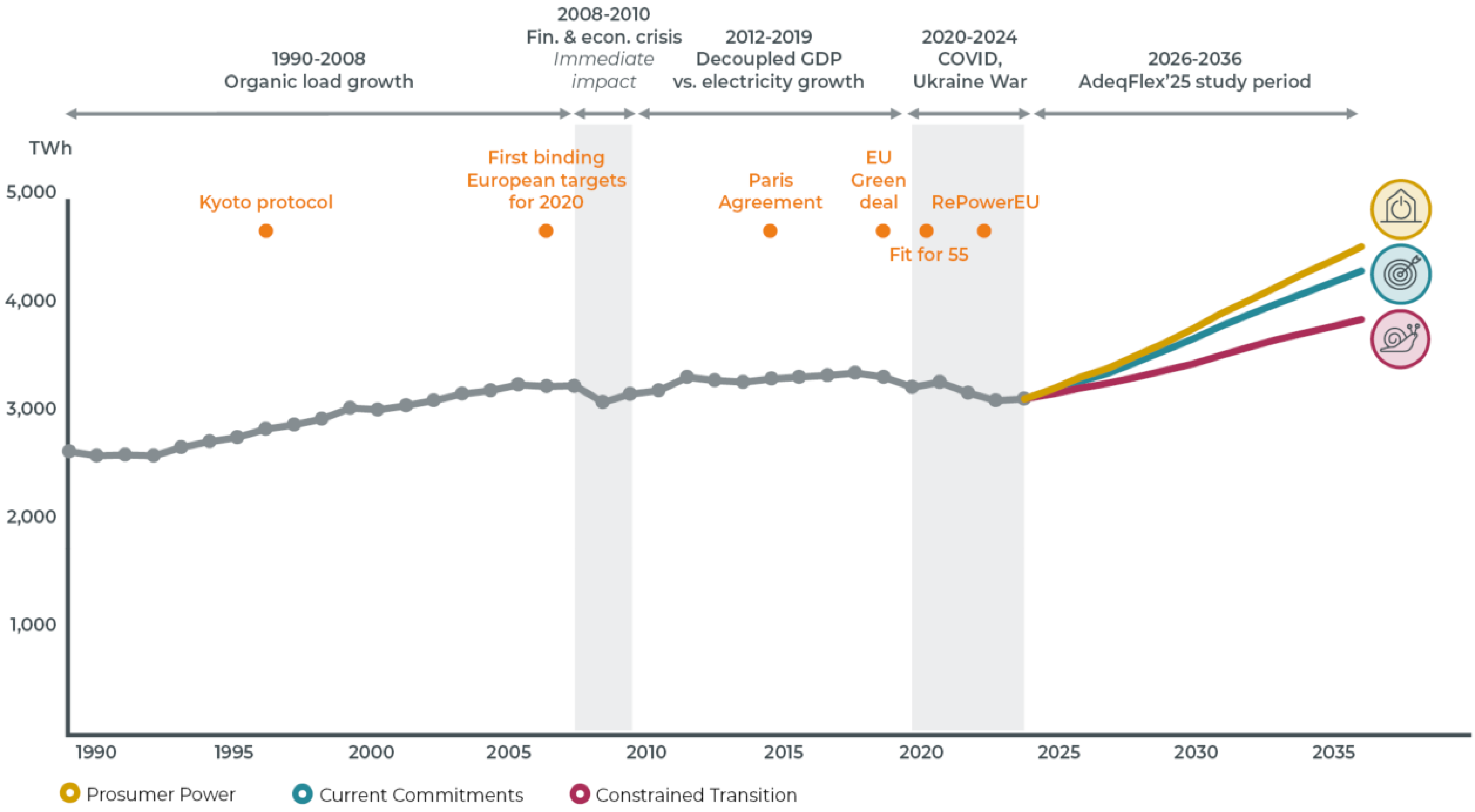


[Capacity Remuneration Mechanism]: all information including calibration reports, rules and process

Thank you

Contact: rafael.feitokiczak@elia.be

Electricity demand is expected to grow in all European countries

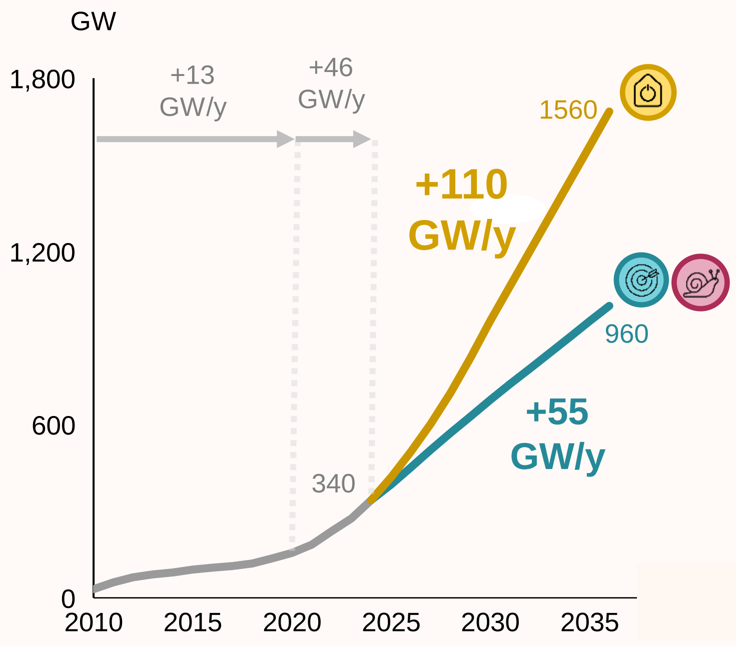


Normalised electricity demand excluding electrolysis for EU27+NO+UK+CH.
Source historical data: EUROSTAT normalised data.

Europe has massive RES ambitions

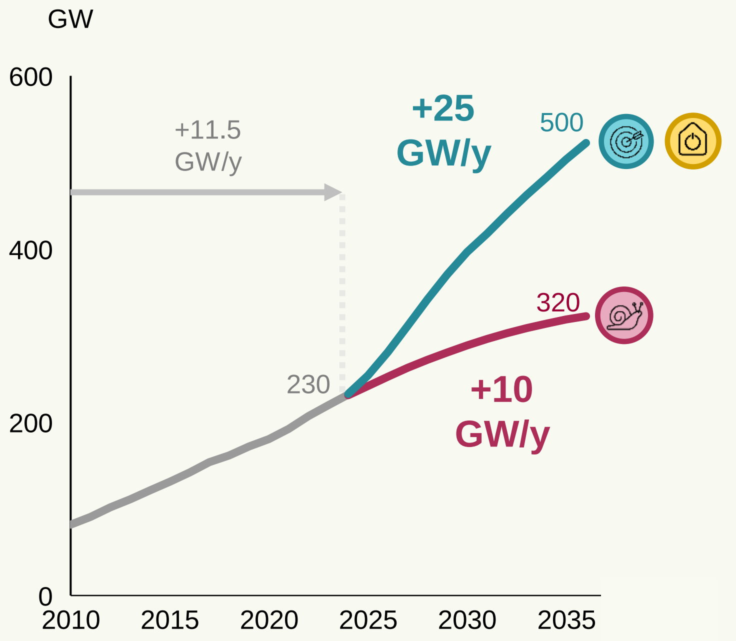
Solar

1000 – 1500 GW by 2035



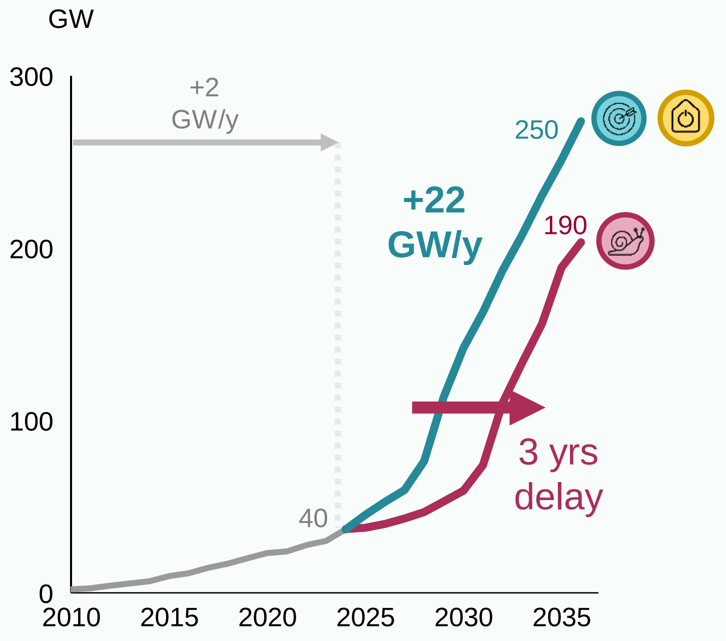
Onshore wind

320 – 500 GW by 2035

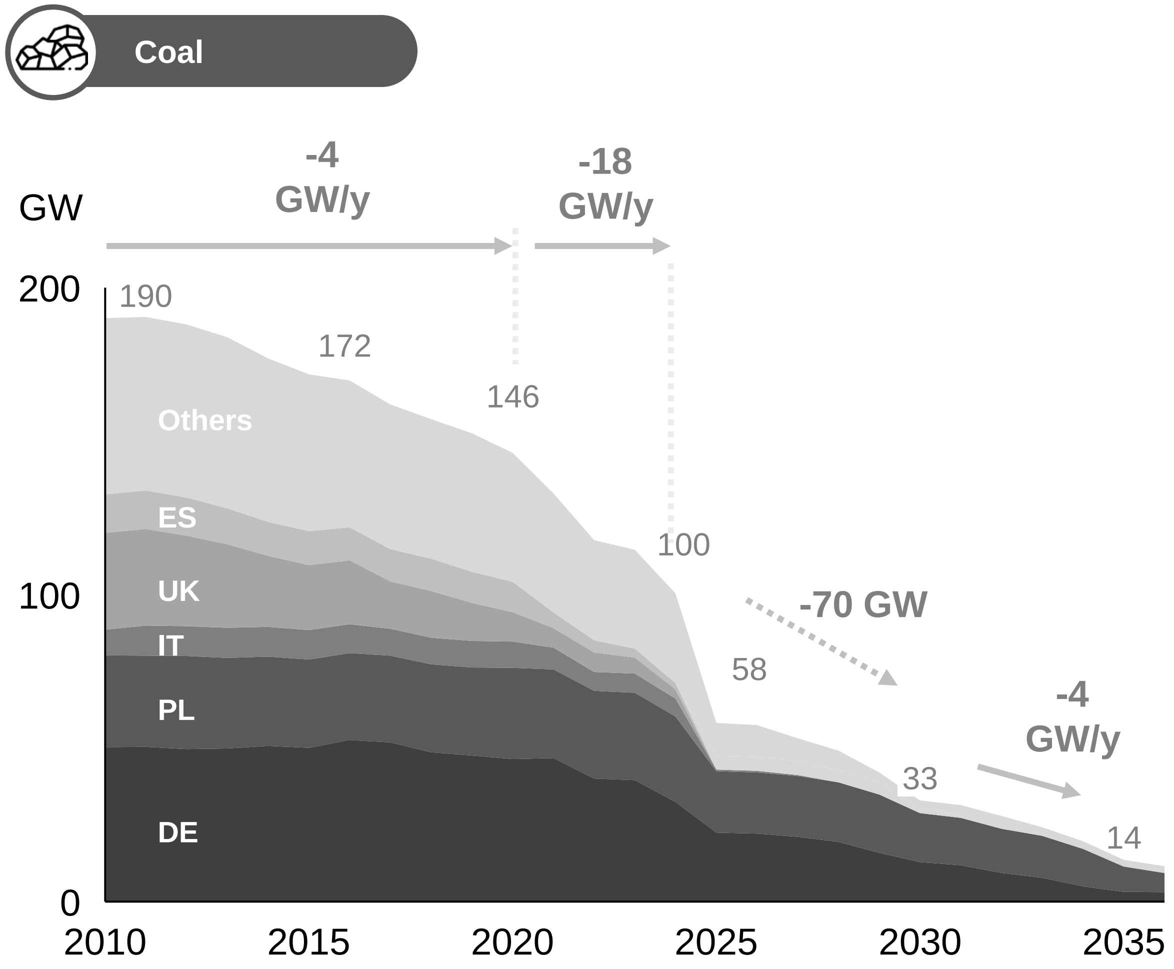


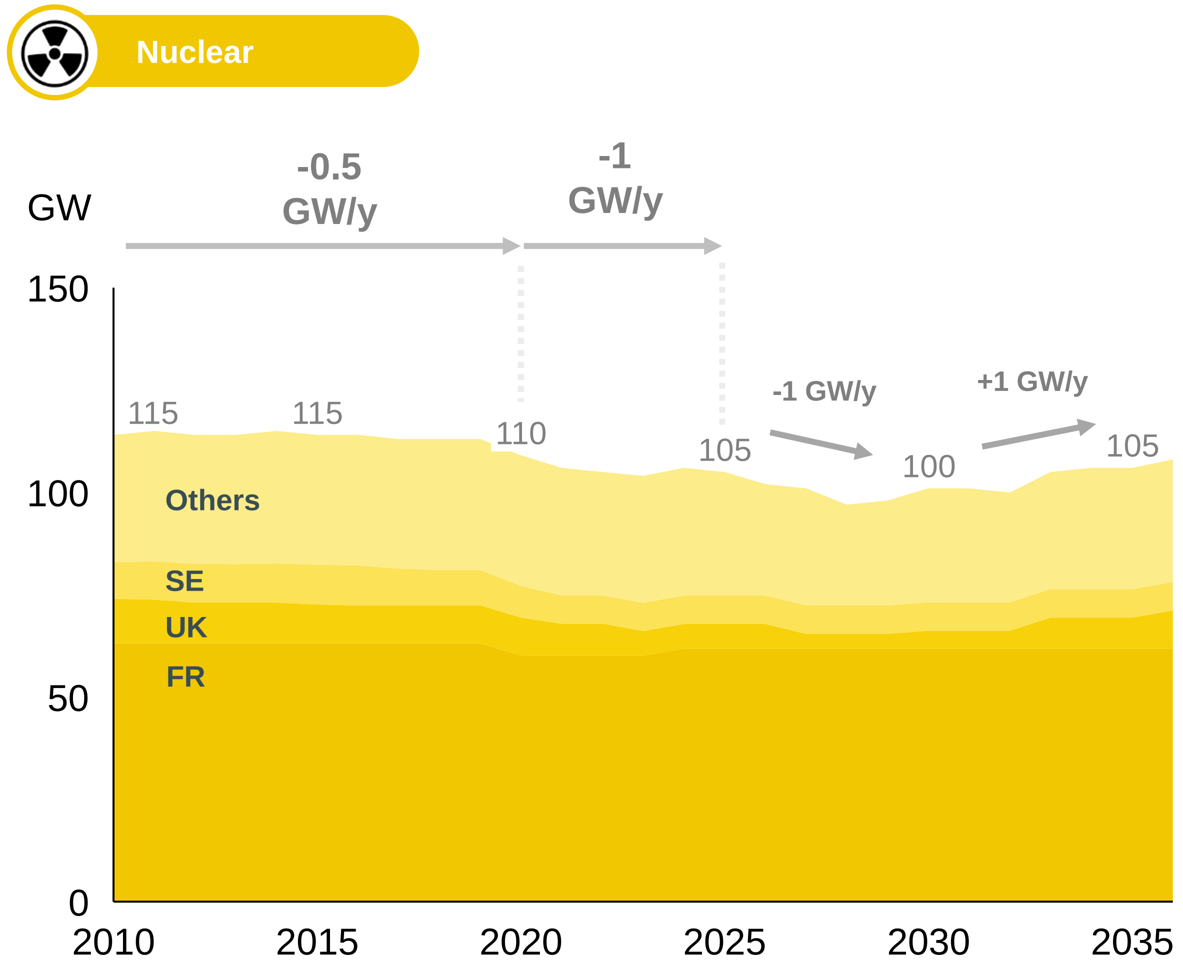
Offshore wind

190 – 250 GW by 2035



While coal capacity is expected to drastically decrease with -70 GW by 2030, nuclear capacity stabilizes





Adequacy & Flexibility study 2026-36

The economic dispatch methodology used is in line with the ERAA methodology. Hourly simulations are performed on several hundreds of ‘Monte-Carlo’ years.

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INPUT DATA

For each of the simulated areas

- Consumption
- Centralised thermal production facilities
- Decentralised thermal production facilities
- Renewable production
- Hydro
- Storage
- Demand flexibility
- Cross-border capacity between countries (NTC/FB)
- Power-to-X

SIMULATIONS

Hourly dispatch optimisation to minimise total costs of the system

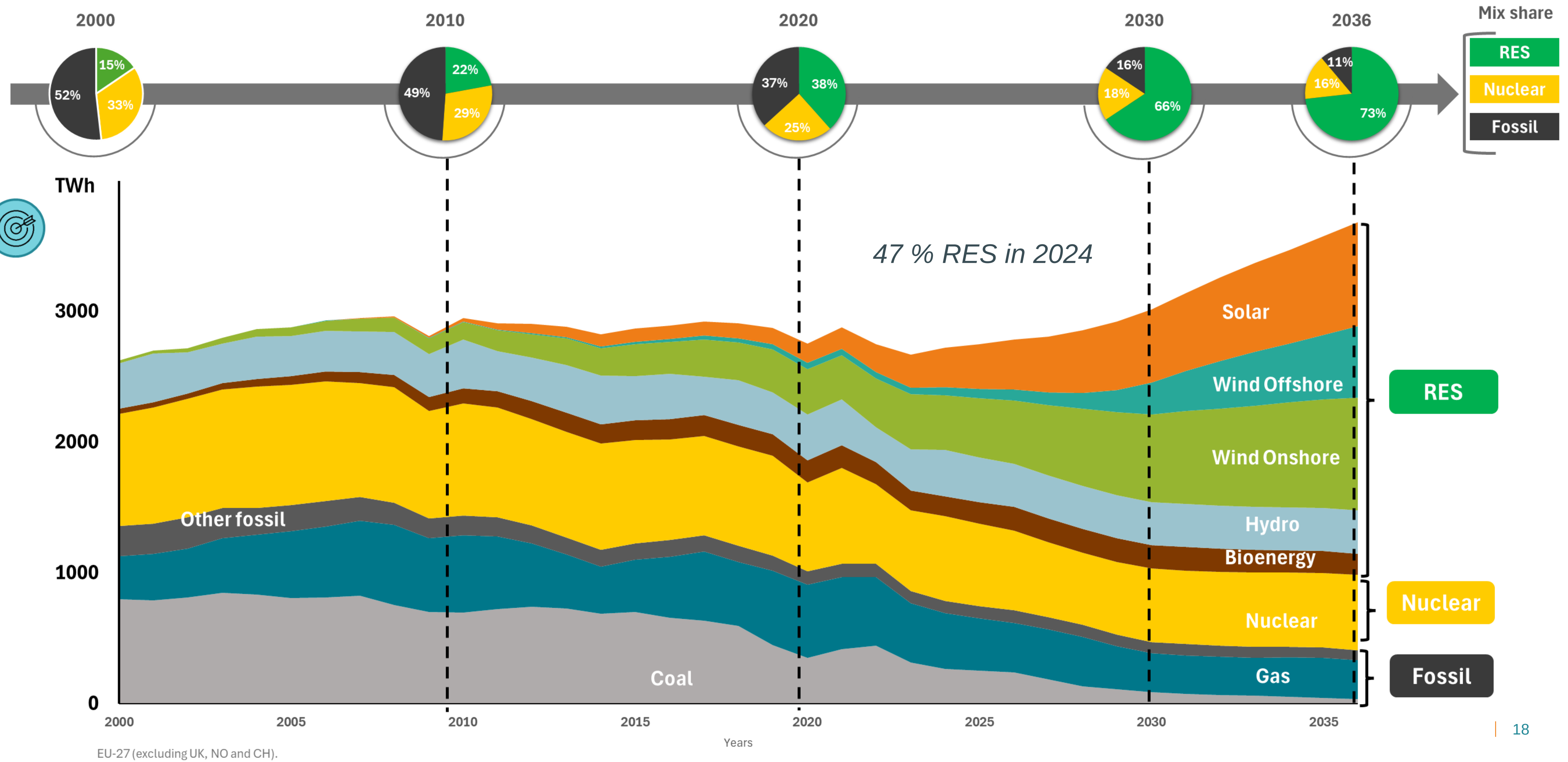
MODEL OUTPUT

- **Hourly dispatch** for all units in each area
- **Commercial exchanges** between areas
- **Hourly marginal prices**

- **Adequacy** indicators
  - LOLE, EENS
- **Economic** indicators
  - Market welfare, total costs, unit revenues, running hours
- **Sustainability** indicators
  - Emissions, RES share
- **Dispatch** indicators
  - Imports/exports, generation per type

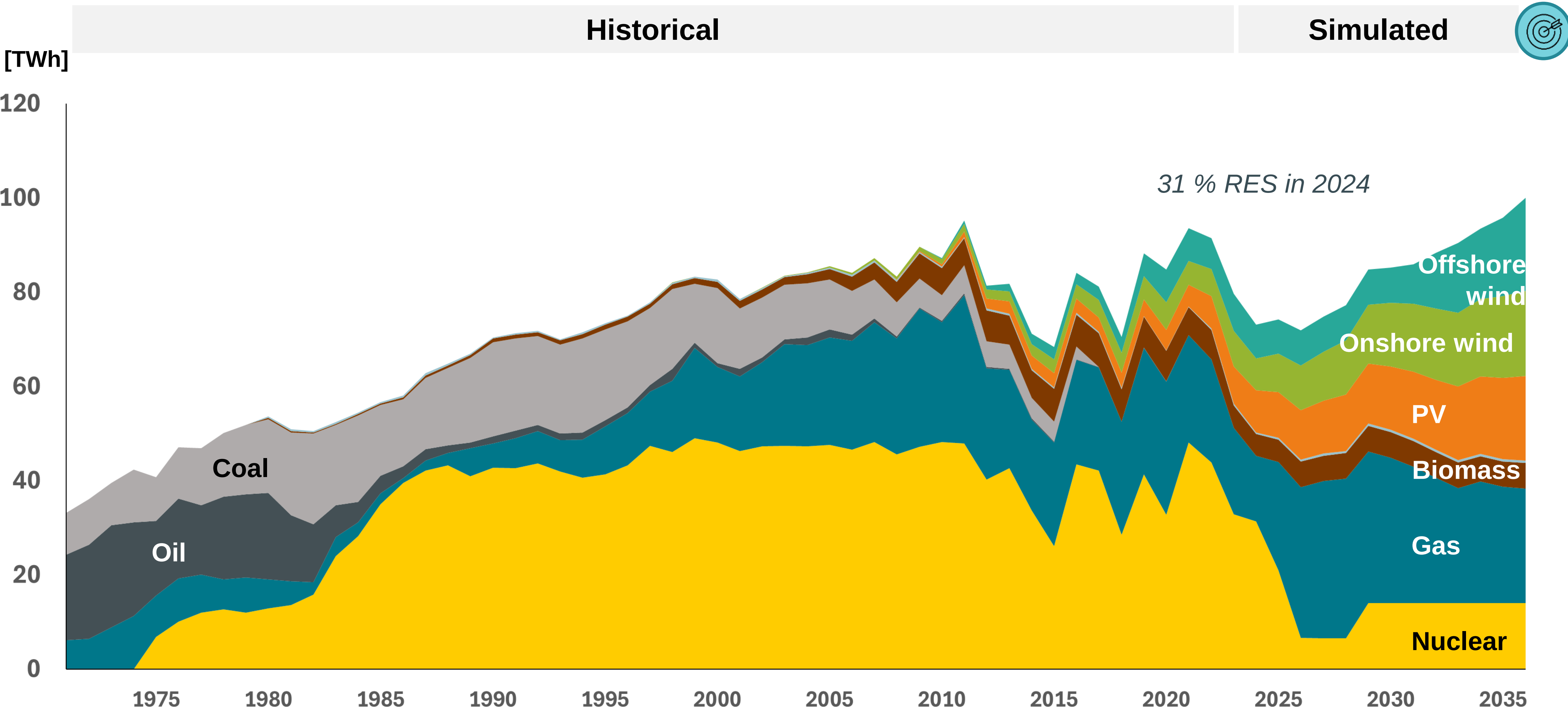
- The **economic dispatch methodology** is fully compliant with the **ERAA methodology**
- Simulation performed assuming a.o. **perfect weekly foresight** and **perfect market**.

The share of RES in the European electricity system is expected to significantly increase over time

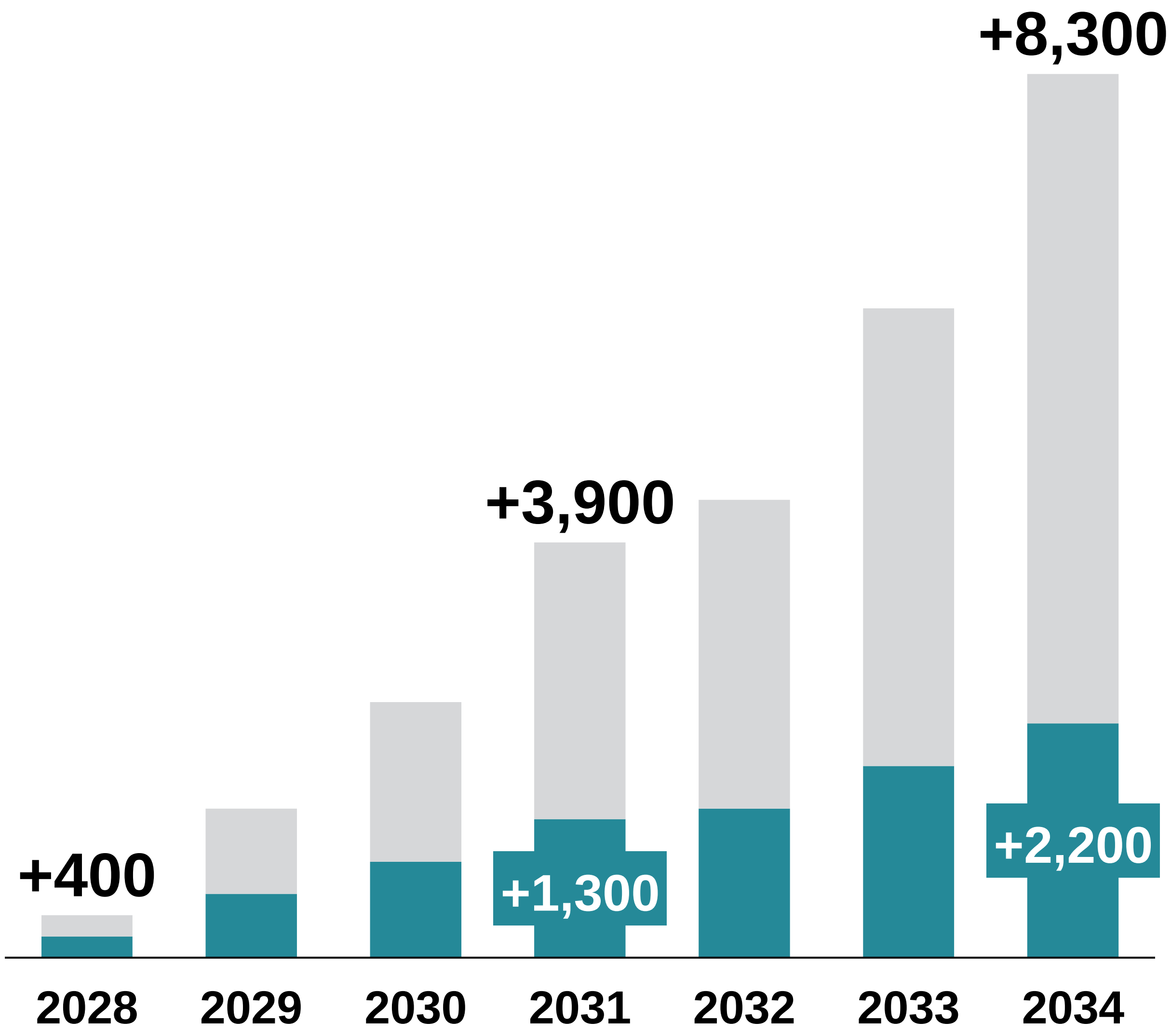


EU-27 (excluding UK, NO and CH).
Source: historical data based on EMBER. Elia simulations from EU-BASE Current Commitments scenario (2027-2037).

Belgian electricity mix: past and future



Increasing storage/flex capacities in the system lead to lower deratings



Additional 4-hour battery nominal capacity in MW that would be required to fill the entire GAP in EU-SAFE-CC

Effective contribution limited to 25% when adding an additional 8,300 MW

GAP identified in the EU-SAFE-CC

Adequacy & Flexibility study 2026-36

Scenarios with the highest degree of electrification and RES uptake achieves the biggest reductions in fossil fuel demand, expenditure and emissions

Comparison of different metrics for the different scenarios in the year 2036

2036	RES-e share	Net electricity imports	Fossil fuel reduction *Vs. 2024*	Fossil fuel expenditure *Vs. 2024*	Emission reduction *Vs. 2024*
	%	TWh	TWh	Bn EUR/y	$MtCO_2$
CT	46 %	25 TWh	-54 TWh	-2,0 Bn EUR	-15 $MtCO_2$
CC	48 %	28 TWh	-69 TWh	-2,5 Bn EUR	-26 $MtCO_2$
PP	54 %	26 TWh	-91 TWh	-3,2 Bn EUR	-31 $MtCO_2$

Fossil fuel reductions, expenditure and emissions reductions only due to changes in electricity generation & consumption versus 2024
Excluding impacts of other levers: energy efficiency, sufficiency, usage of green molecules etc

Main messages

1 The transformation of the system faces flexibility and infrastructure challenges

Belgium’s electricity system is undergoing a profound transformation.

- **Renewables and storage** sites are rapidly being expanded, **electrification** is progressing across sectors, and **digital consumption** - driven by data centres - is accelerating.
- At the same time, **industries** are facing growing competitiveness pressures and delays in the development of critical infrastructure.
- However, the efficiency of this transition is hindered by the **slower**-than-expected uptake of **end-user flexibility**.

2 The CRM is essential for securing existing and new capacities, and may be complemented by structural levers

- Our adequacy assessments confirm that Belgium's **electricity system will remain reliable in the short term**, thanks in large part to the various CRM auctions which will begin to deliver capacity from 2025 onwards and the lifetime extension of nuclear units.
- From 2028 onwards, the **CRM** will continue to play a key role in the system, since it will help to retain vital ageing dispatchable capacity and support investments in new capacities.
- **Additional structural levers could be mobilised** to complement the capacity developed through the CRM. Timely decisions regarding these options would enable the Belgian system to gradually build a more diversified, resilient and decarbonised energy mix.

Adequacy & Flexibility study 2026-36

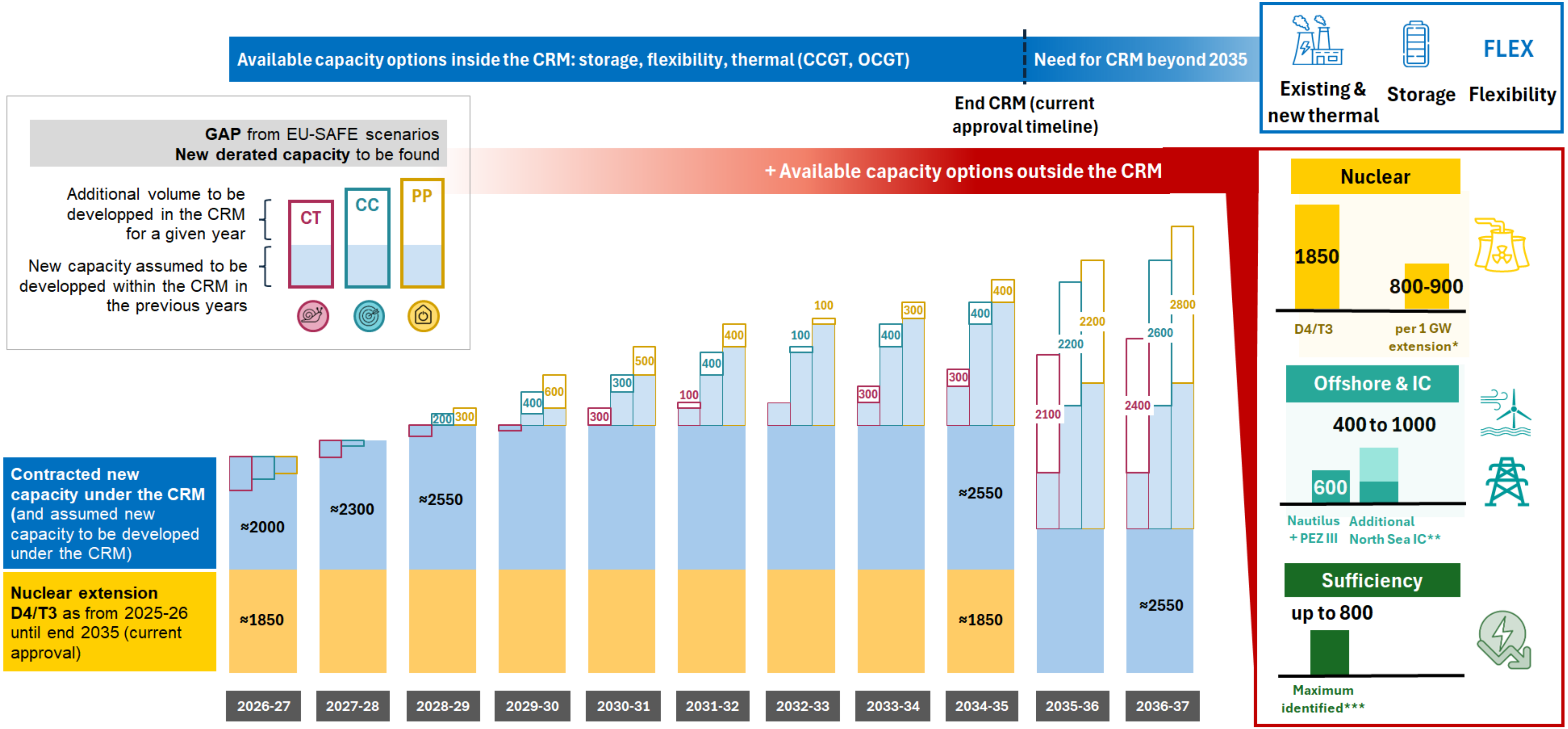
3

Flexibility across all levels is key for managing periods of oversupply and variability

- **Accelerating the rollout of system-wide flexibility** - across consumers, including the residential and industrial sectors – will be critical for ensuring that the system remains efficient, resilient and future-proof.
- As the levels of renewable generation continue to grow, periods of **oversupply** will become increasingly frequent.
- Meeting these challenges will require a **balanced combination of solutions**: the deployment of storage solutions, increased levels of flexibility from end users, and enhanced levels of flexibility from (decentralized) renewable energy sources themselves.
- By **unlocking** the end-user **flexibility** the **consumer wins twice**: lower system costs and a lower electricity bill. Further market, regulatory and technical reforms are necessary to enable this

Adequacy & Flexibility study 2026-36

Annual derated GAP: Evolution and filling options



**Nuclear extension*: The effective contribution could be limited by potential redispatching measures that may be required depending on the year of extension.

***Additional North Sea IC*: contribution to adequacy will depend on the cable size, configuration and the country to which it is connected.

****Sufficiency:* Demand reduction driven by behavioral changes (e.g., temperature setpoints, vehicle size choices, modal shifts, circular economy practices), also referred to as 'sobriété' in French. The indicated value represents the maximum potential impact, assuming full implementation of all measures outlined in the study.

CT: *Constrained Transition;* ***CC***: *Current Commitments & Ambitions;* ***PP***: *Prosumer Power*

Unlocking Flexibility through Cross-Sector Links

experience from the project BeFlexible

20 November 2025

BeFlexible EU

@BeFlexible EU

https://beflexible.eu

Presenter ***Marco Rossi***

Ricerca sul Sistema Energetico – Milan (ITALY)

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them

Renewables Grid Initiative

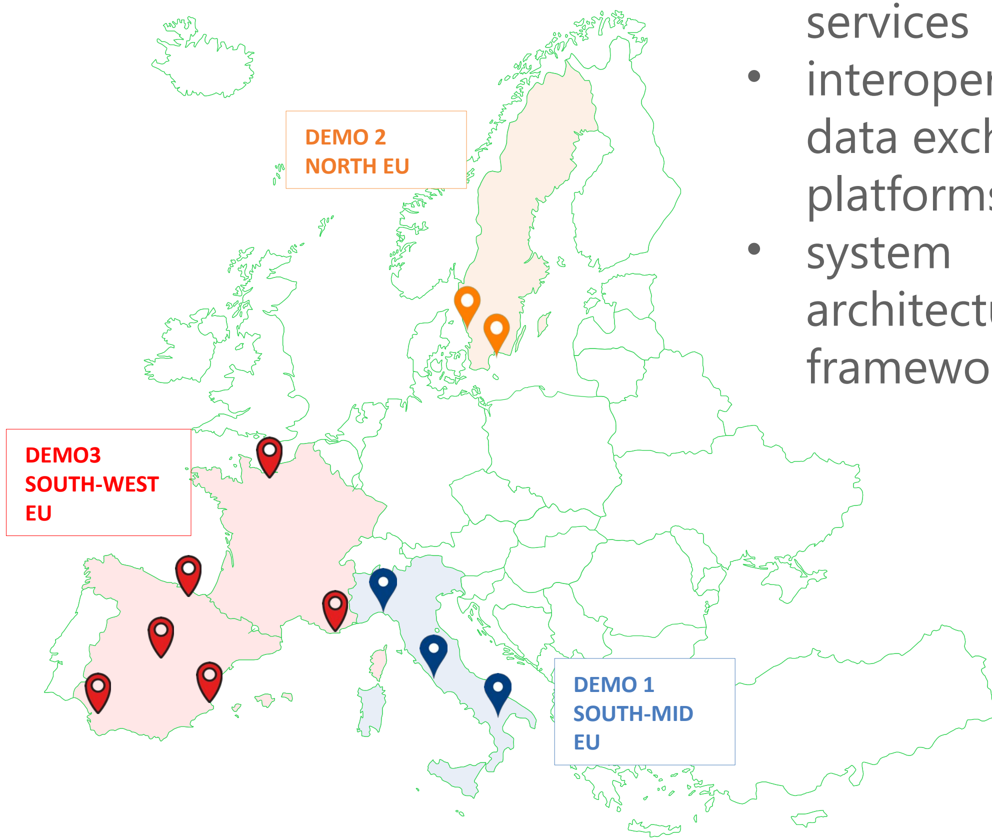
Project description

4 Years
September 2022 – August 2026

10,5M€

21 Participants

7 Countries



- cross-sectoral services
- interoperable data exchange platforms
- system architecture framework

BeFlexible project aims to increase the flexibility of the energy system, improve cooperation between Distribution and Transmission System Operators, and facilitate the participation of all energy-related stakeholders.

Project partne

BFLEXIBLE

Index

Flexibility from

1. Electric vehicles
2. Heat pumps
3. Smart water heaters
4. Retrofitted water heaters
5. Water distribution system

level of automation
and investments

Activity in progress: cost-benefit analysis

Conclusions

Flexibility from electric vehicles

Steer the charge session through the app or the car itself

overriding employees' private app/vehicle

☒ unsuitable for use in commercial sites

Oversteer the electric vehicle charger

requires physical integrations into each charger and installation of a gateway on site

☒ technically possible, but not cost-effective

Steer on fuse level in electric subcentral

gateway in the electrical distribution board, connected to power interruption relays

☑ simple and cost-effective solution

☑ optimal in the short-term, improvable in the long-term

Swedish demo

Oversteer the CPO's operation and monitoring system

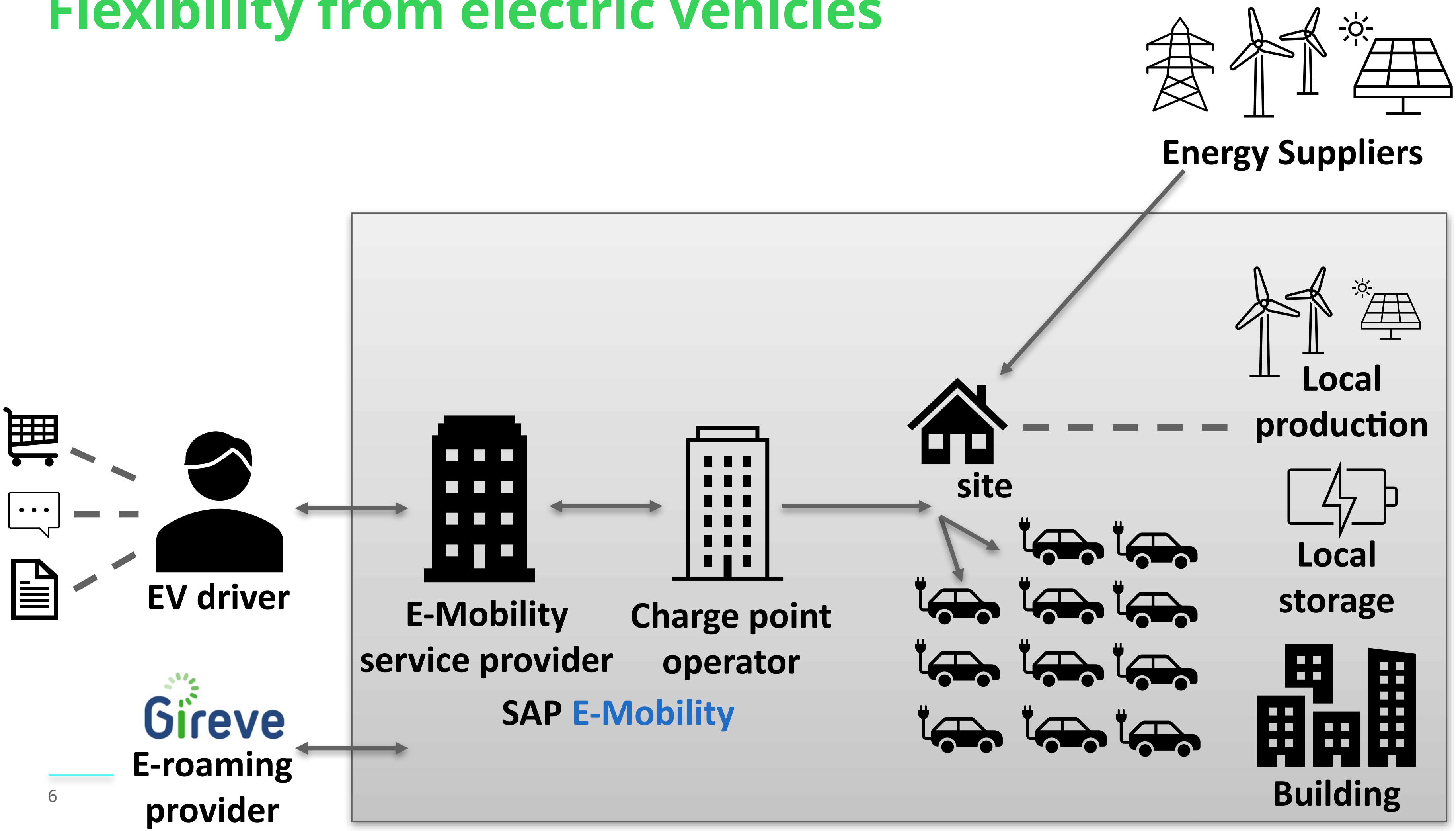
control signals sent to the CPOs' monitoring and control systems

☑ requires technical integration between aggregator and CPOs

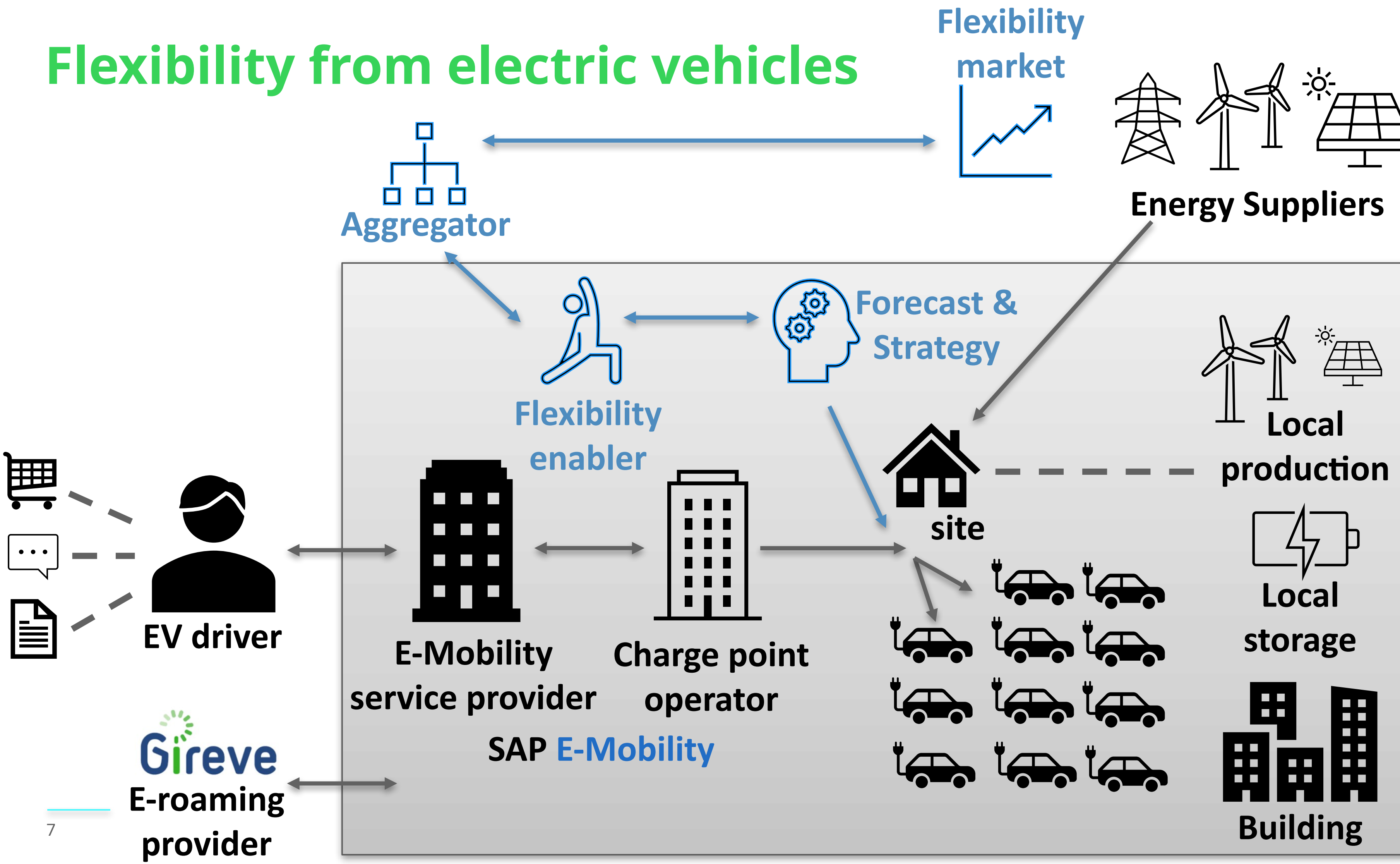
☑ optimal exploitation of vehicle flexibility potential

French demo

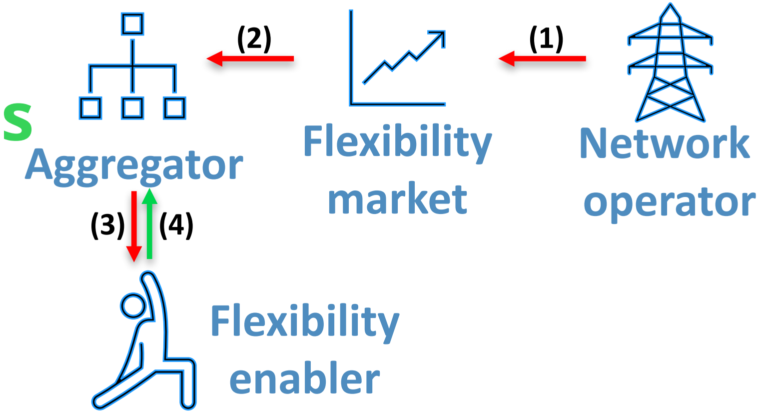
Flexibility from electric vehicles



Flexibility from electric vehicles



Flexibility from electric vehicles



New flexibility need

SAP E-Mobility <e-mobility@sap.com>
To: CRECEA, Calin

Hello Calin,
A new GDBN Flexibility Need has been created and might need you attention.

🔍 Type: SHORT_TERM
📊 Status: AGREEMENT
⏰ Start DateTime: 2025-07-14T04:00:00Z
⏳ End DateTime: 2025-07-14T16:00:00Z
📍 Grid Nodes: Alpes-Maritimes, Provence Alpes Côte d'Azu, FR
⚡ Volume: 4 GWh
⬇️ Direction: DOWN
💰 Price: 100

Go to agent chat

Flexibility Workflow Details

Flexibility Need

- **ID**: d32dda77–a242–439b–a5ab–ec0cd48d2733
- **Type**: SHORT_TERM
- **Status**: AGGREGATION
- **Start Time**: 2025-07-14 04:00:00 UTC
- **End Time**: 2025-07-14 16:00:00 UTC
- **Volume**: 4 GWh
- **Price**: 100 EUR
- **Grid Node**: Alpes-Maritimes, Provence Alpes Côte d'Azu, FR

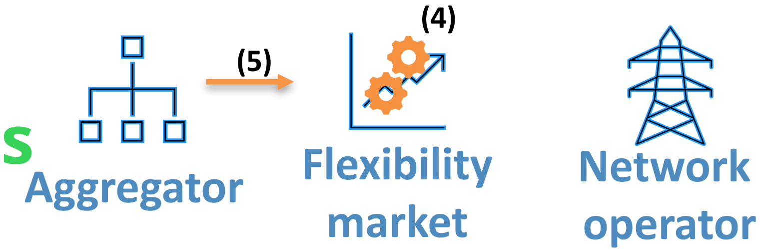
Bid Proposals

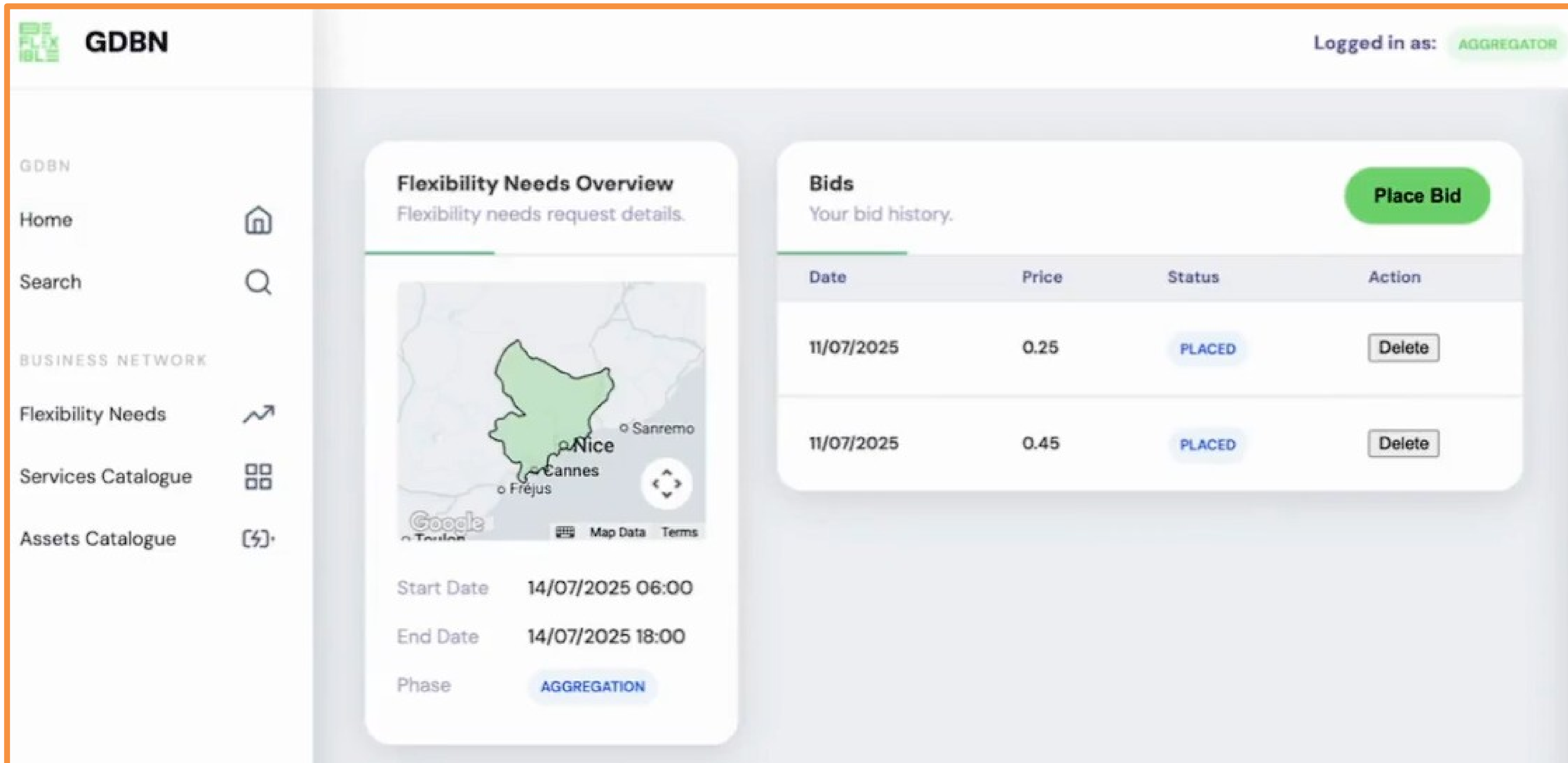
Proposals

Quantity (KWh)	Price (EUR)	Site Area Name	Start Time	End Time	Status
48,053	0.25	Mougins North	2025-07-14 04:00:00 UTC	2025-07-14 16:00:00 UTC	NEW
22,746	0.45	Mougins North	2025-07-14 05:30:00 UTC	2025-07-14 15:15:00 UTC	NEW

17:11

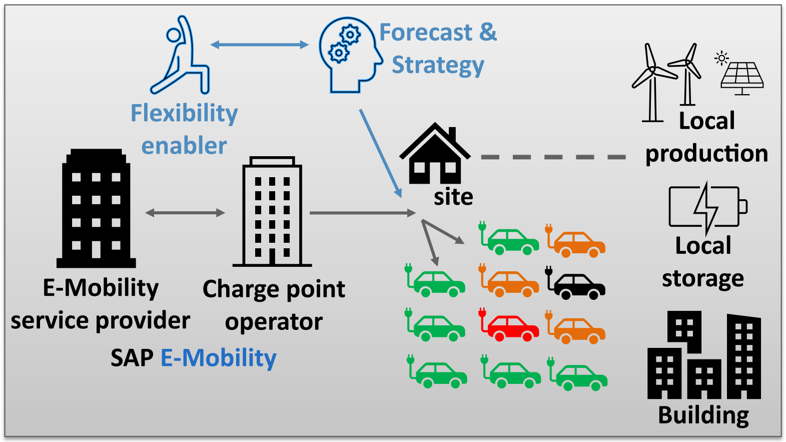
Flexibility from electric vehicles





Grid Data and Business Network

Flexibility from electric vehicles



Energy Consumption	1240.5 kWh	986.8 kWh (-20.5%)	1172.4 kWh (-5.5%)
Total Cost	€313.58	€196.64 (-37.3%)	€266.30 (-15.1%)
CO2 Emissions	138.17 kg	103.56 kg (-25.0%)	129.48 kg (-6.3%)
Average Wait Time	70.0 min	36.1 min (-48.3%)	62.3 min (-10.9%)
Average Final SoC	78.4%	73.0% (-6.9%)	77.2% (-1.6%)
SoC Achievement Rate	42.9%	30.0% (-30.0%)	40.4% (-5.8%)
Target Achievement Rate	21.7%	10.0% (-53.8%)	15.0% (-30.8%)

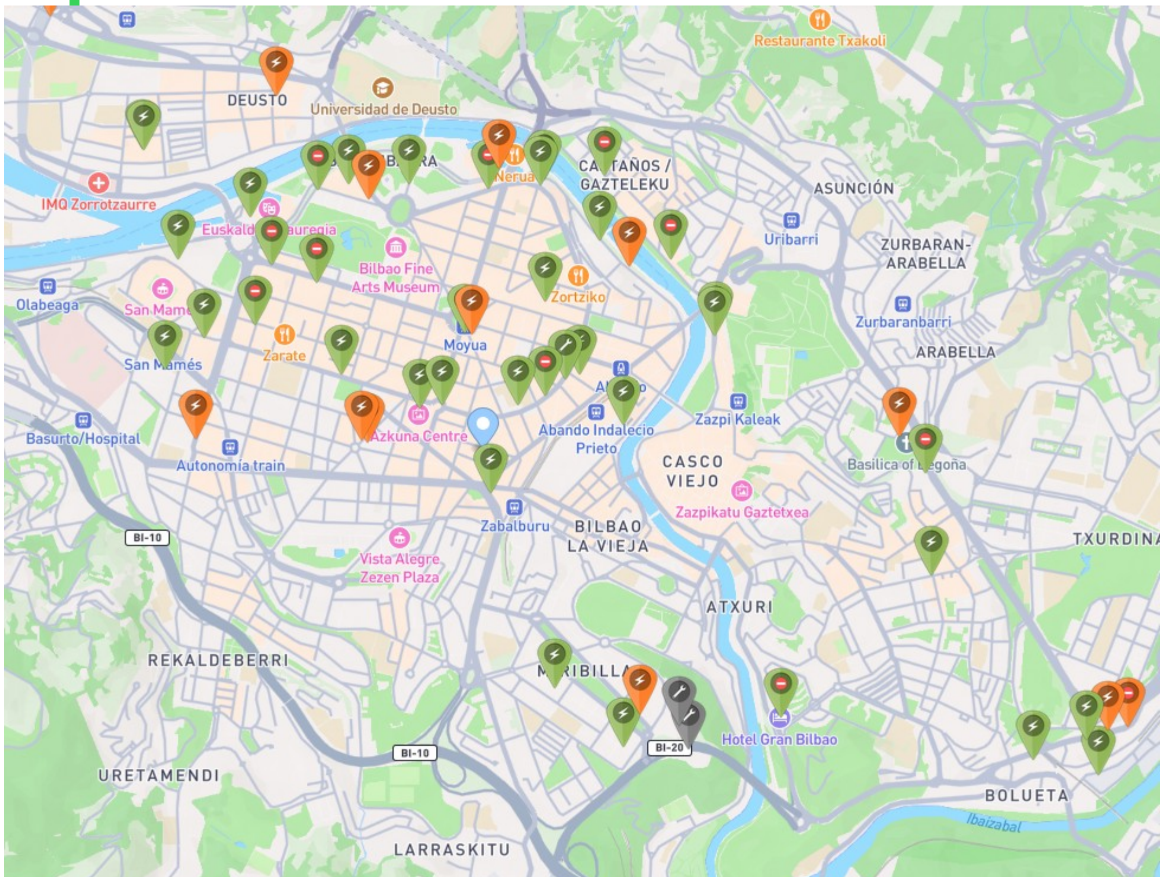
Price & CO2 Intensity Analysis (2025-07-14):

Metric	Baseline	101kW Flex (32.7% reduction)	137kW Flex (8% reduction)
Price per kWh	€0.220/kWh	€0.171/kWh (-22.2%)	€0.199/kWh (-9.5%)
CO2 per kWh	0.093 kg CO2/kWh	0.093 kg CO2/kWh (+0.0%)	0.093 kg CO2/kWh (+0.0%)

Vehicle Categories Distribution (2025-07-14):

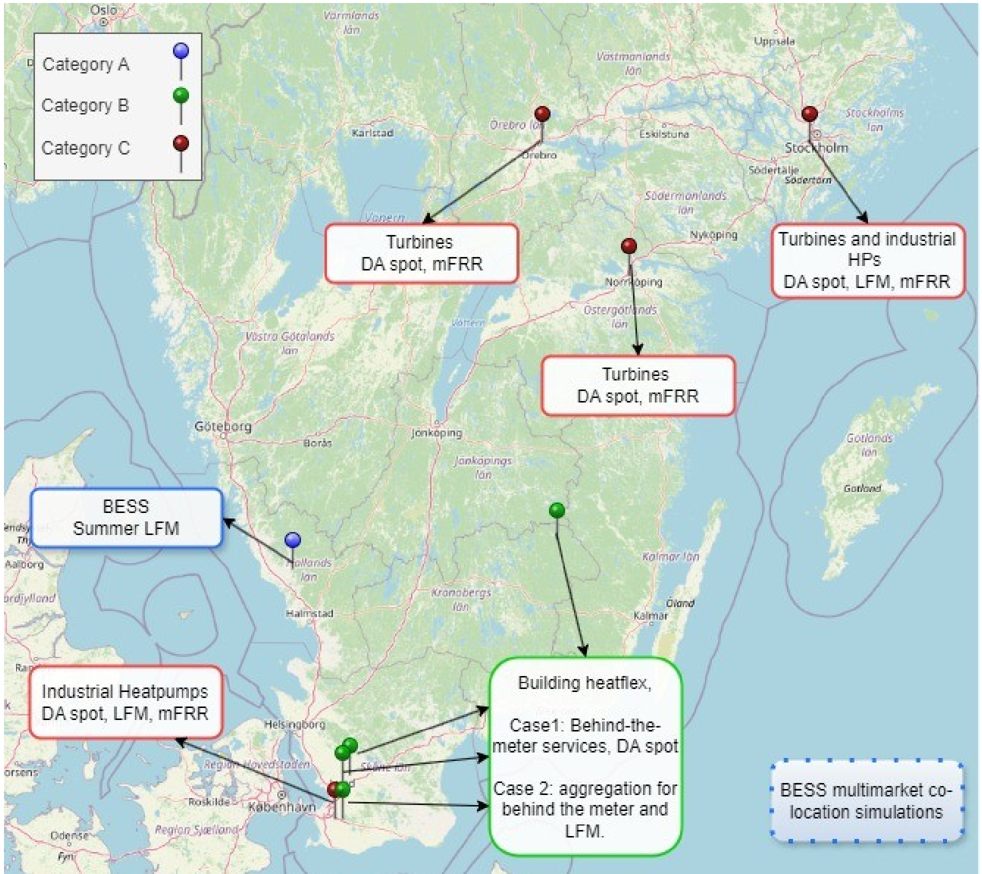
Category	Baseline	101kW Flex (32.7% reduction)	137kW Flex (8% reduction)
🟢 **GREEN (Target Reached)**	13 vehicles	6 vehicles (-7)	9 vehicles (-4)
🟠 **ORANGE (Partial Success)**	36 vehicles	42 vehicles (+6)	39 vehicles (+3)
🔴 **RED (Insufficient)**	7 vehicles	8 vehicles (+1)	8 vehicles (+1)
⚫ **BLACK (Critical/Failed)**	4 vehicles	4 vehicles (+0)	4 vehicles (+0)

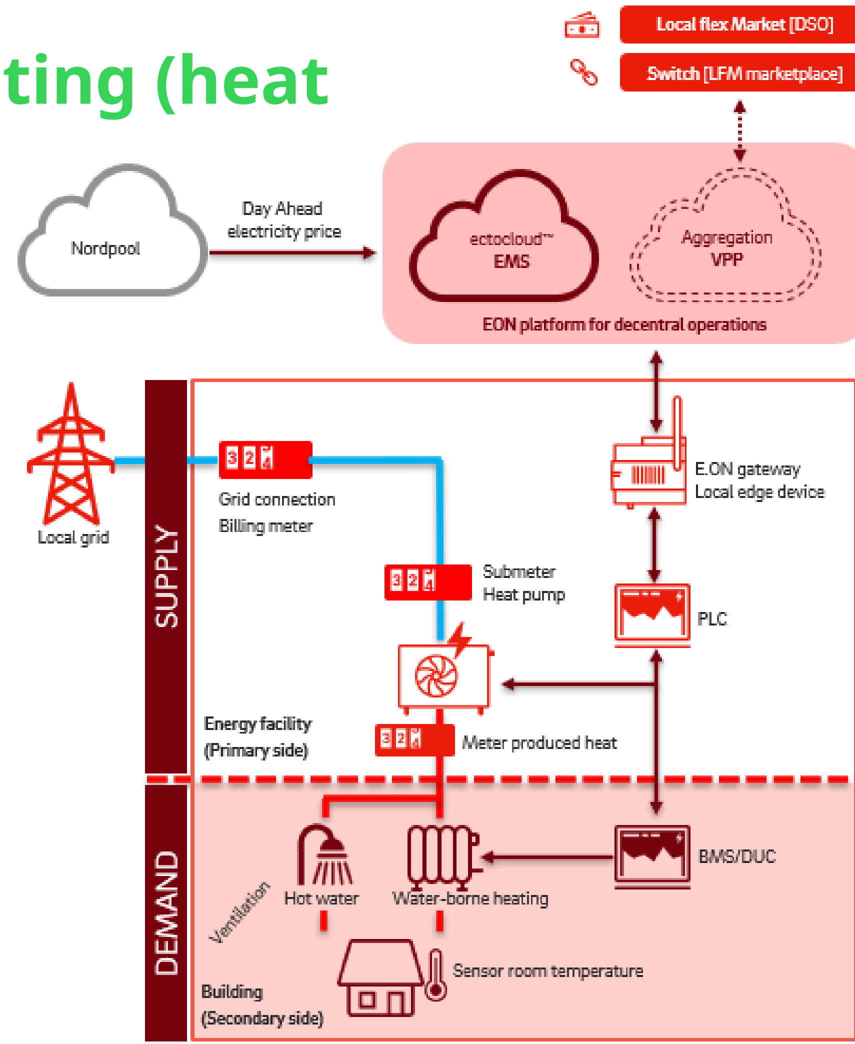
Flexibility from electric vehicles – route optimization



- Identifying and mapping the locations of available charging stations at the destination
- Monitoring the vehicle battery level and predicting energy consumption for the planned charger routing
- Checking the charging prices
- Calculating the most efficient EV charging point based on distance, prices and charging station availability
- Estimating travel and charging times to optimize the overall journey

Flexibility from district heating (heat pumps)





B FLEXIBLE

Flexibility from smart water heaters

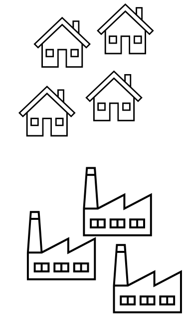
extended guarantee +
1 time replacement in
exchange of flexibility
services revenue

Curtailment operators

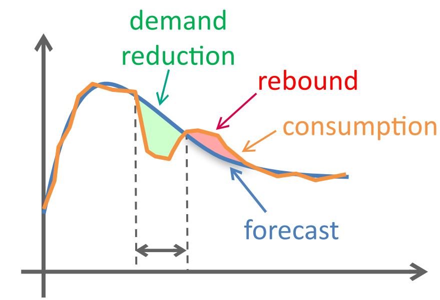
Suppliers

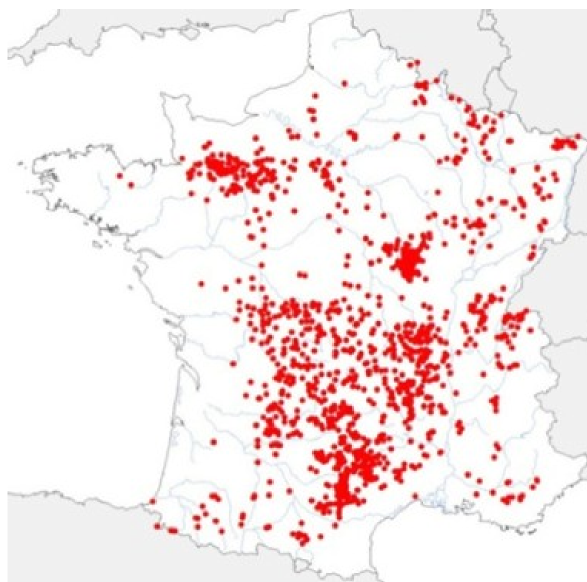
Transmission System Operator

activation request



change in consumption





850 water heaters
prequalified for
Block Exchange Notification of Demand Response (NEBEF)

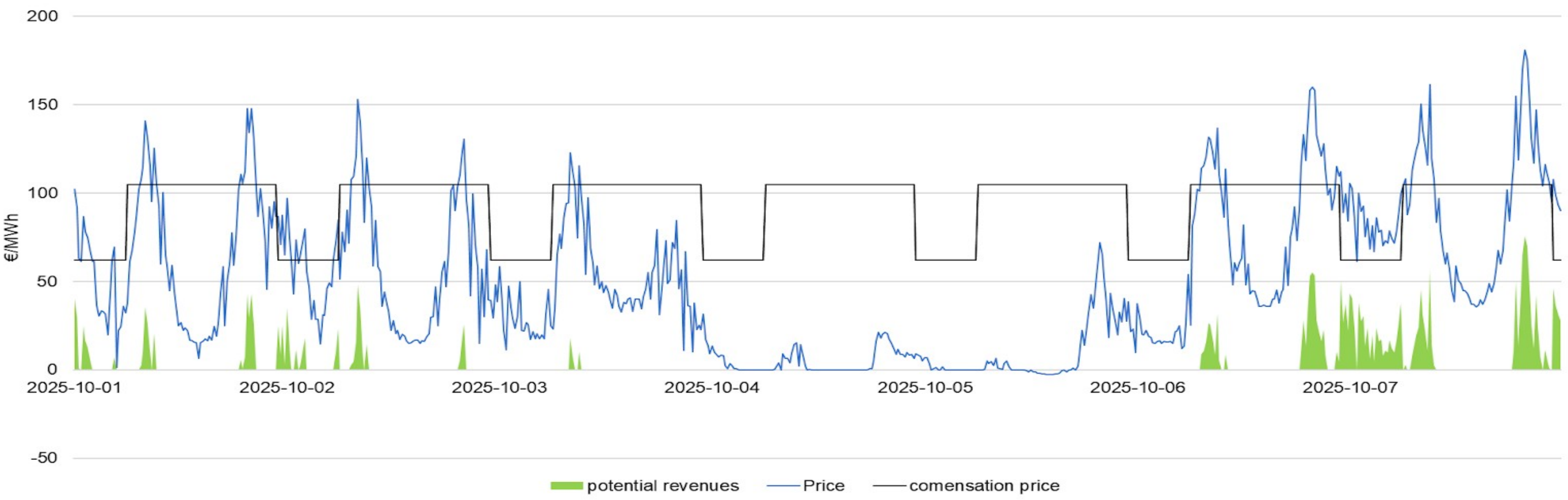
Flexibility from smart water heaters

- **NEBEF:** reduction in demand at the Day-Ahead or Intra-Day price.
- Compensation price:

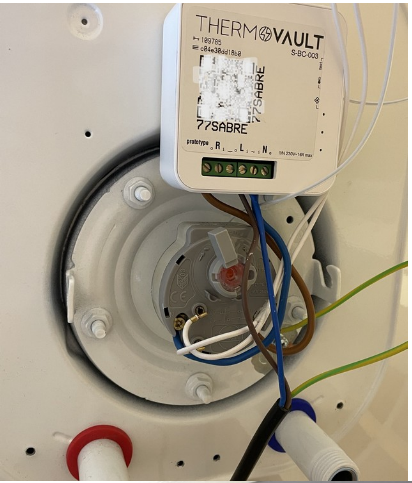
  62 €/MWh during off-peak hours and

  105 €/MWh during peak hours

  - Installed capacity: **1.3 MW**
  - Biddable capacity: **200 kWh per activation** (200 kW for 1 h or 400 kW for 30



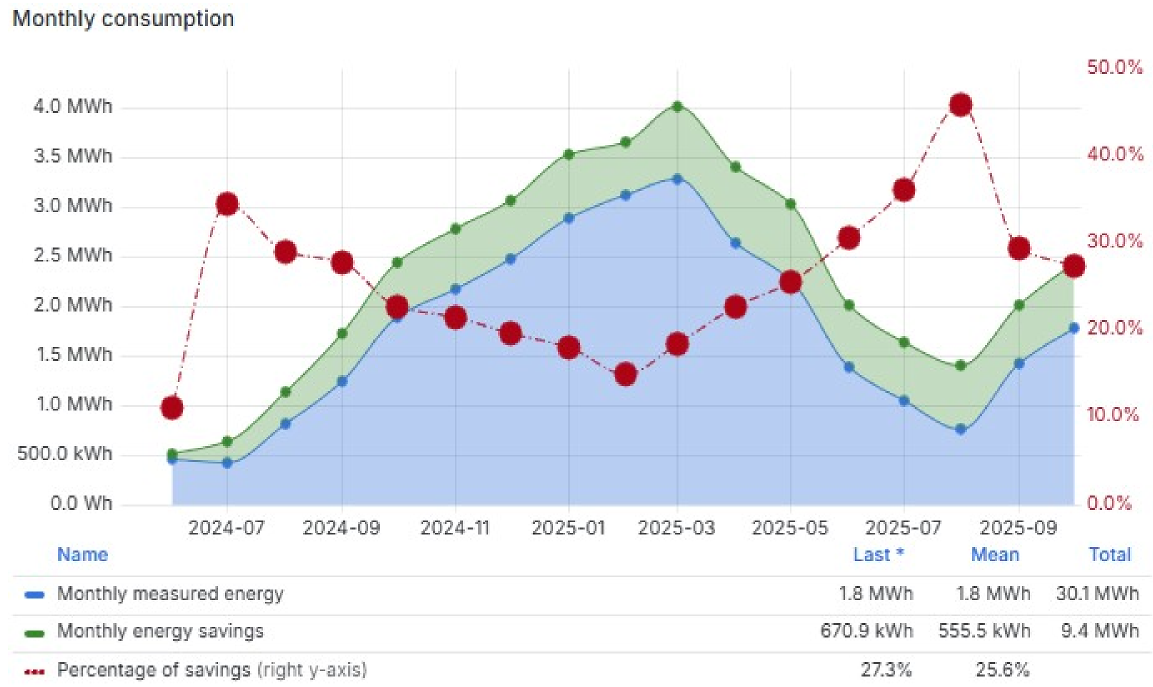
Flexibility from retrofitted water heaters



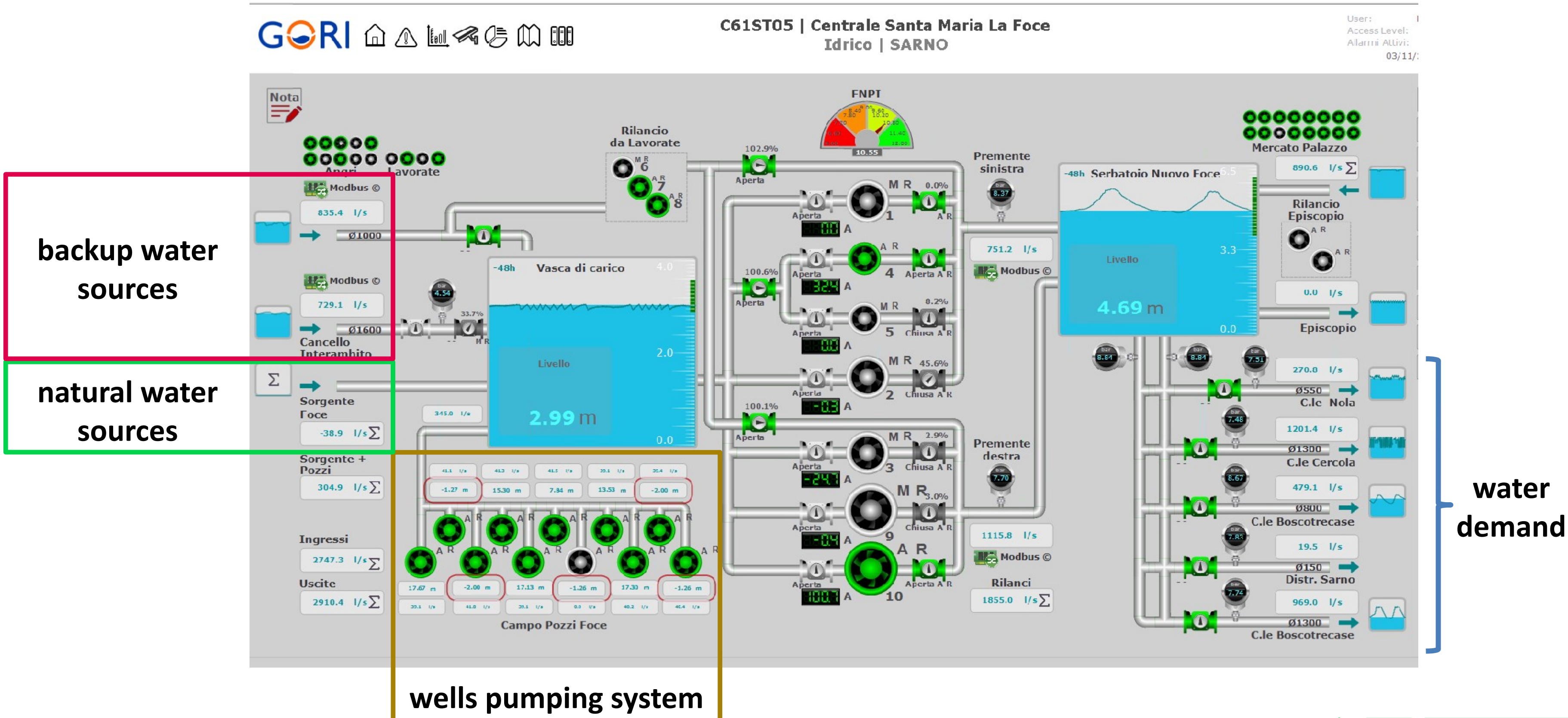
32 water heaters retrofitted in Seville area (Spain)

- consumption reduction in exchange of flexibility services revenue
- flexibility used to test local market (DSO congestion management)

Average energy savings: 25.6% (9.4 MWh)

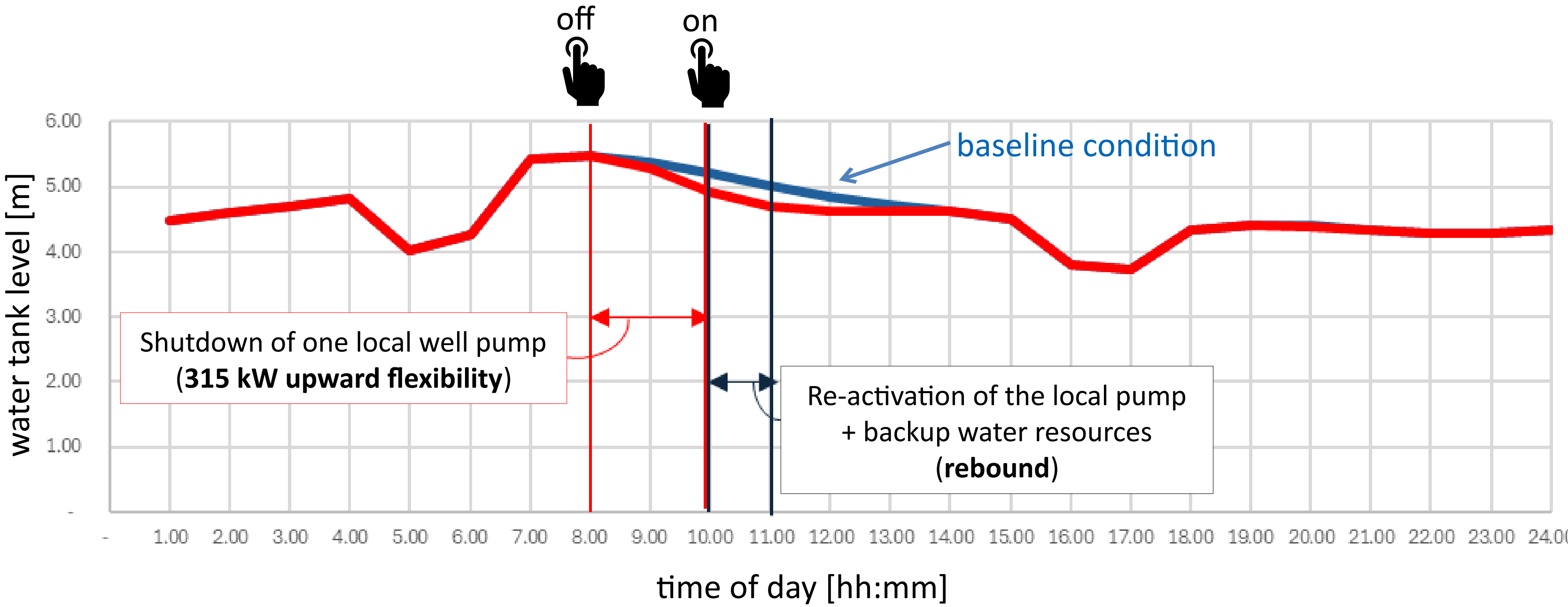


Flexibility from water distribution system



FLEXIBLE

Flexibility from water distribution system



Leverage inherent flexibility: Use existing assets like **storage tanks** and **backup water sources** to shift pumping schedules without major upgrades.

Flexibility from water distribution system

- **Minimal operational impact**: Adjust pumping times to align with grid needs, exploiting natural buffer capacity in the system.
- **No significant hardware/software investment**: Most plants can participate without installing new equipment or control systems.
- **Scalable approach**: Start with basic flexibility services; evaluate **future investments** (e.g., variable-speed drives or inverters for water pumps) to enhance efficiency and controllability.

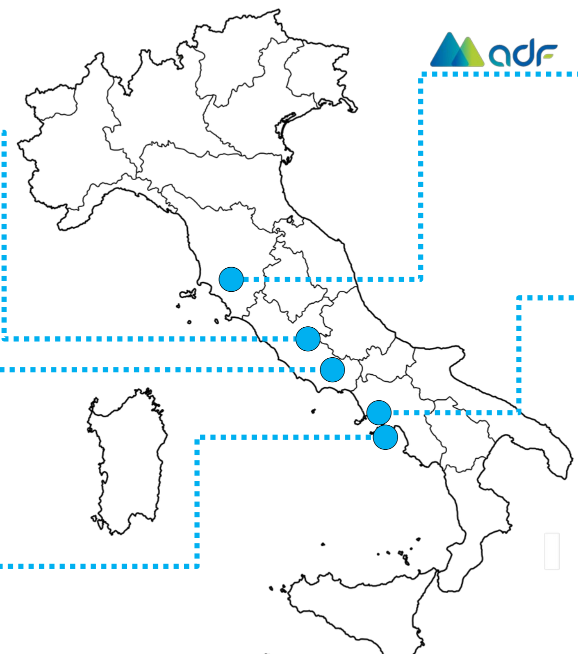
ACEA Ato 2	
Flex. volume	**0.06 MW**
Availability	**120 min**

ACEA Ato 5	
Flex. volume	**- MW***
Availability	**- min***

*** interconnection with nearby plants required to improve system flexibility**

Gori (drinkable)	
Flex. volume	**0.25 MW***
Availability	**60 min***

*** depending on the season**



Acquedotto del Fiora	
Flex. volume	**0.15 · 1.00 MW***
Availability	**150 · 450 min***

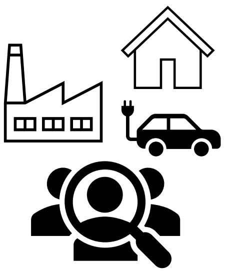
*** depending on the water flow**

Gori (sewage)	
Flex. volume	**0.25 MW**
Availability	**13 · 45 min***

*** depending on the water flow**

Activity in progress: cost-benefit analysis

Final users

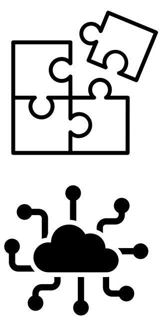


Device upgrades
Investment in smart functionalities (e.g., remote controllers, inverters, variable-speed drives) for better controllability, often cost-covered by the aggregator.

No direct cost for end-users and potential comfort improvement
Participation typically does not involve financial burden; comfort remains unaffected or improved when smart devices enhance convenience and user experience.

Operational adjustments
Minor scheduling changes that may require staff coordination.

Aggregators



Integration and automation
Cost of adding control systems or communication interfaces if required.

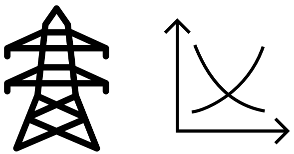
Predictable upgrade costs
Highly stable and often not affected by market price fluctuations.

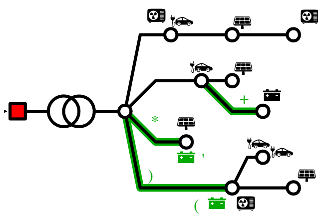
Market competitiveness
Low-price flexibility bids are highly attractive in local and global markets.

Data-driven market insights
Historical statistics allow accurate prediction of bid acceptance rates, reducing uncertainty for aggregators.

Activity in progress: cost-benefit analysis

Energy system





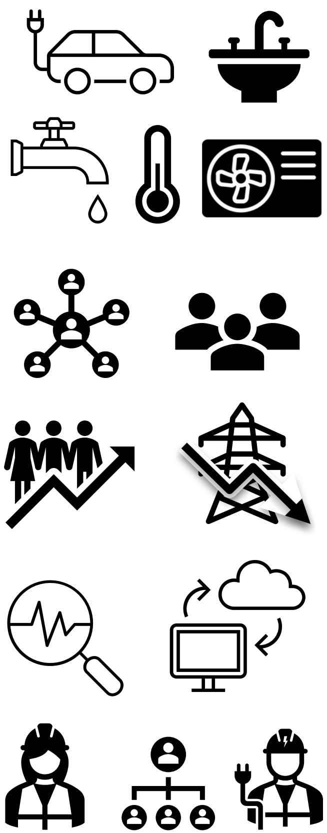
System-level savings
Flexibility reduces the need for costly network reinforcements and/or dependence on high-cost flexibility reserve.

Predictable economic advantage
Easier to forecast benefits compared to conventional grid investments, thanks to geographically detailed future energy scenarios.

Reduced planning costs
Lower cost for grid planning across all voltage levels.

Integration and automation
Cost of adding control systems or communication interfaces if required.

Conclusions



Cross-sector flexibility is achievable and brings clear benefits to the energy system.

Solutions (EVs, smart water heaters and heat pumps, water systems) require **minimal investment** and operational changes.

Participation is **easy for end-users**, often with improved comfort and no direct costs.

Flexibility services deliver system-level savings and reduce **grid reinforcement** needs and **reserve procurement** costs.

Data-driven approaches and **interoperable platforms** enhance market competitiveness and predictability.

Collaboration among all stakeholders is essential for maximizing flexibility value.

Thank you!

Empowering Grids from Planning to Practice
(19-20 November 2025)

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them

Renewables Grid Initiative | FLEXIBLE

20/11/2025

Flexibility, oversight and automation
For lower consumer bills

RGI Workshop Empowering Grids

Bram Claeys
bclaeys@raponline.org
@bramclaeys.bsky.social

RAP REGULATORY ASSISTANCE PROJECT

29 September, 2025

Making electricity cheaper: RAP's eight priority actions

Louise Sunderland, Zsuzsanna Pató, Monika Morawiecka and Bram Claeys

The future energy bill for European industry, businesses and households is an electricity bill. The benefits of electrification are manyfold: electricity can be home grown removing the increasing threat of reliance on fossil supply from third countries, electrically-powered end-uses are more efficient and electricity is decarbonising faster than any other energy carrier. Electrification is the best solution for the majority of end uses to pivot away from fossil reliance.

Lowering electricity prices is vital to improve competitiveness of Europe's electrified economy, increase affordability for many Europeans and unlock the benefits of electrification at the fastest possible pace.

Figure 1: The future energy bill is (primarily) an electricity bill

https://www.raponline.org/knowledge-center/making-electricity-cheaper-8-priority-actions/

RAP REGULATORY ASSISTANCE PROJECT | BEYOND FOSSIL FUELS

October 2025

Better oversight, better foresight

Mandating Europe's energy regulators to think long-term to unlock clean investment

Bram Claeys (RAP) and Juliet Phillips (BFF)

Europe's clean energy transition depends on modern, efficient electricity grids to unlock its full potential, but outdated regulatory structures and insufficient oversight are slowing down progress. In this paper we propose two urgent reforms for national governments: **granting national energy regulators a statutory mandate focused on the energy transition and establishing independent system operators and planners (ISOPs) to oversee grid planning and operation**.

These reforms would align regulatory decisions with long-term climate goals, reduce investment barriers and improve system efficiency, paving the way for a secure, affordable and resilient energy future.

The grid: Europe's strategic asset for energy security and competitiveness

Electricity grid upgrades will be central to Europe's future energy security and competitiveness. Greater grid capacity and faster connections will accelerate electrification and the deployment of homegrown renewables, and allow Europe to reduce dependence on volatile energy imports. A more flexible and electrified industry will reap the benefits of greater efficiency and lower long-term prices, allowing the EU to lead in key clean tech markets. A great prize is in reach: robust management of the decarbonising electricity grid will result in energy abundance, energy resilience, and energy affordability.

It is clear that Europe needs to build out grid infrastructure faster, and use its existing grids more efficiently. Without action, grid connection bottlenecks will continue to delay the roll-out of renewables and the future-proofing of key industries. As highly regulated entities, Europe's grid operators need clear signals and independent oversight to ensure they are planning, investing and operating networks in a way which is fit for the future.[1] Yet, at present, many

[1] Both transmission system operators and distribution system operators.

https://www.raponline.org/blog/better-oversight-better-foresight/

EMBER | RAP

How to scale demand flexibility in Europe

Boosting demand side flexibility can lower consumer bills and provide grid stability. Ember and RAP identify the top policy actions to scale demand flexibility.

Published: 5 November 2025
Authors: Beatrice Petrovich and Bram Claeys

Demand side flexibility is when consumers adjust their electricity use in response to financial incentives. They might be offered payments or benefit from a lower rate to consume less or even feed back to the grid when electricity is in short supply and expensive, or consume more at times of excess cheap renewable energy production.

Although the EU agreed on enabling rules for demand flexibility in 2019, national implementation has been slow and barriers remain. Now, momentum is building to boost demand flexibility. The European Commission plans to approve new technical standards in early 2026 (Network Code for Demand Response) and publish guidance on remuneration of flexibility in retail contracts. Member states will set national objectives for demand flexibility and storage by January 2027.

Three policy actions to scale household and business demand flexibility in Europe

1. Prioritise smart grids and smart meter rollout: In 8 EU countries, only a minority of households have a smart meter— from just 2% in Germany to 36% in Poland — whereas in others, such as France and Spain, coverage already exceeds 90%.

- It is important to financially incentivise grid operators to procure non-wire solutions to grid congestion, such as demand flexibility, as opposed to grid expansion alone.
- Swift smart meter rollout should be a priority: either by the distribution grid operator, or using dedicated measurement devices by third-parties (often linked to specific appliances like EV-chargers or heat pumps). Both are possible since the last electricity market reform. Regulations and hardware should enable metering at the asset level.

2. Encourage time-of-use network tariffs and innovative retail offerings: The structure of the electricity bill can reward consumers for shifting electricity use to times when renewable generation is high and prices are low. New types of dynamic or static time-of-use network charges and retail offerings are gaining traction.

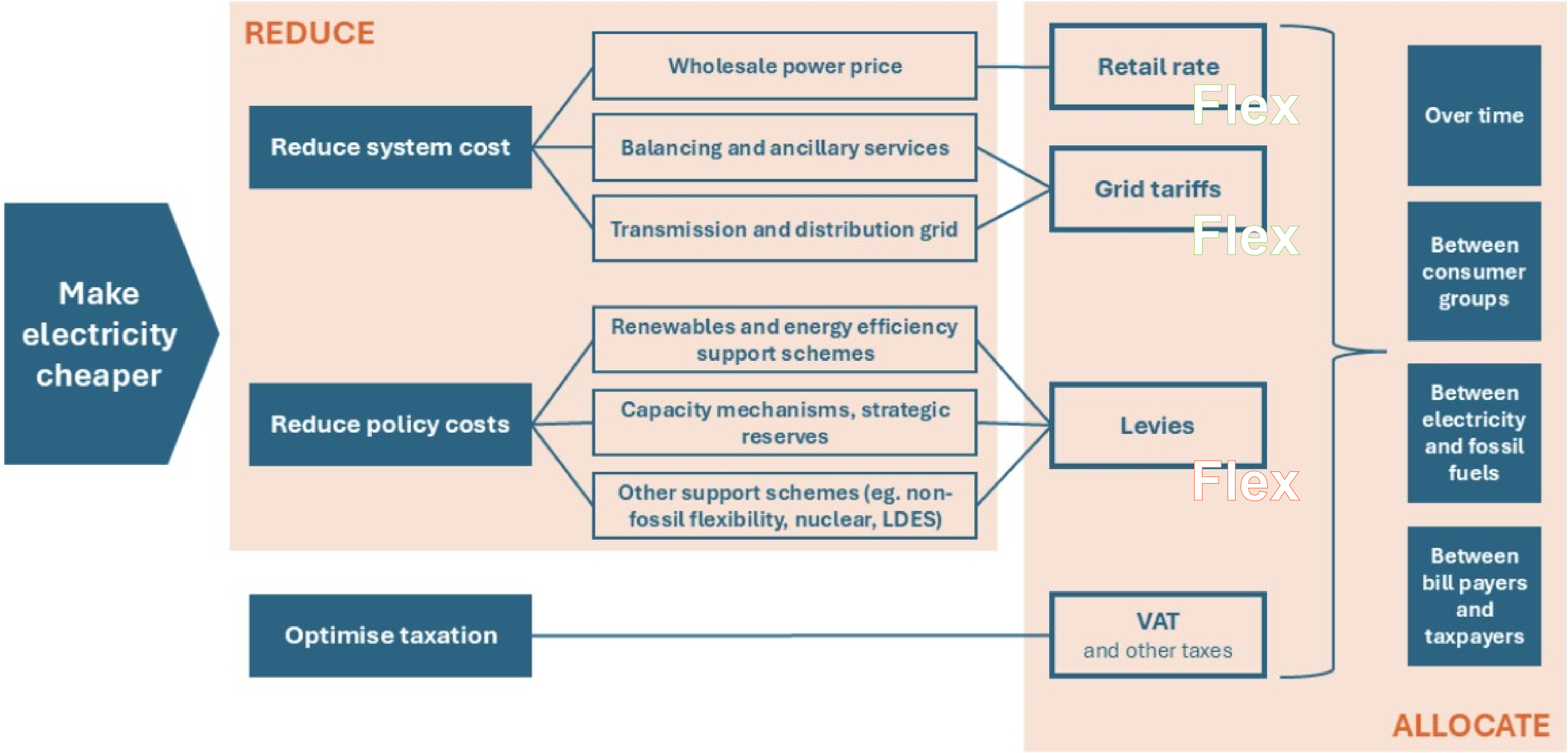
https://ember-energy.org/latest-insights/how-to-scale-demand-flexibility-in-europe/

The future energy bill is (primarily) an electricity bill

Eight levers to implement immediately to make electricity cheaper

Short term impact	Medium term impact	Long term impact
1. Reducing taxes added to electricity	3. Ramping up **demand-side flexibility** at scale	7. Locational pricing
	4. Using grids more efficiently	
2. Policy and network cost recovery that supports efficiency and flexibility	5. Double-sided contracts for difference that reflect system value	8. Efficient planning and build out of transmission grids
	6. Efficient design of capacity mechanisms	

A series of regulatory and policy decisions and market prices add up to the price paid



Levers to scale demand-side flexibility are available today

Prioritise smart grids and smart meter rollout	Encourage time-of-use network tariffs and innovative retail offerings	Eliminate barriers to automation and aggregation
• **Financially incentivize grid operators** for non-wire solutions. • Roll out smart meters or **dedicated measurement devices**.	• Update **ToU bands** to reflect daytime solar. • Shift policy costs from electricity. • Minimise disruption and complexity. Make flexibility accessible for **vulnerable households**.	• Ensure electrification can be **automated** & aggregated. • Avoid unreasonable **compensation requirements** for suppliers. • Enable DSF participation in energy, capacity, balancing.

Grid governance to unlock demand-side flexibility

Prioritise smart grids and smart meter rollout	Encourage time-of-use network tariffs and innovative retail offerings	Eliminate barriers to automation and aggregation

• **Financially incentivize grid operators** for non-wire solutions.
  • **Mandate regulators** for net zero
  • **Plan and operate** grid independently
• Roll out smart meters or **dedicated measurement devices**.
	• Update **ToU bands** to reflect daytime solar.
	• Shift policy costs from electricity.
	• Minimise disruption and complexity. Make flexibility accessible for **vulnerable households**.
		• Ensure electrification can be **automated** & aggregated.
		• Avoid unreasonable **compensation requirements** for suppliers.
		• Enable DSF participation in energy, capacity, balancing.

REGULATORY ASSISTANCE PROJECT

About RAP

Regulatory Assistance Project (RAP)® is an independent, global NGO advancing policy innovation and thought leadership within the energy community.

Learn more about our work at raponline.org

RES generation and batteries-as-a-service for system value

SolarPower Europe

solarpowereurope.org

SolarPower Europe in a nutshell

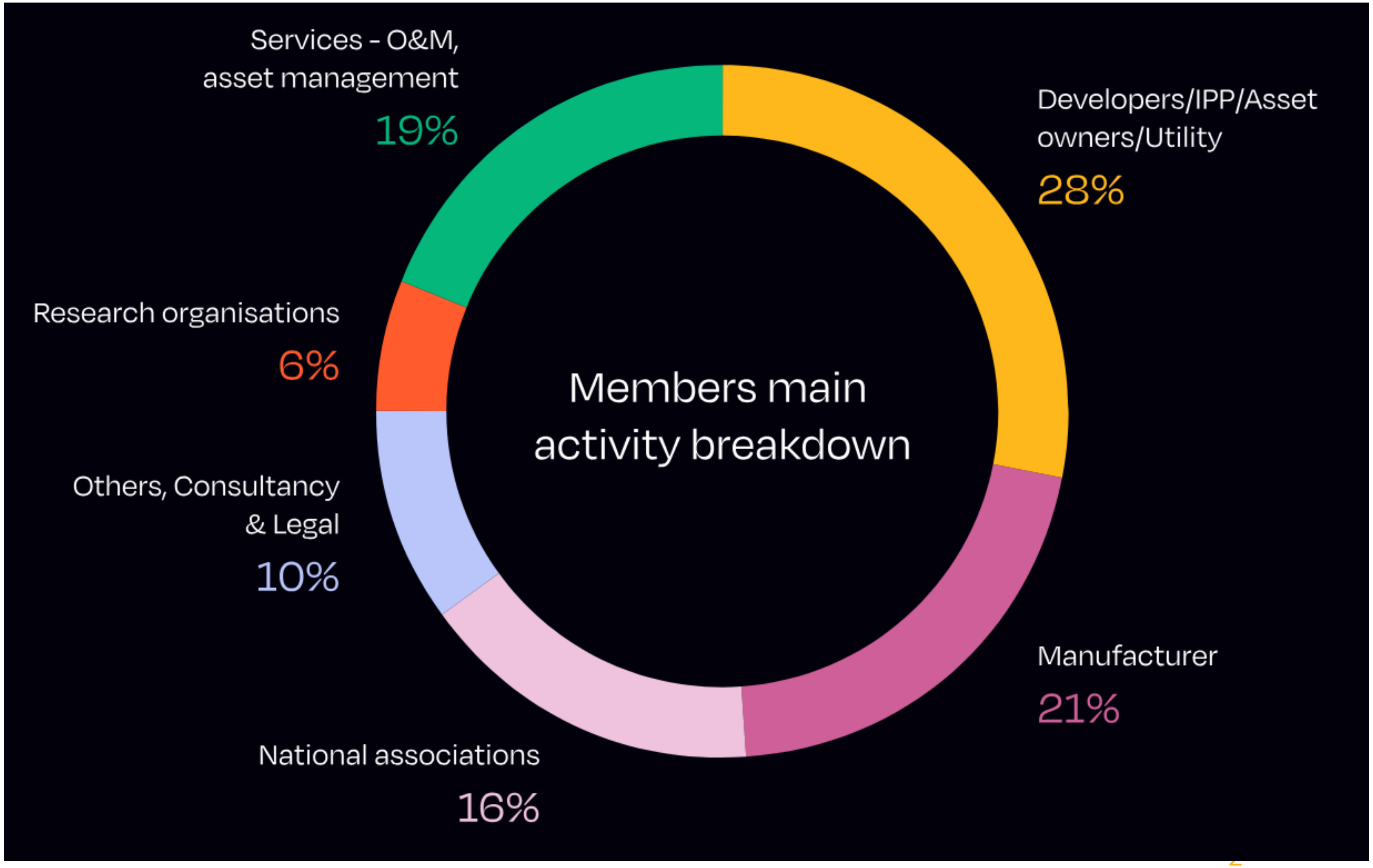
We represent the whole solar value chain

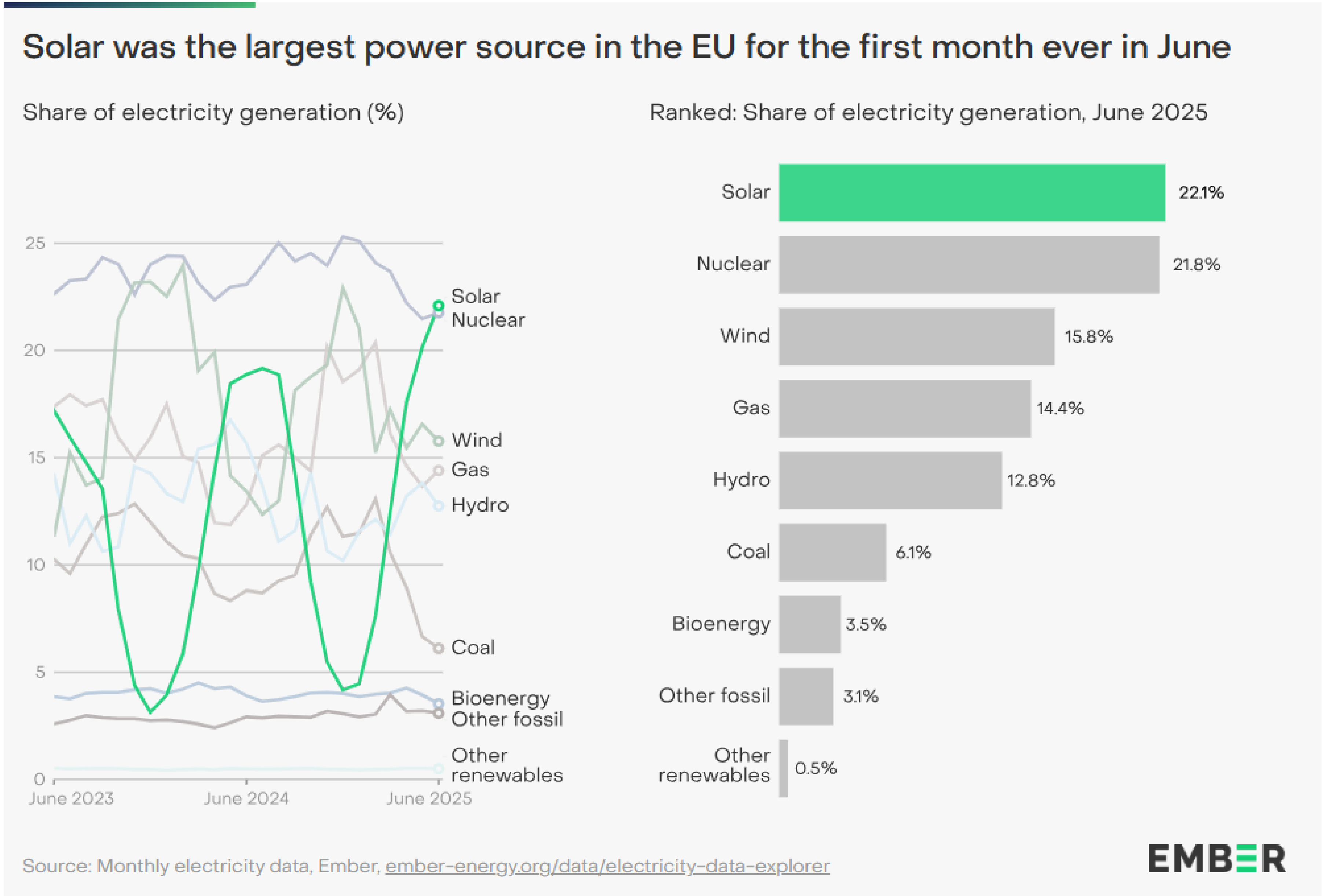
320+ organisations

90% EU headquartered

We work closely with 40+ national associations

Solar
Storage
Flexibility



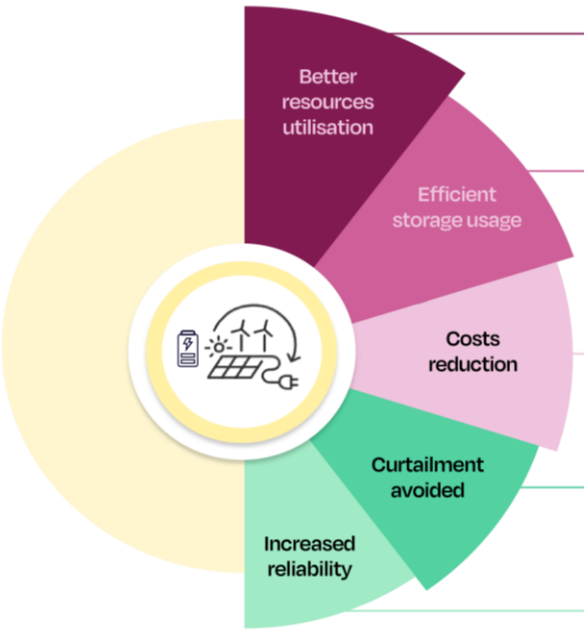


Solar generated a record 22% of EU electricity last month.

This surge, driven by heatwaves, helped ease grid pressure when it was needed most.

Benefits of hybrid PV systems & BESS

How do hybrid PV & BESS systems contribute to flexibility in the energy system?



Better resources utilisation. By combining different generation technologies, a more efficient usage of the existing resources can be achieved.

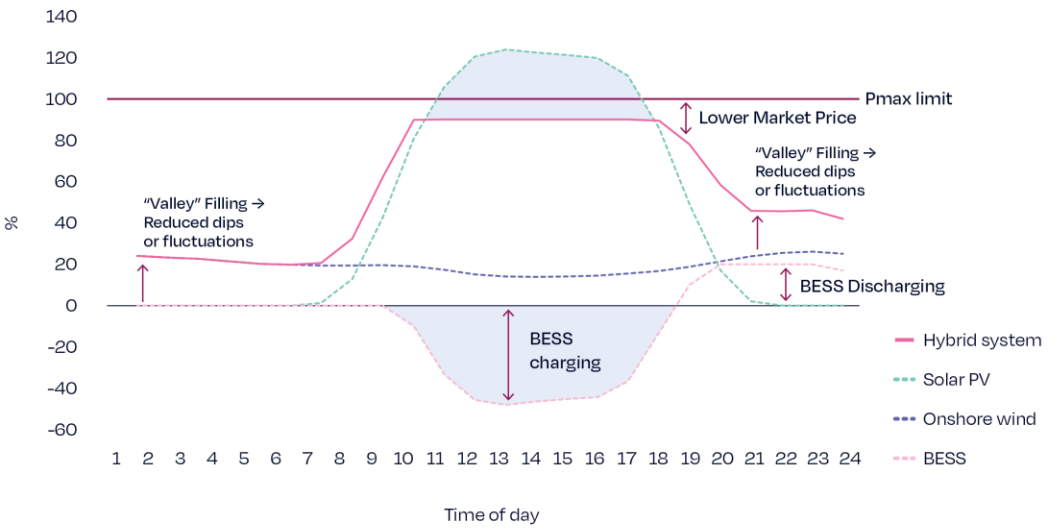
Efficient storage usage. Allowing hybrids to withdraw electricity from the grid enables an optimised operation of the system.

Costs reduction. Hybrid projects realise cost synergies by maximising existing infrastructure usage and reducing the financing costs for renewables.

Curtailment avoided. By hybridising renewables with storage, the surplus renewable output can be stored and be injected later into the grid during hours of peak demand.

Increased reliability. Combining different generation technologies and/or storage increases the reliability of the energy output.

Illustrative grid connection point usage optimisation (%)

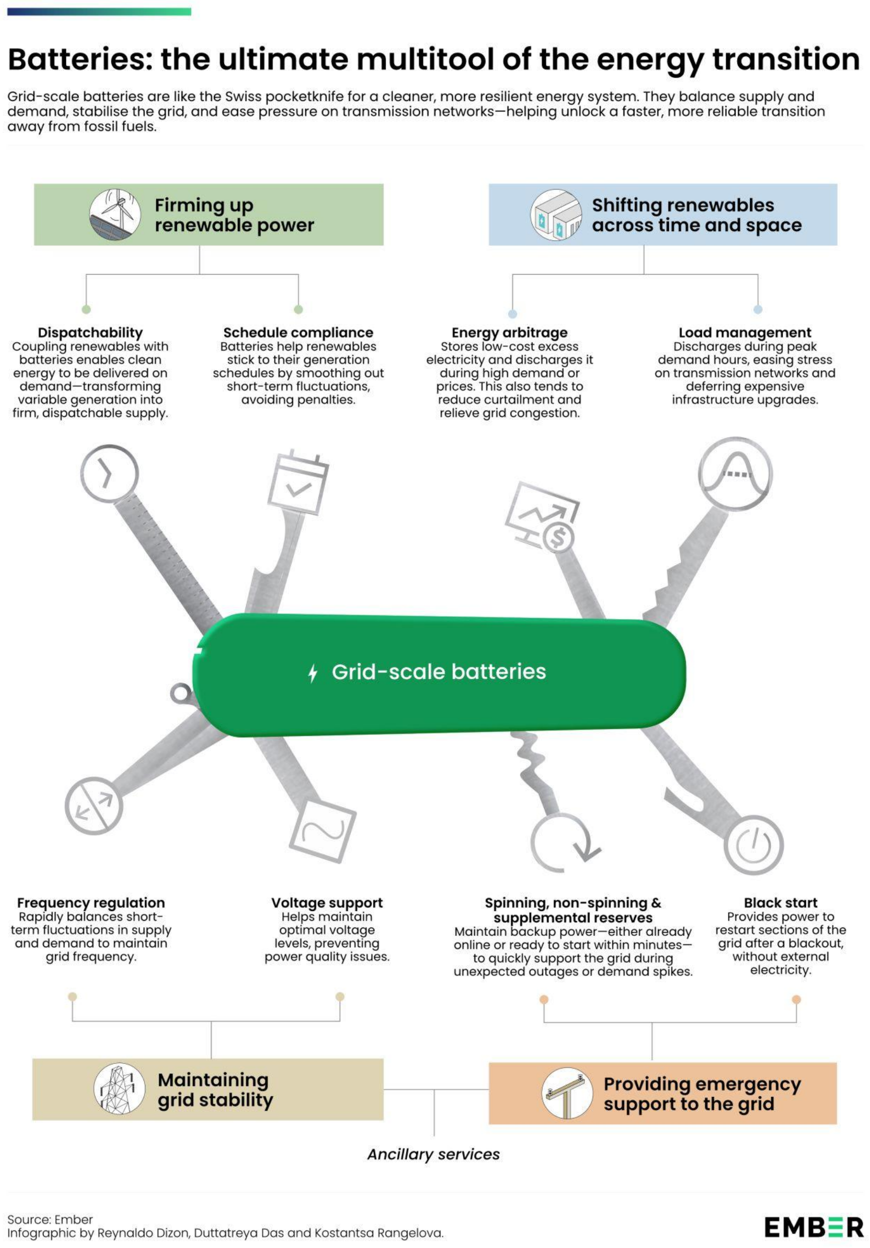


Source: AFRY and SolarPower Europe's analysis

Beyond flexibility, what function do BESS systems serve in the energy transition?

	Hydropower and fossil assets	PV-only	PV + storage	Standalone batteries
Transmission grid	Technology is commercially available	Technology is not mature	Technology is available	Technology is commercially available
Distribution grid	Technology is available			Technology is available

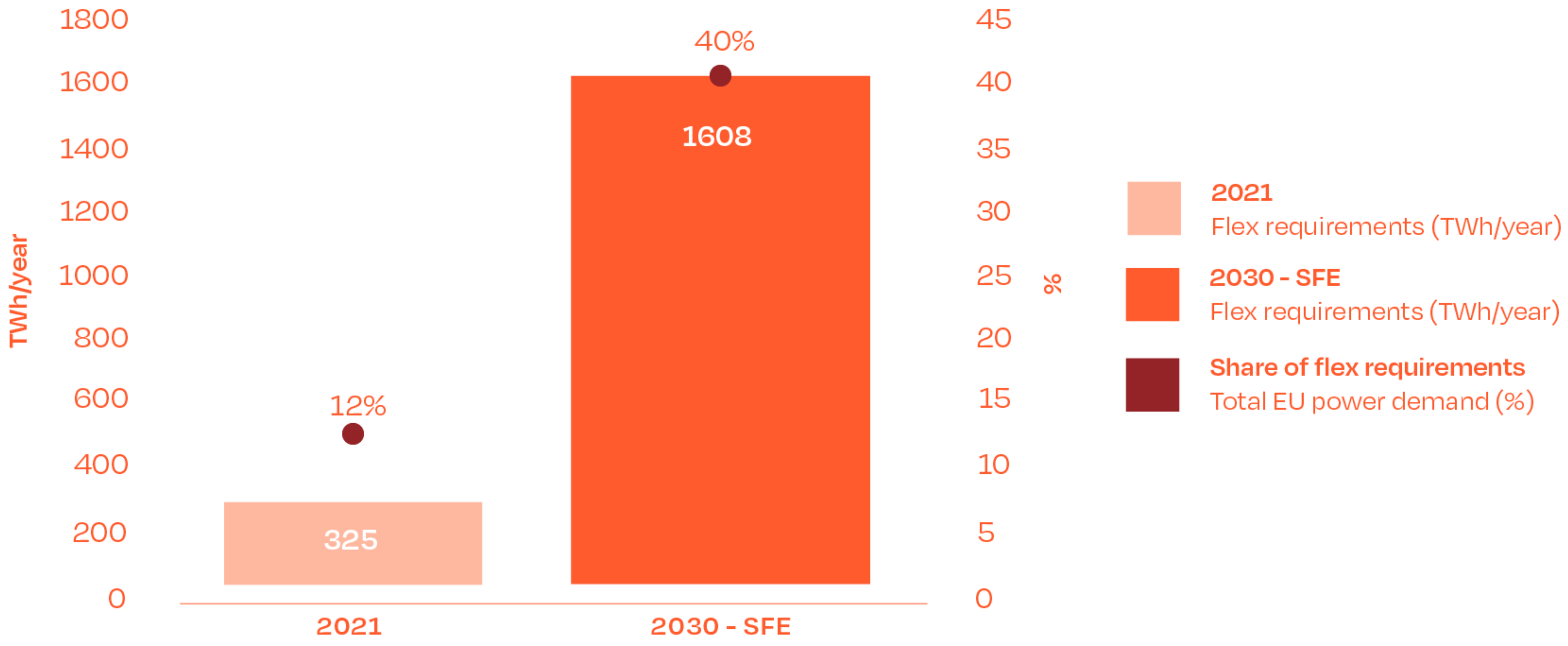
Grid stability feature	Hydropower and fossil assets – Traditional Synchronous Generator	Grid-Forming Inverter – Mostly via batteries
Frequency regulation	**Yes.** Ramping up/down generation	**Yes.** Ramping up/down injection, also fast regulation
Voltage control	**Yes.** Inherent	**Yes.** Inherent by actively controlling reactive power
Inertia	**Yes.** Rotating turbines naturally create and respond to stabilise voltage and frequency	**Yes.** Specifically designed control algorithms to provide the behaviour of an inertial voltage source at the inverter's output
Black start capability	**Depends, often yes.**	**Yes.** Limited by energy availability.



Meeting europe’s flexibility and stability needs: the expanding role of BESS

EU POWER FLEXIBILITY NEEDS TO GROW FIVE-FOLD BY 2030

40% of total EU power demand will have to be flexible by the end of the decade



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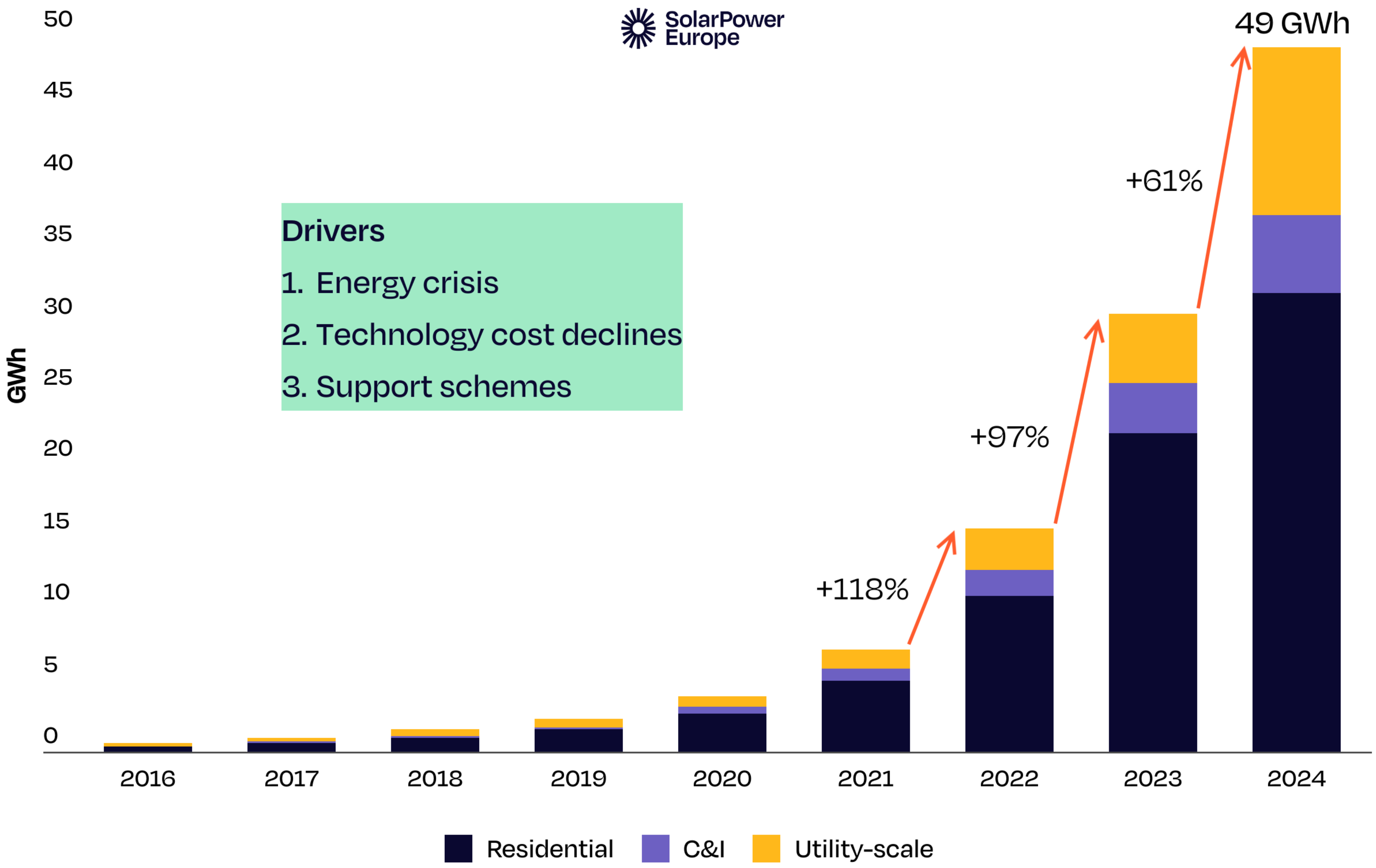
Source: Mission Solar 2040 - SolarPower Europe

EU’s battery fleet reached almost 50 GWh by end-of-2024

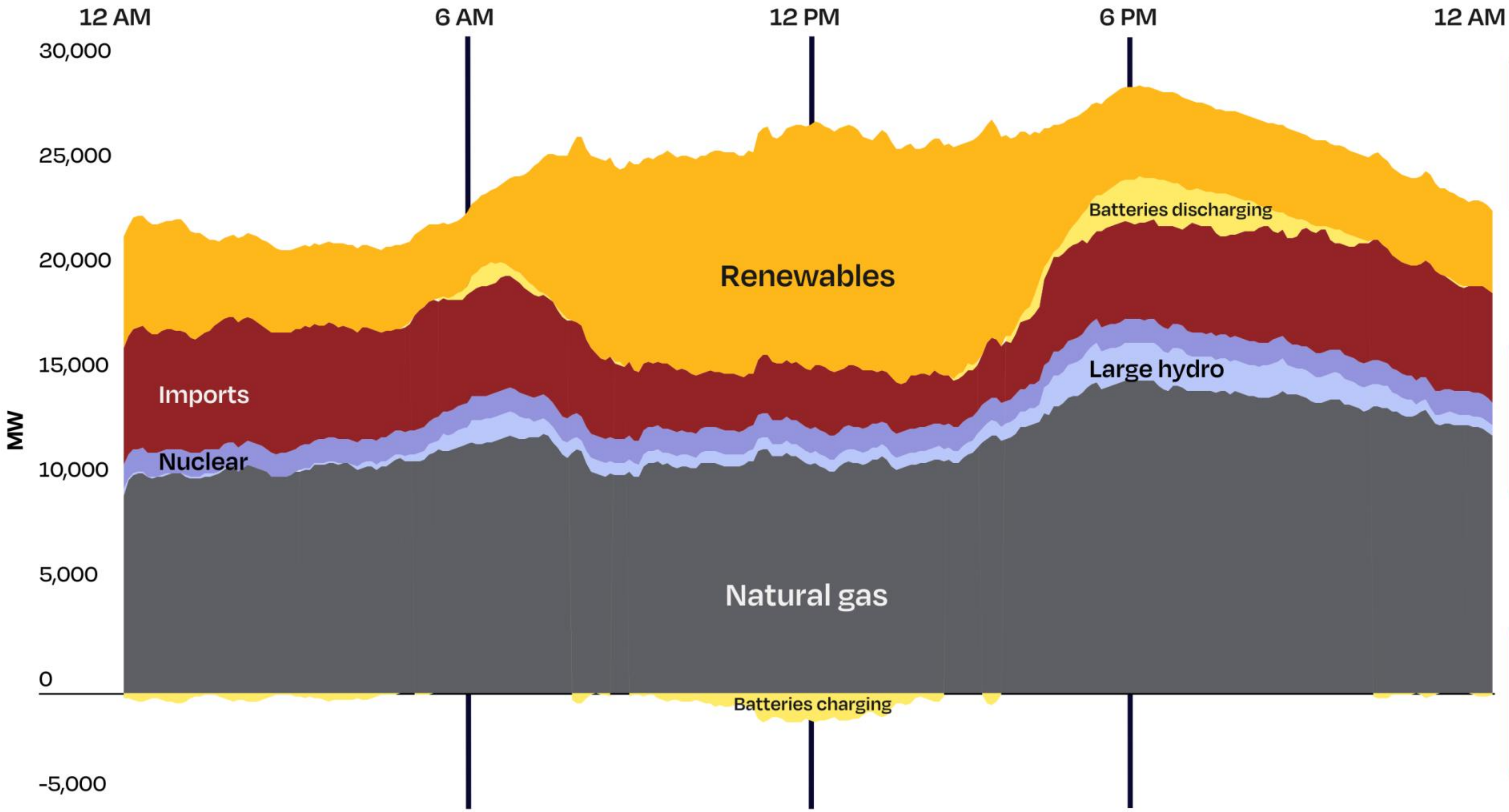


Drivers

1. Energy crisis
2. Technology cost declines
3. Support schemes

Source: European Market Outlook for Battery Storage 2025-2029

This is what 6 GWh of batteries could do 3 years ago in California



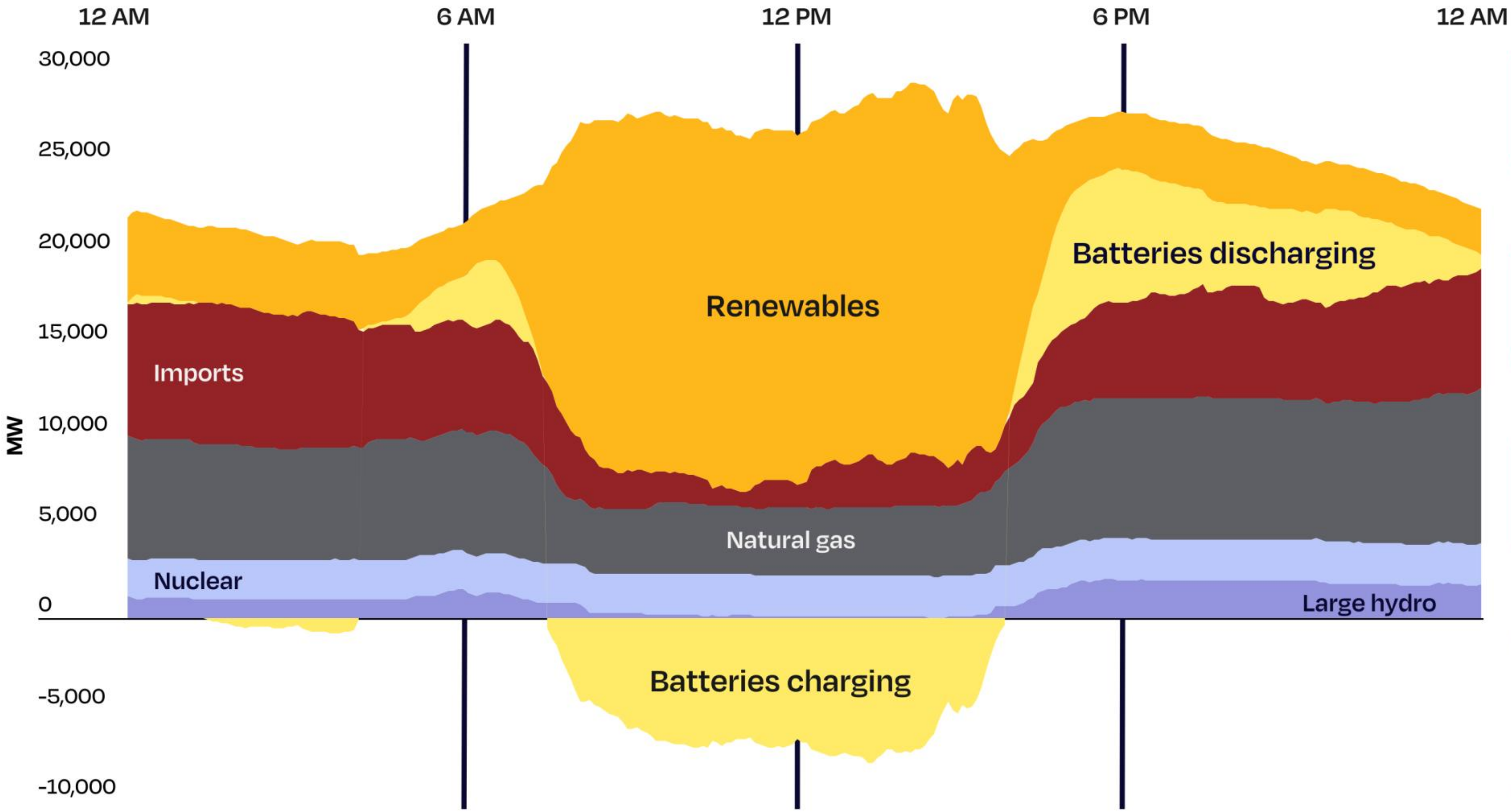
Less than 50% of midday generation came from renewables

Around 50% of power demand was supplied with gas across the day

Less than 10% of peak evening demand was met with batteries

Source: California ISO (07/11/2022)

With 30 GWh of batteries, California is phasing out gas at increasing speed



70% of midday generation comes from renewables

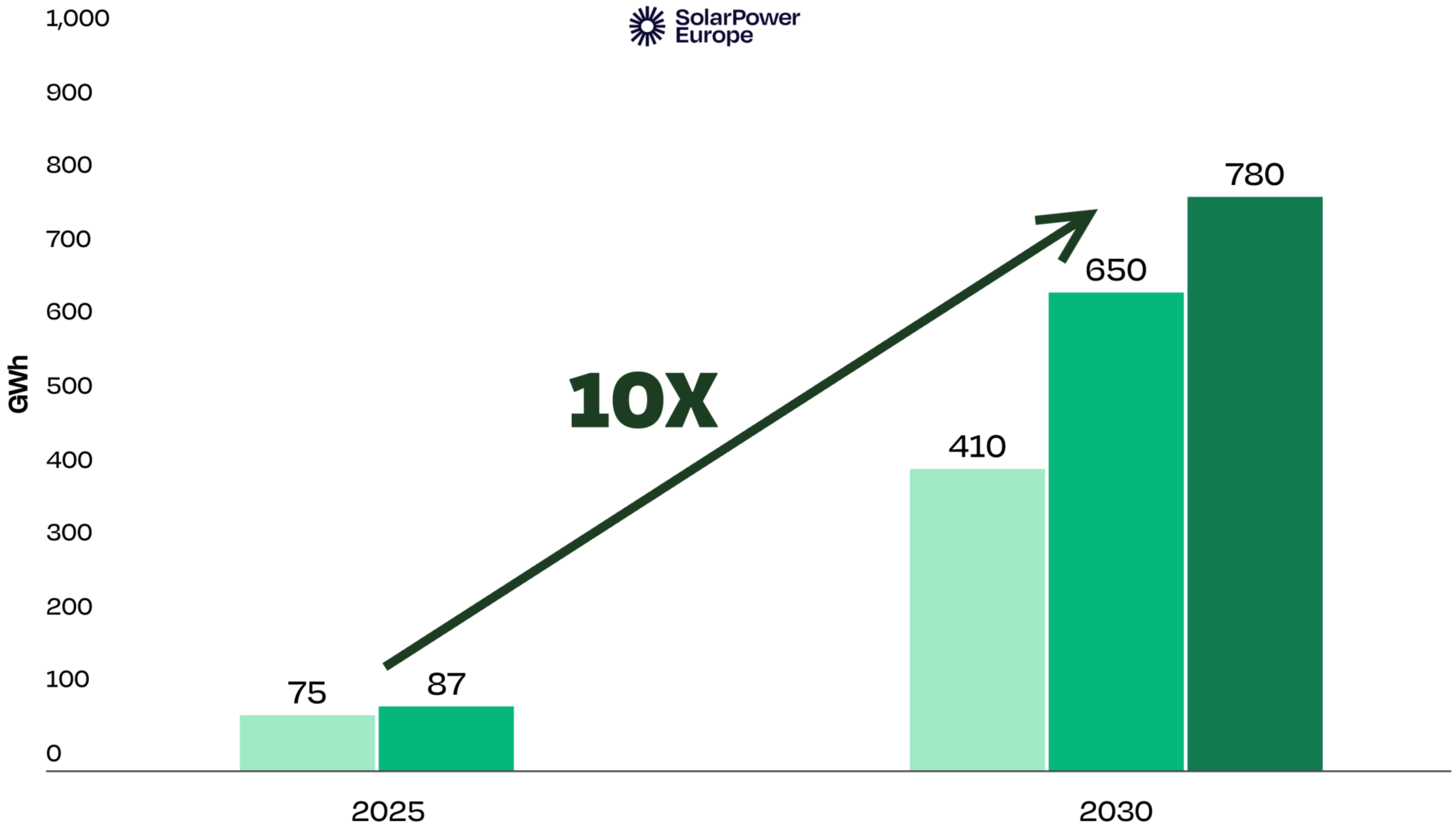
30+% of peak demand is met with batteries

Less than 40% of supply comes from natural gas

Renewables + storage already displace gas in the evening peak

Source: California ISO (07/11/2025)

Fleet required to grow 10X by 2030



Source: SolarPower Europe

The EU Flexibility Strategy and BESS Action Plan are missing

EU Flexibility Strategy: Shaping Europe's Grid with BESS & Demand Response

Take A Flexibility-first Approach to Grid Development

Unlocking The Full Potential Of Demand Response

Embracing The Opportunity Of Battery Storage

with a concrete

A Battery Storage Systems Action Plan

Take A Flexibility-first Approach To Grid

SolarPower Europe proposes an EU Flexibility strategy

- Grid planning that genuinely considers flexibility options
- System operators' remuneration that rewards congestion relief and avoided costs
- Transparent grid hosting capacity maps that signal available grid
- Grid connection queues with clear entry and prioritisation for grid-friendly assets
- Grid tariffs that incentivise flexibility

Unlock The Full Potential Of Demand Response

SolarPower Europe proposes an EU Flexibility strategy

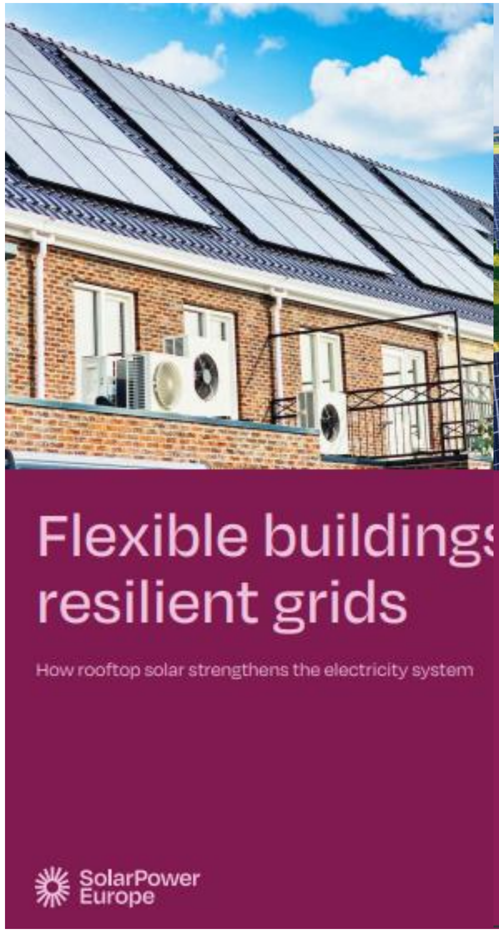
- Electricity markets that treat demand response as equals to supply solutions
- Harmonised network codes that facilitate access to all demand response providers
- Dynamic contracts and flexibility metering devices to empower consumers to react to price signals
- Industrial electrification policies that reward consumer flexibility

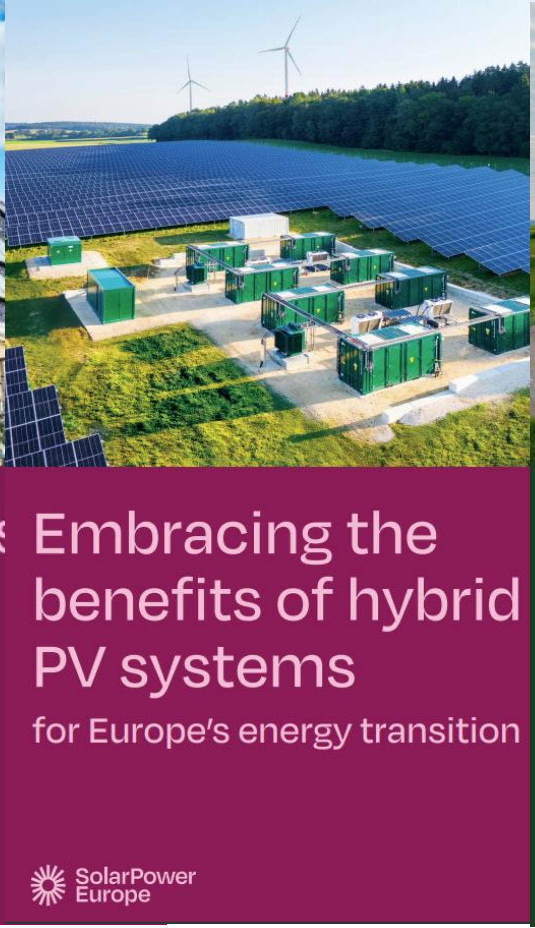
Embrace the opportunity of battery storage

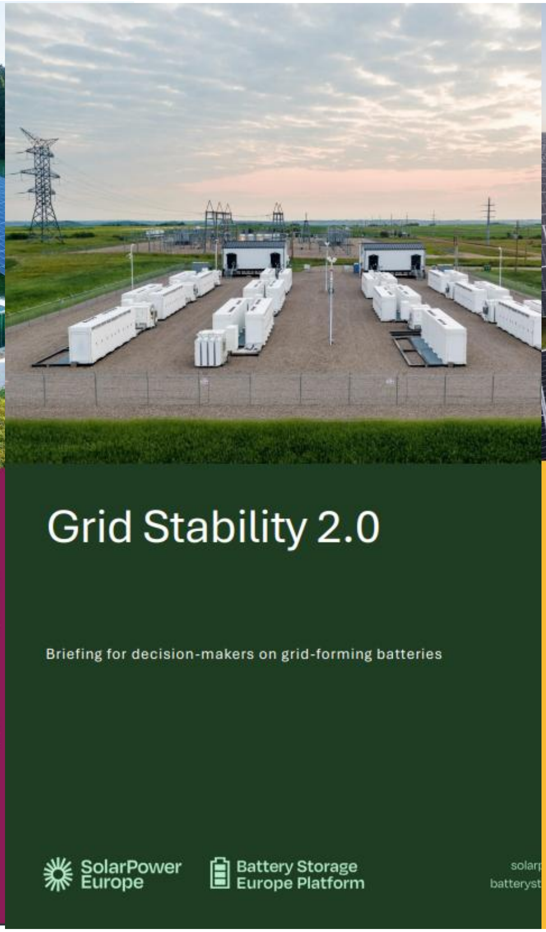
SolarPower Europe Proposes An EU Battery Storage Action Plan

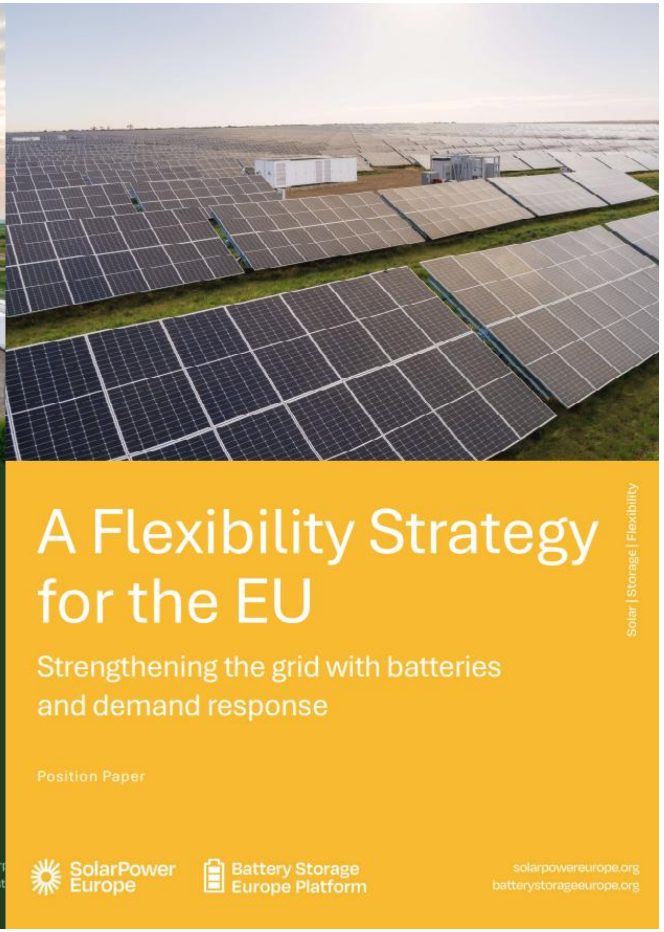
- Permitting rules that facilitate retrofitting existing plant with batteries
- Grid tariffs that reflect battery storage's system value, avoiding double charge
- Electricity markets that reward all BESS services, including grid stability markets
- Industrial policies that support European production and strategic partnerships
- Safety and quality standards that are clear and harmonised across Europe
- Circularity policies and waste streams that make full use of the Single Market

All you need to know from technical to policy









[Flexible Buildings, Resilient Grids - SolarPower Europe]

[Embracing the Benefits of Hybrid PV Systems - SolarPower Europe]

[Grid Stability 2.0 - SolarPower Europe]

[Flexibility strengthening the grid with storage and demand response - SolarPower Europe]

Thank you!

Questions?
No? So, Let's Flex!

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