BUSINESS NETWORK INNOVATION

Flexibility Framework & Mapping

05 December 2019

10.30 CET

WEBINAR

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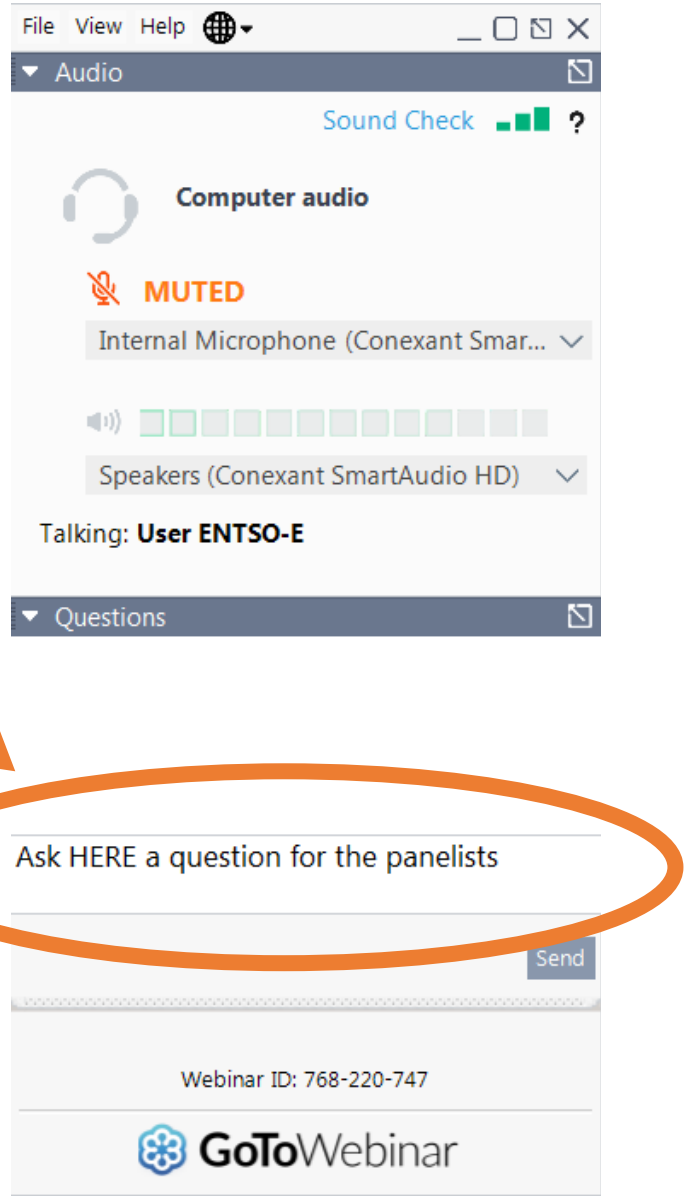
AGENDA

1.	**Introduction**	**10:30**	**Norela Constantinescu, ENTSO-E Research & Innovation Manager**
1.	Flexibility needs of Power System	10:35	Laurent Schmitt, ENTSO-E Secretary General
1.	Introduction to the Flexibility Framework	10:45	Håkon Borgen, ENTSO-E Research, Development and Innovation Committee Chair (Statnett)
1.	Flexibility Framework & Mapping	10:55	Matthias Hofmann, ENTSO-E RDI Committee former convener of Working Group3 (Statnett)
1.	TSO-DSO - flexibility products and services	11.15	Helena Gerard, Senior researcher at EnergyVille/Vito
1.	Questions and comments, look ahead	11:35	Norela Constantinescu, ENTSO-E Research & Innovation Manager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Norela Constantinescu
R&D manager of ENTSO-E

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Laurent Schmitt
Secretary General of ENTSO-E

BNI Flexibility Framework & Mapping

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Flexibility needs of the power system

Laurent Schmitt, Secretary General ENTSO-E

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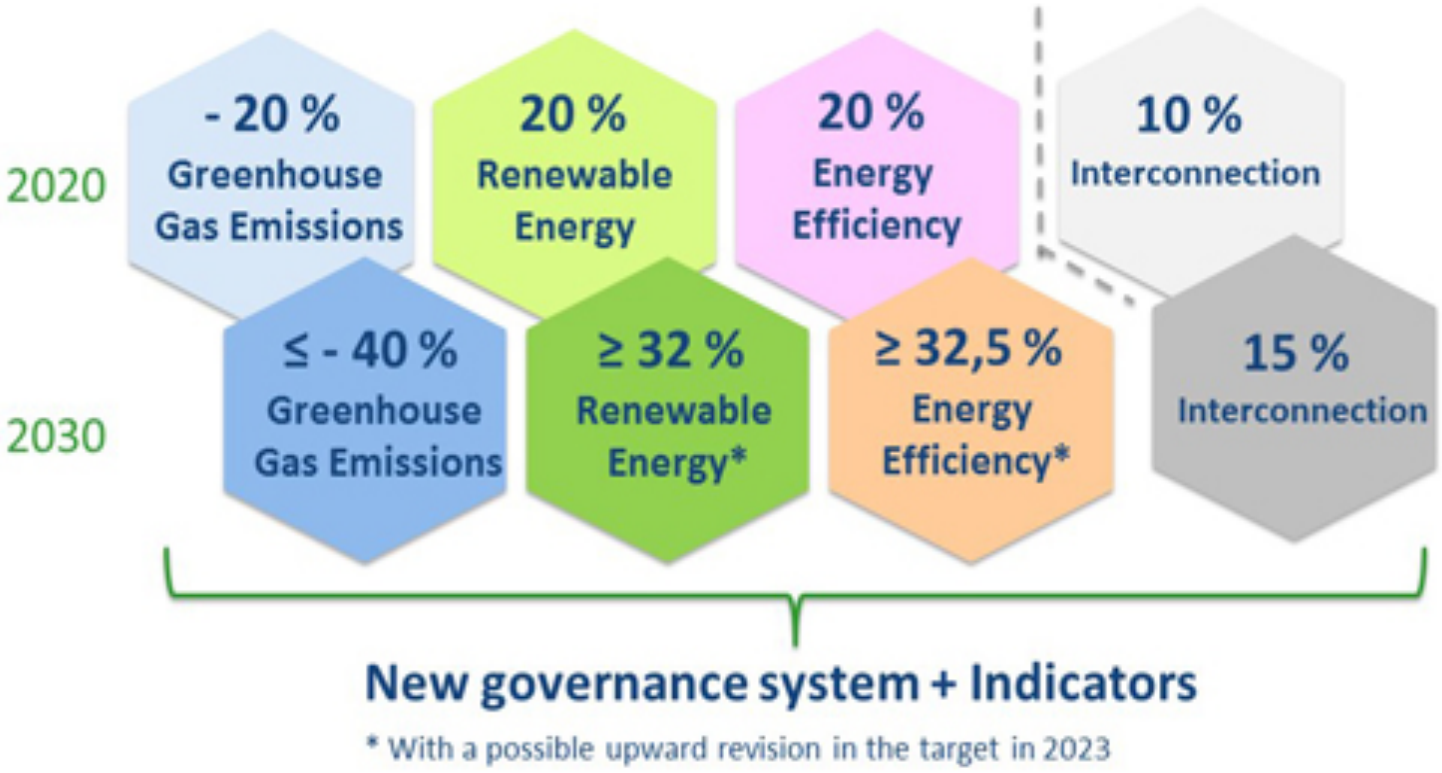
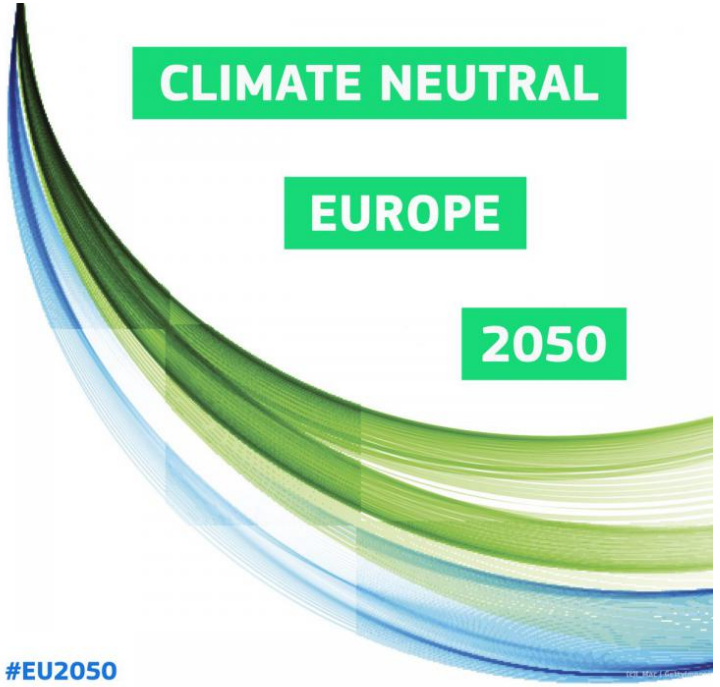
Reliable Sustainable Connected

2020, 2030 & beyond

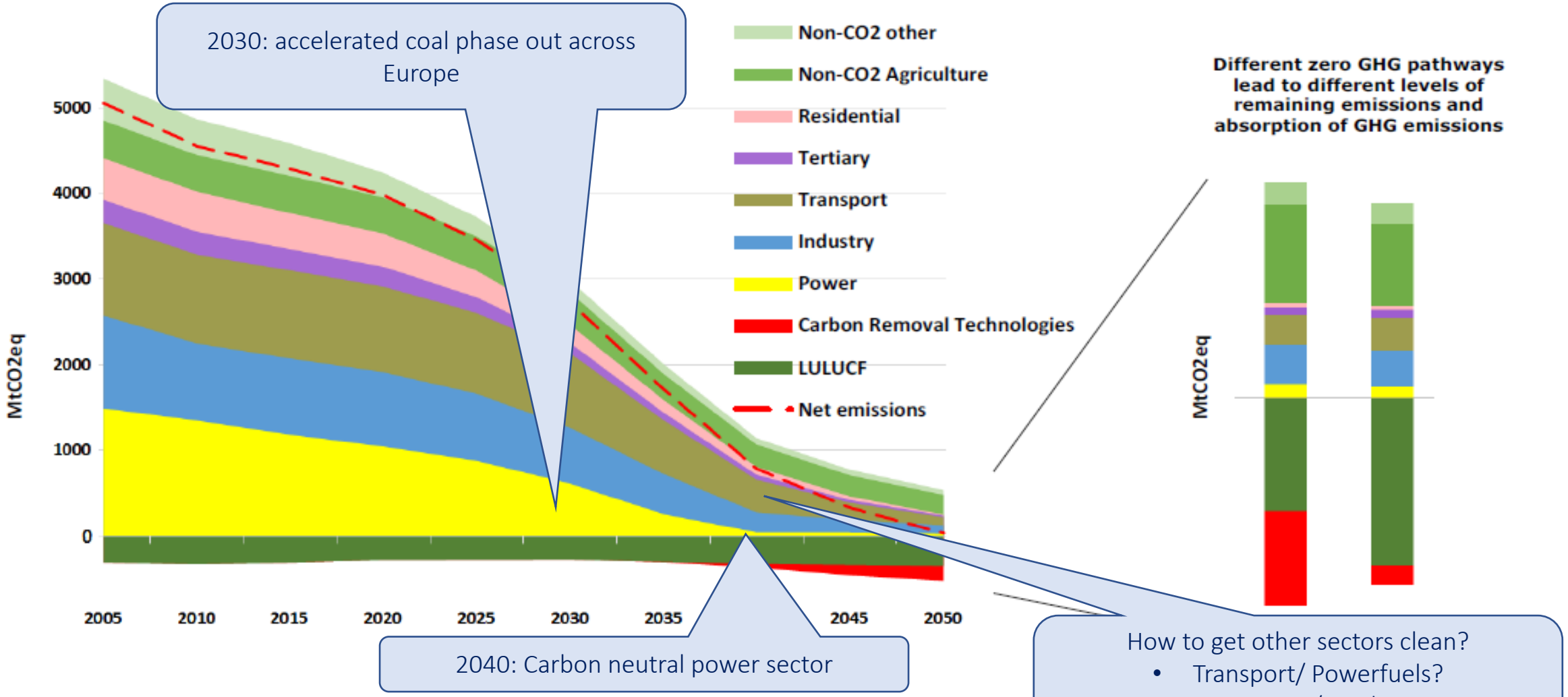




Source: www.climat.be

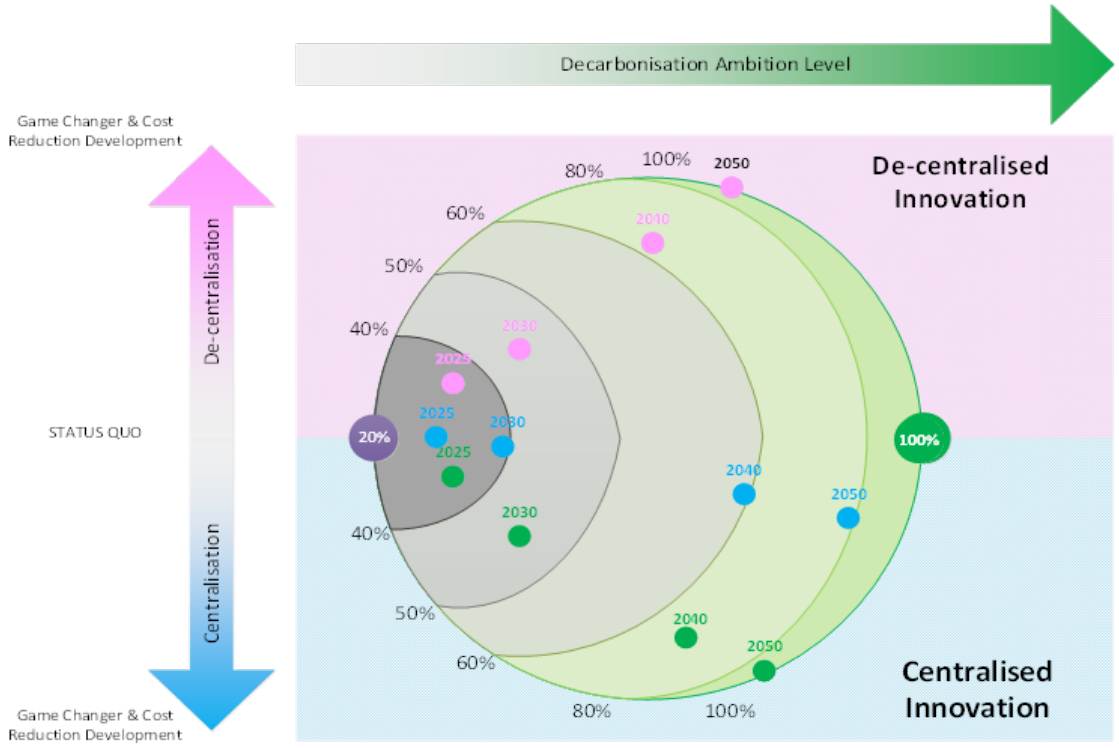
European trajectories towards Carbon Neutrality

GHG emissions in a 1.5°C scenario



Source: EU Long term Strategy November 2018

Possible Energy System development storylines



Base storyline based on National Energy & Climate Plans

- Align with EU 2030 targets : 32 % RES, 32.5 % energy efficiency
- EC 2050 Long-Term Strategy: 80 – 95 % CO2 reduction

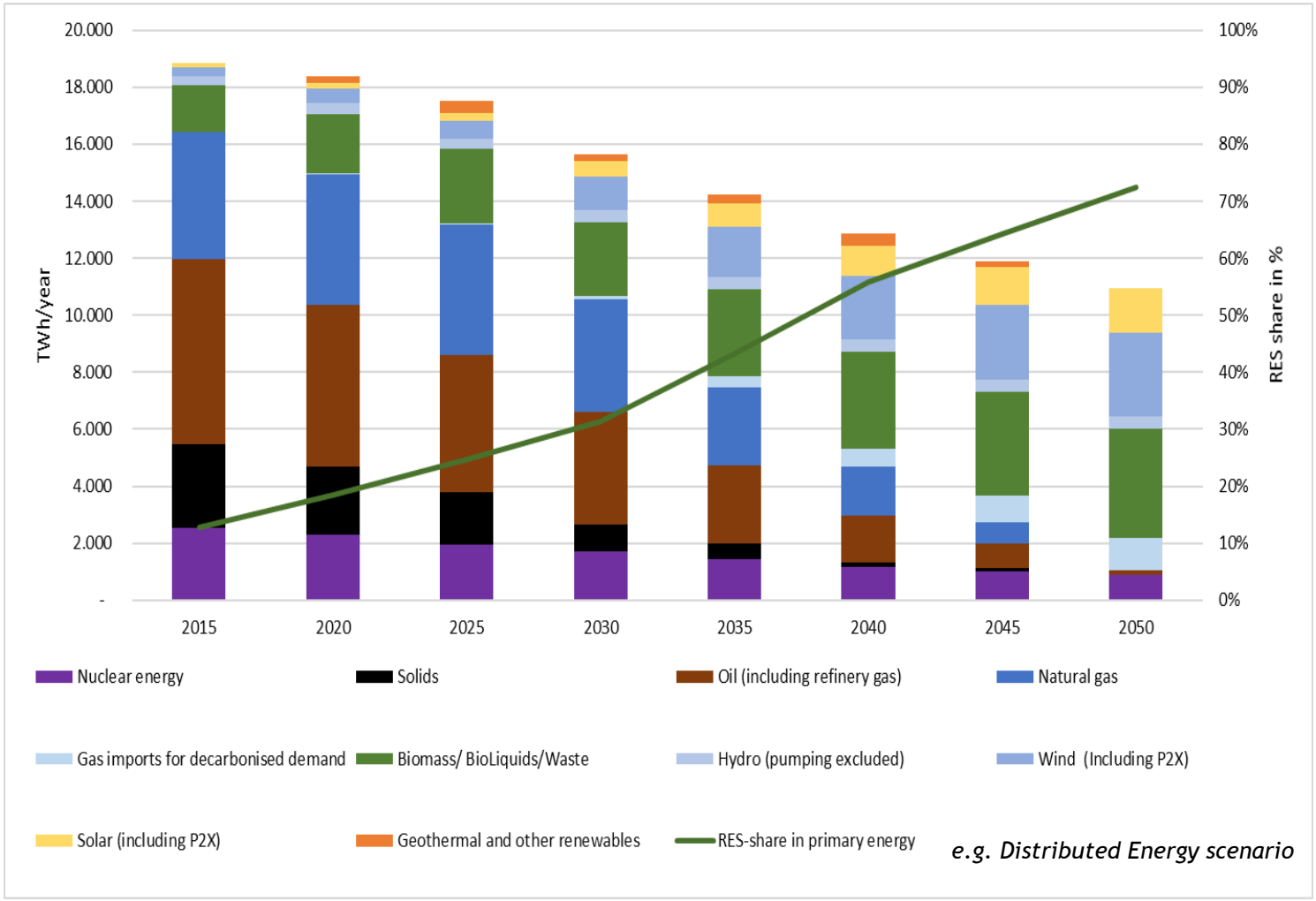
Distributed Energy (DE)

- COP 21: +1.5°C target with 66.7% probability
- Carbon neutrality by 2050
- De-centralised approach to the energy transition: active customers, small-scale solutions, circular approach.

Global Ambition (GA)

- COP 21: +1.5°C target with 66.7% probability
- Carbon neutrality by 2050
- Future is led by global economic developments in centralised generation, large-scale renewables and decarbonisation

Impact Primary Energy Mix and its RES-share



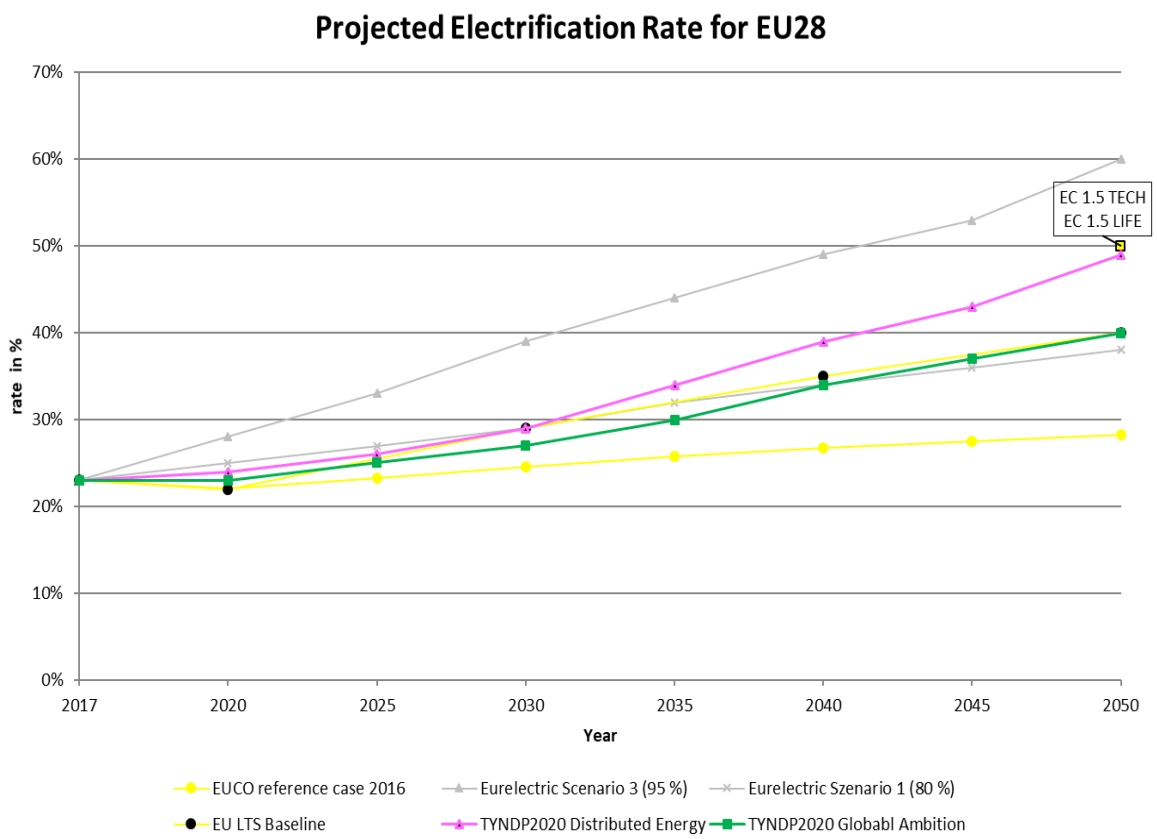
e.g. Distributed Energy scenario

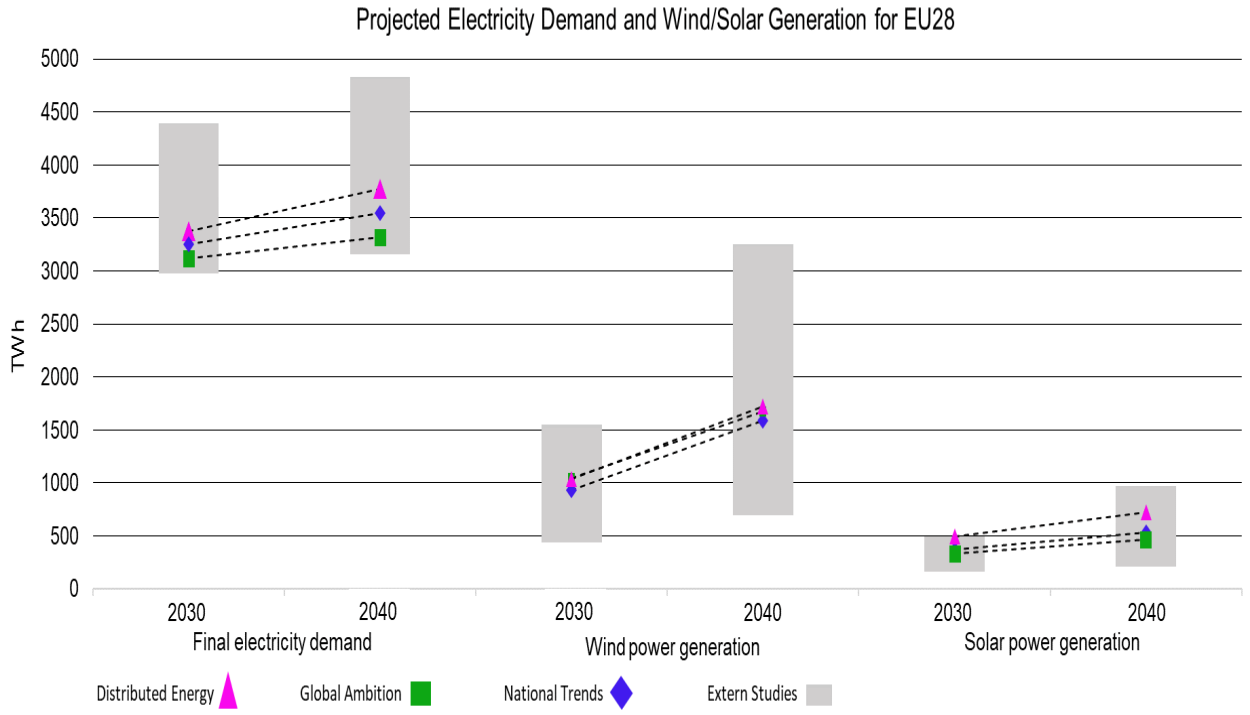
- Both COP21 compliant scenarios need significant increase in both renewables and further CO_2 removal technologies, while reducing primary energy demand

2050	Demand decrease	RES share
Global Ambition	42%	64%
Distributed Energy	43%	80%

Source: TYNDP 2020 Scenario Report

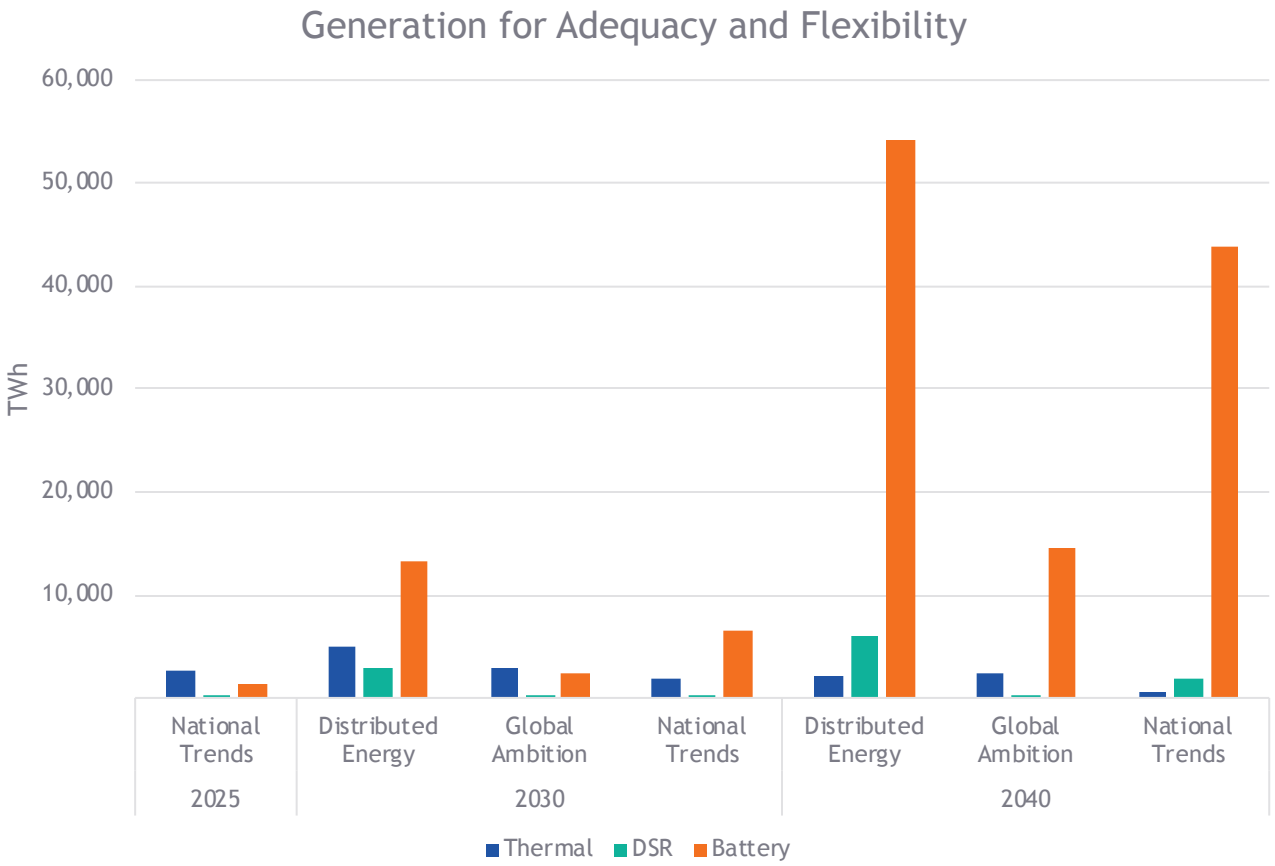
Electrification Rate for EU28

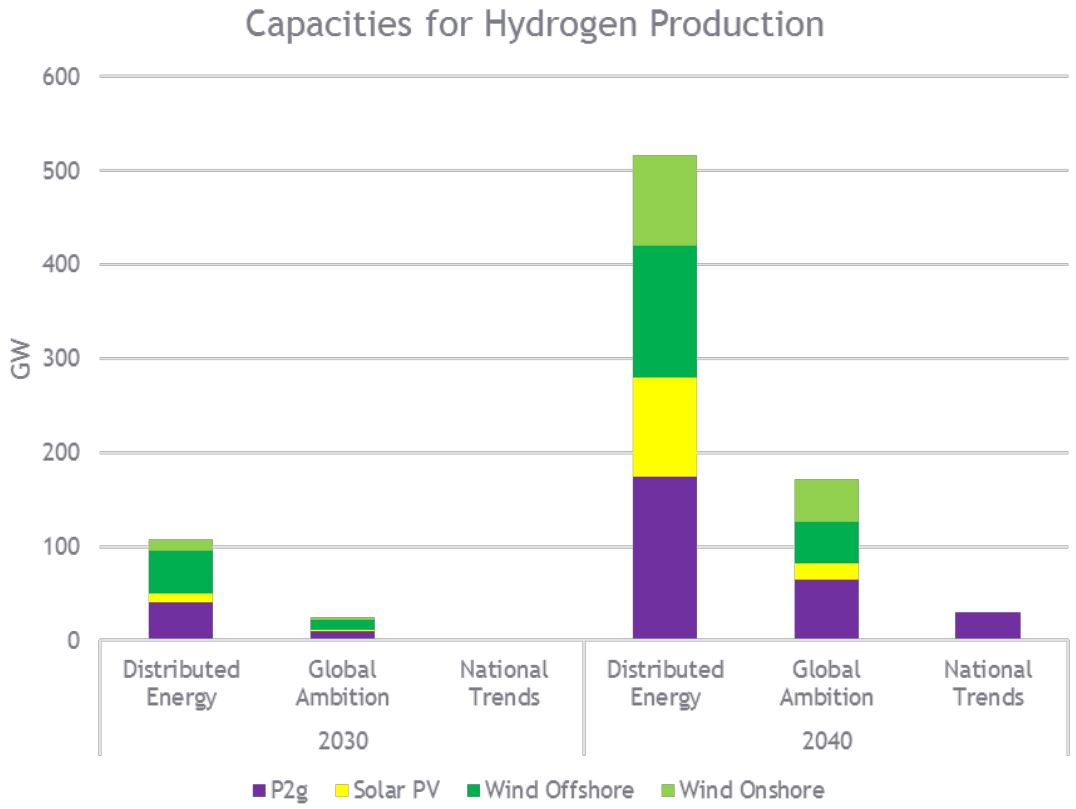




Source: TYNDP 2020 Scenario Report

Generation Adequacy





Source: TYNDP 2020 Scenario Report

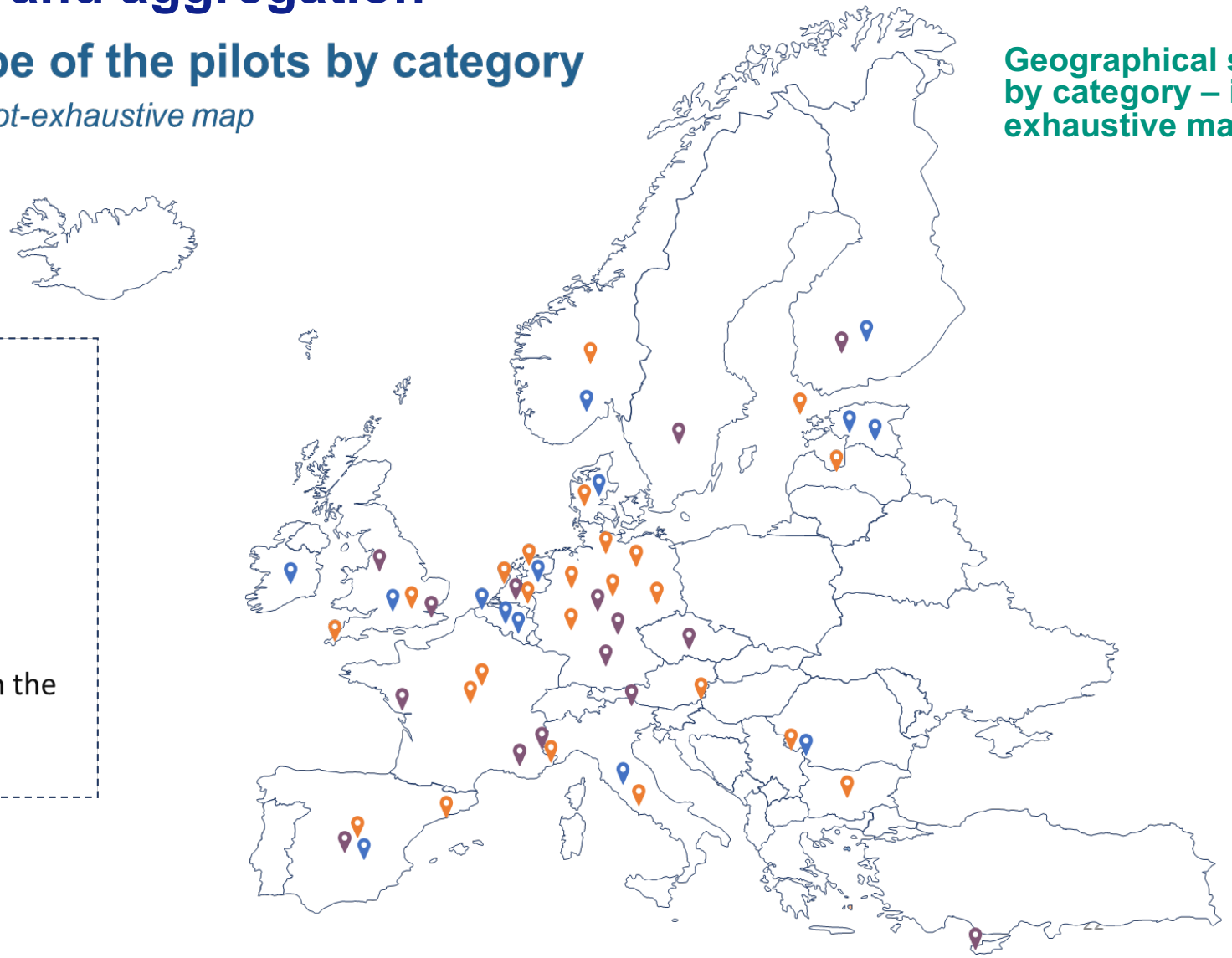
TSO-DSO flexibility projects and integrated system management are a reality all across Europe and deal with markets, technical solutions, data management and aggregation

Geographical scope of the pilots by category

Disclaimer: illustrative and not-exhaustive map

Categories of the pilots:

- Flexibility Market Places
- Data Exchange
- Technical Solutions
- Assets aggregation (not in the map as covering all European countries)



Geographical scope of the pilots by category – illustrative and non-exhaustive map

Source: ENTSO-E

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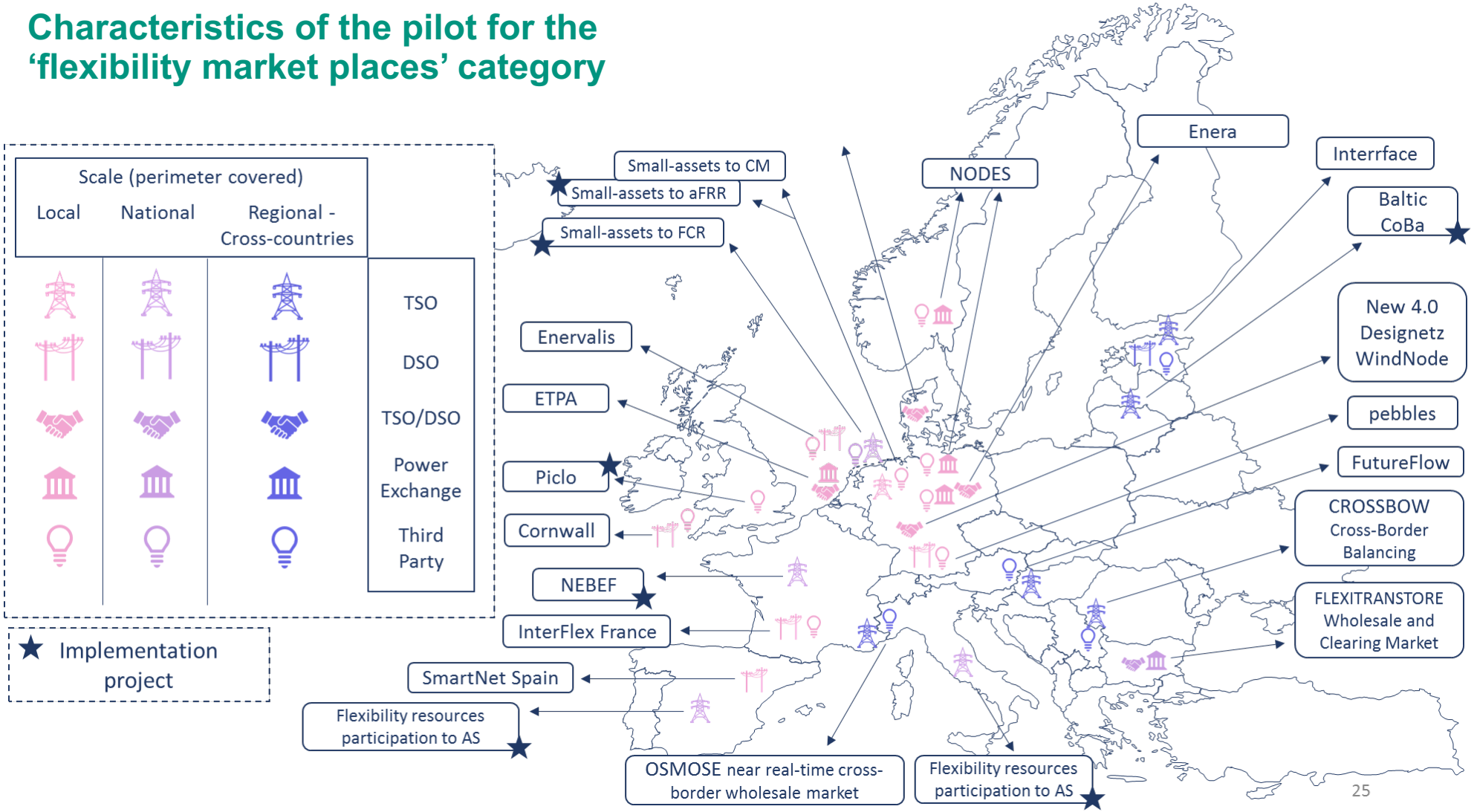
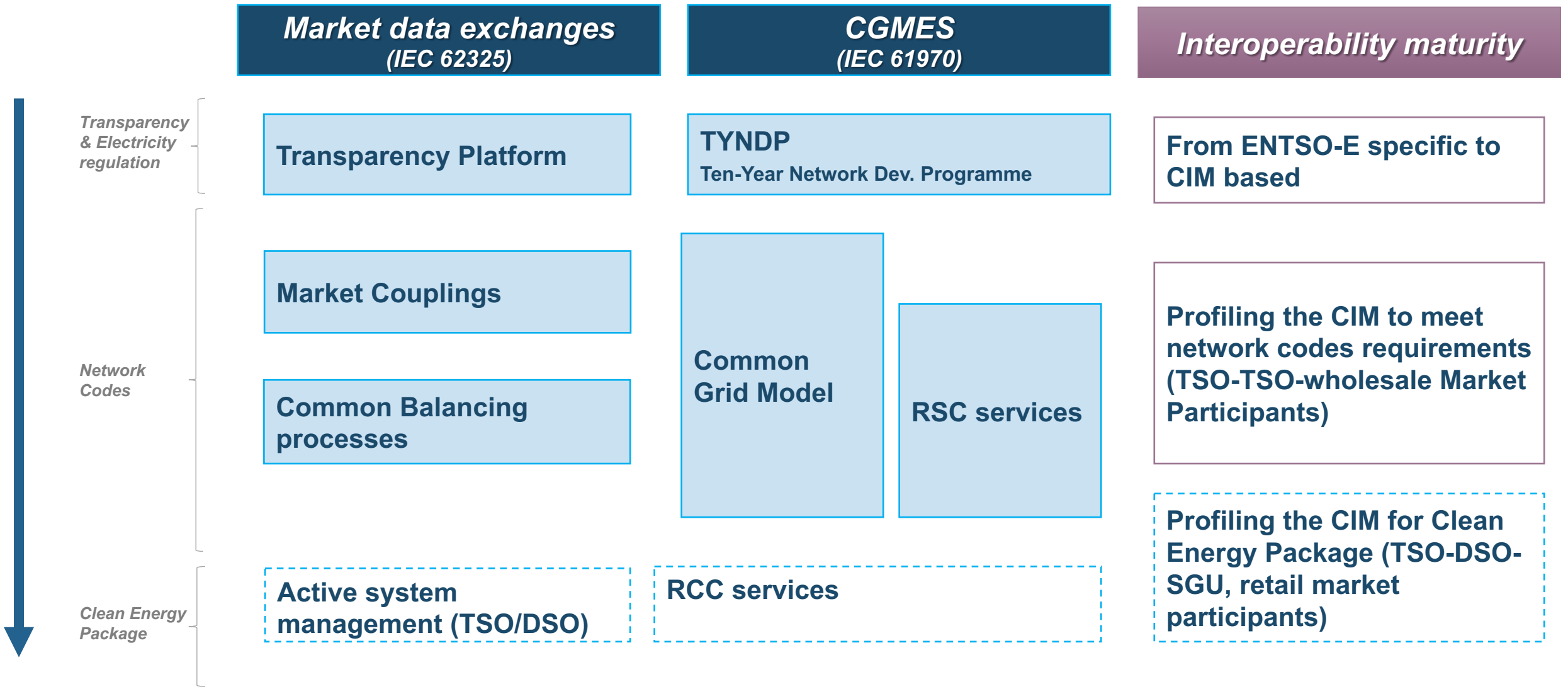
TSO-DSO flexibility projects and integrated system management

Characteristics of the pilot for the 'flexibility market places' category



Source: ENTSO-E

Developing the European interoperability

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GmbH
ΔΣΜΚ
Διαχειριστής Συστήματος Μεταφοράς
Κύπρου
Transmission System Operator - Cyprus
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RED ELÉCTRICA
DE ESPAÑA
ΑΔΜΗΕ
Terna
ΜΕПСО
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OST
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Håkon Borgen
Chairman of ENTSO-E Research, Development and Innovation Committee (Statnett)

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BNI Flexibility Framework & Mapping

BUSINESS NETWORK INNOVATION

Flexibility Framework

Hakon Borgen , Chair ENTSO-E Research Development and Innovation Committee

5 December 2019

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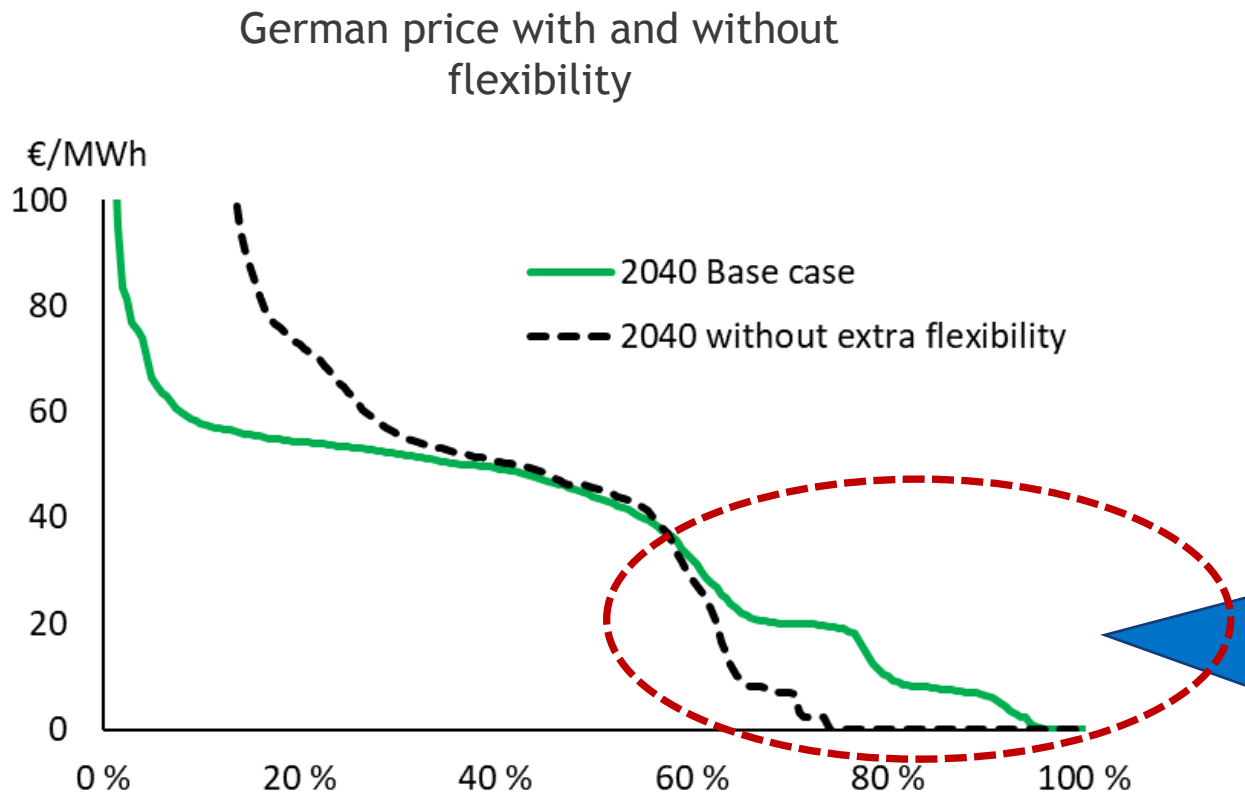
Reliable Sustainable Connected

2050 EU Goal
(Energy Roadmap 2050)

Flexibility framework: new solutions for surplus of wind and solar



Needs

Sources

Services & instruments

All types of flexibilities
- Sector coupling (Power to gas, smart charging of EVs , power to heat etc)
- Demand response , prosumers
- Storage

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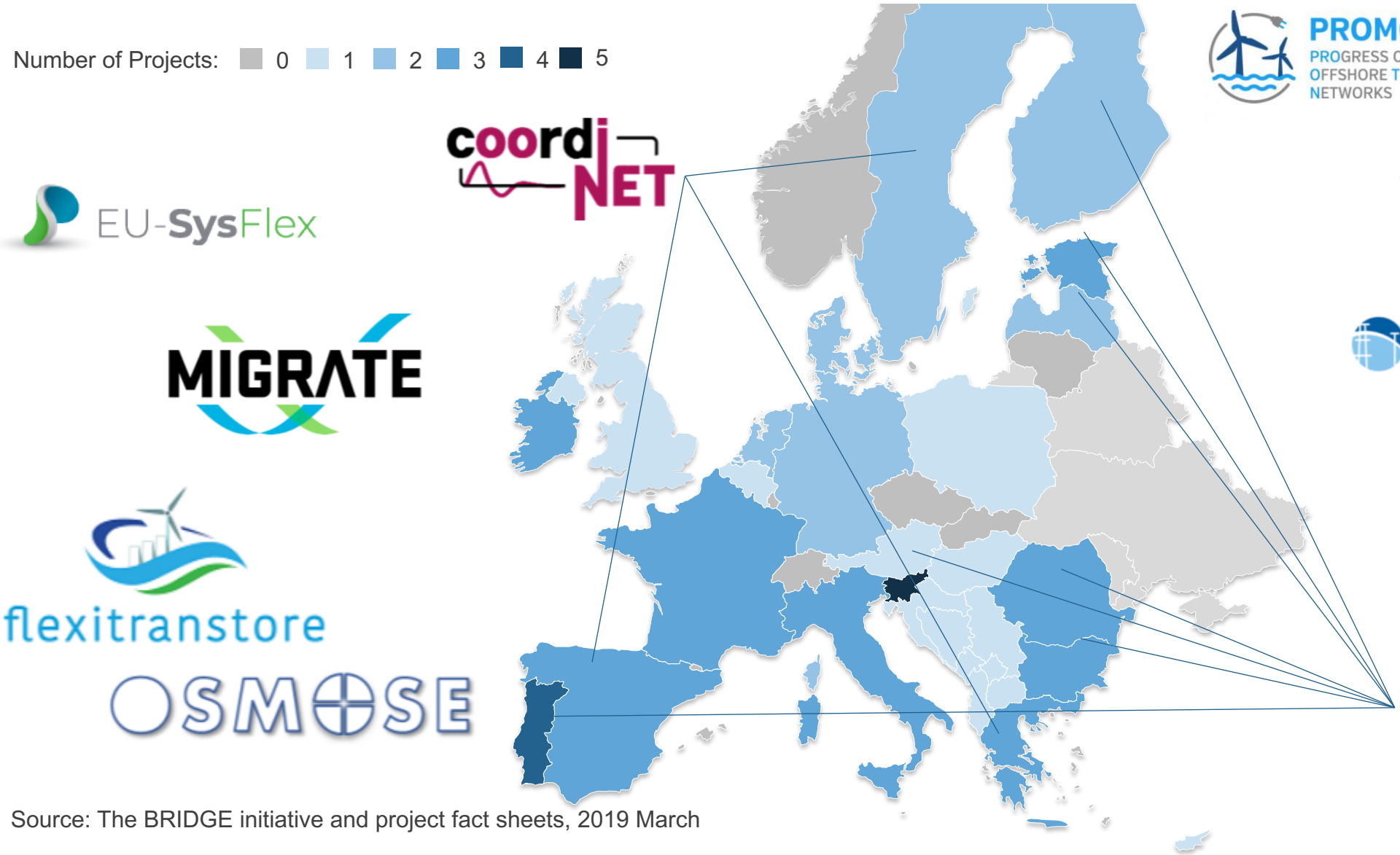
TSOs bet on innovation on a European scale as their participation in EU projects show



Source: The BRIDGE initiative and project fact sheets, 2019 March

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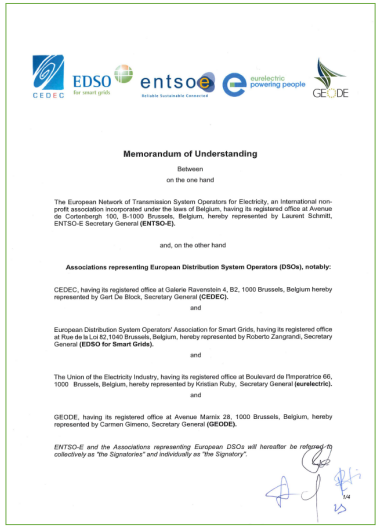
Evolving TSO-DSO Cooperation Framework

- Key areas of **common interest identified with DSOs**
  - ➢ Roles and responsibilities of TSOs and DSOS
  - ➢ Interfaces between DSOs and TSOs
  - ➢ Active and reactive power management
  - ➢ Digitalisation, including data management
  - ➢ Coordinated planning of network development
  - ➢ Network codes/Guidelines implementation
  - ➢ R&D schemes

- 2019: new **Report on Active System Management**
  - ➢ Common approach to Active System Management

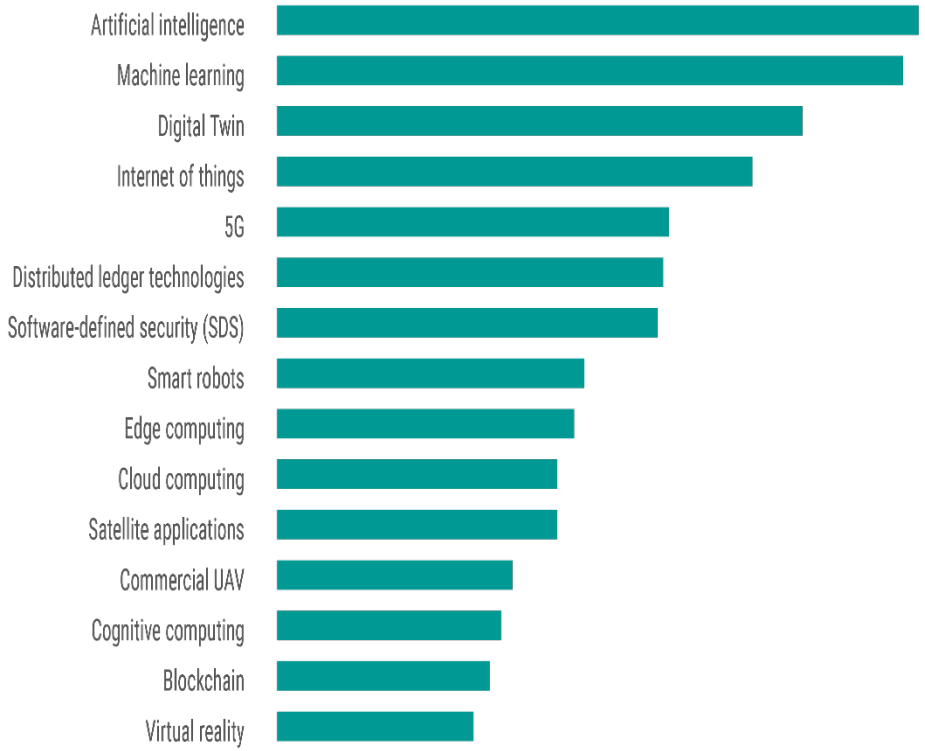


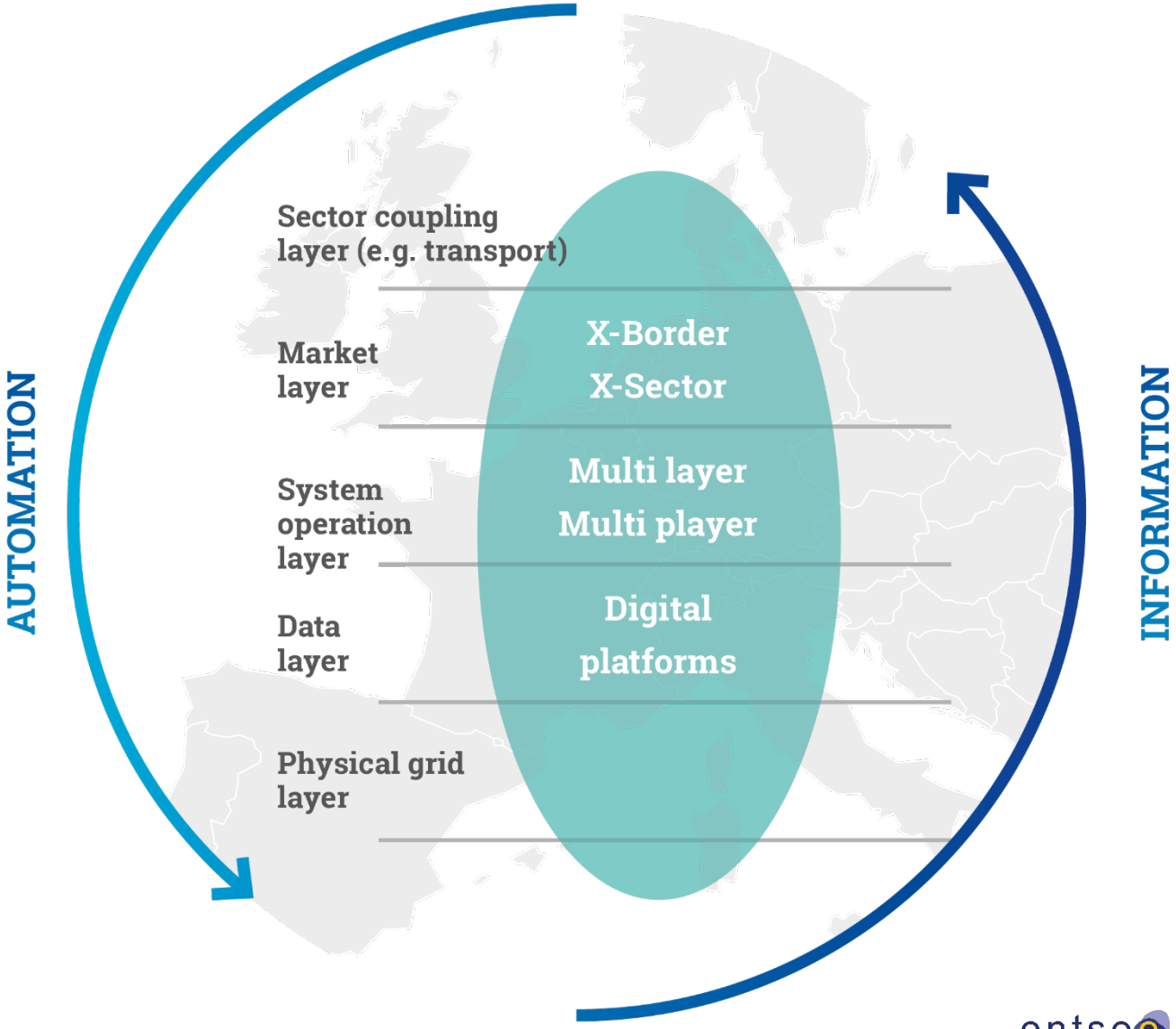
Digitalisation and Power System Transformation

VISION 2030

100 projects surveyed

The Cyber Physical Grid





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Matthias Hofmann
ENTSO-E RDI Committee former convener of Working Group3 (Statnett)

Mapping of R&D projects on flexibility

ENTSO-E Research, Development and Innovation Committee

WG3 Flexibility & Markets

5th december 2020

Matthias Hofmann, matthias.hofmann@statnett.no

Structure

1. Introduction
   - Motivation and methodology
   - Flexibility framework
2. Mapping of research on flexibility solutions
   - Statistics on projects mapped
   - Mapping results on research on flexibility solutions
3. Conclusions

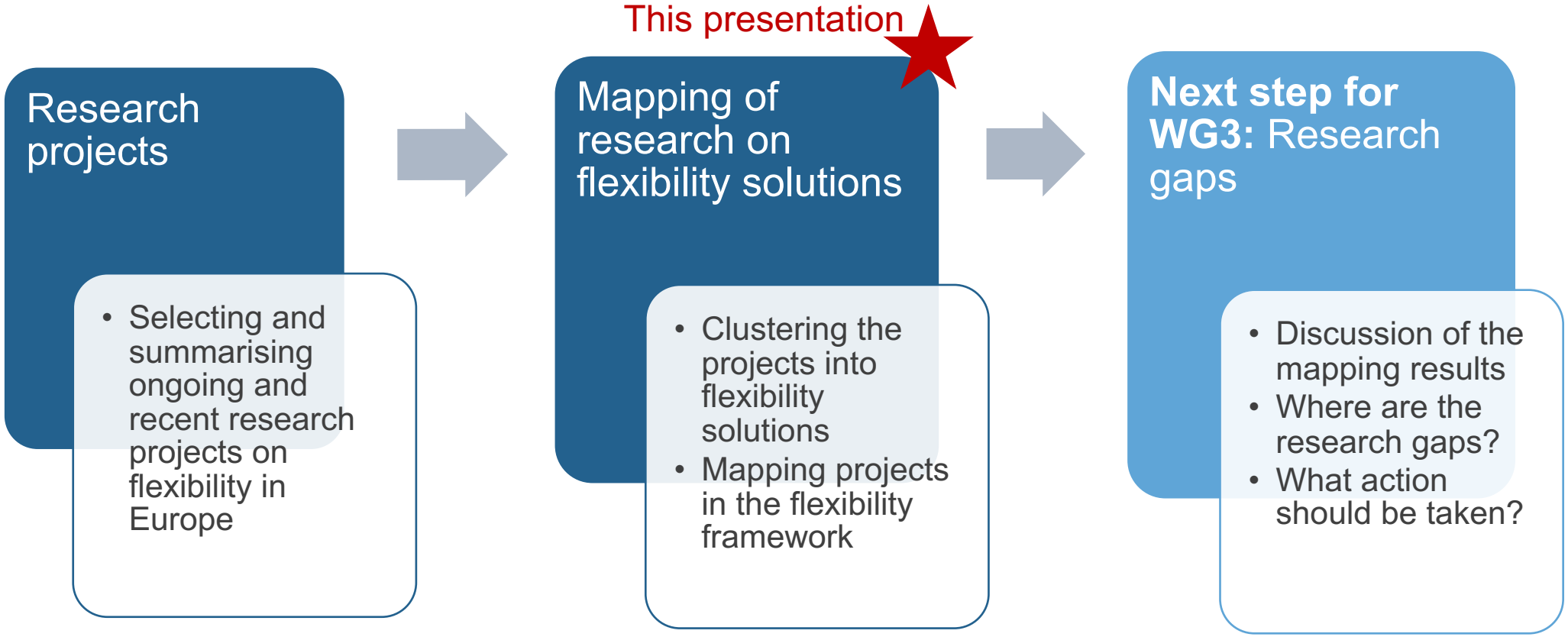
Introduction

I. Motivation and methodology

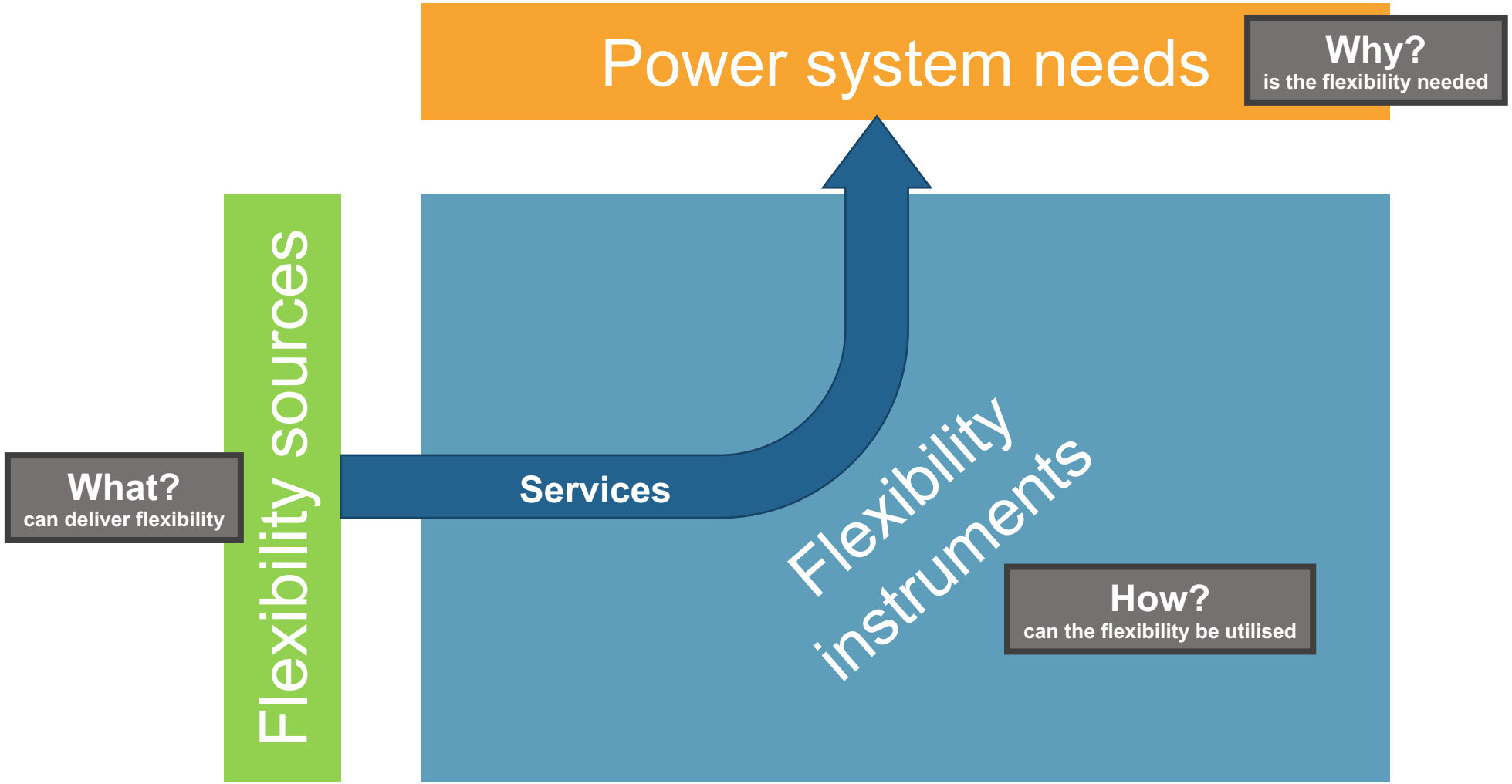
II. Flexibility framework

Motivation and methodology

WG3 wanted to obtain an overview of recently finished and ongoing R&D projects in Europe. This work will lay the groundwork for a future analysis of research gaps in the field of flexibility.



General framework for power system flexibility



Flexibility sources

- **Generation**: can modify their generation injection
  - Controllable generation
  - Variable generation

- **Demand**: can modify their consumption patterns
  - Small loads in residential and commercial sector
  - Large loads in industrial processes
  - Electric vehicles

- **Storage**: has the ability of both consuming and deliver electricity from and to the grid
  - Electrochemical storage (classic batteries, …)
  - Electrical storage (supercapacitors)
  - Mechanical storage (fly wheels, compressed air, pumped hydro, …)
  - Chemical storage (hydrogen, methane, …)
  - Thermal storage

Instruments

- **Market/incentive-based (explicit flexibility):** Market-based activation of dispatchable flexibility that can be traded on the different energy markets
  - Examples: Markets (wholesale energy, ancillary services, capacity, flexibility, …) and product specifications
- **Price-based instruments (implicit flexibility):** Customers react to price signals without participating actively in markets
  - Examples: price signals from variable power prices and grid tariffs
- **Agreement-based:** Direct agreements between grid company and customers
  - Example: Connection agreements with certain grid users so that they provide a certain service
- **Rule-based:** Implementation of requirements from technical rules, laws and regulation.
  - Example: rule-based curtailments as a consequence of the implementation of technical requirements from connection codes
- **Information-based:** Information to the owners of flexibility sources for better informed decisions
  - Examples: Information campaigns, apps containing near real-time electricity consumption

Power system needs

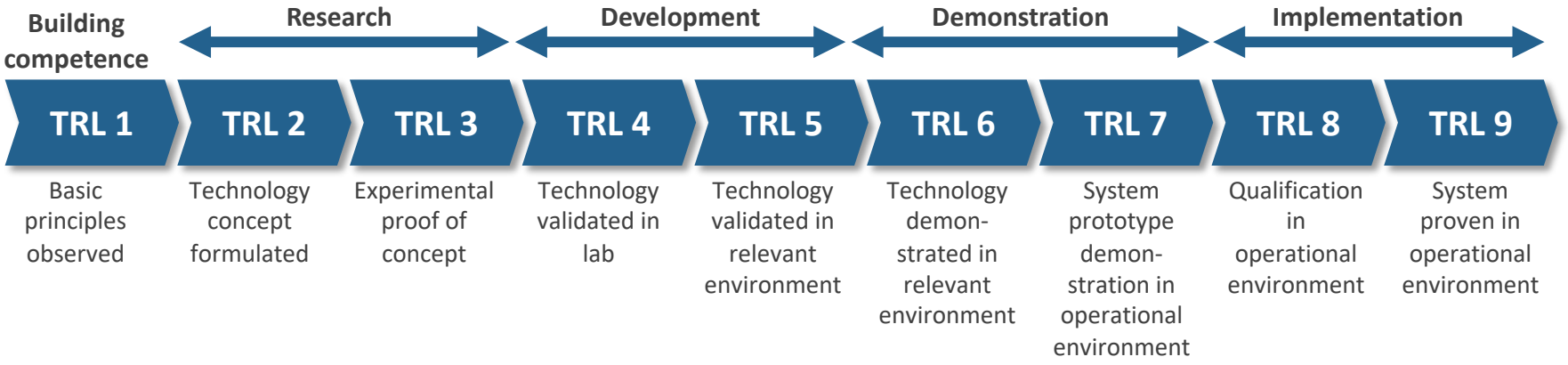
- System perspective: balance of demand and production on all time horizons
  - **Adequacy**: Need to maintain the long term equilibrium (hours to several years) between energy supply and energy demand
  - **Stable frequency**: Need to maintain frequency stability by keeping the short term equilibrium (fractions of a second up to an hour) between power supply and power demand and in situations of disturbance and contingencies
  - **Reliability of supply**: avoidance of interruptions in power supply and/or their consequences to end-users due to failures and unplanned outage occurrences in the power system, also called contingencies

- Grid perspective: need for transfer capacities, voltage and power quality
  - **Congestion management**: Short to medium term ability (minutes to hours) to transfer power between supply and demand, where local or regional limitations may cause bottlenecks, by activating a remedial action to respect operational security limits.
  - **Voltage stability**: Short term ability (seconds to tens of minutes) to keep the bus voltages within predefined limits on local and regional scale

Technology readiness level – TRL

A technology readiness level (TRL) assessment is used to describe how mature the technology is. TRL is assessed based on the most advanced project in each solution, and does not necessarily reflect all projects within one solution, nor the TRL of the technology beyond the projects mapped.

TRL is used for any research activity, including technology, software, knowledge and markets. While TRL does not describe the commercial readiness or success of a technology or product, it describes the extent to which the technology succeeds at delivering services for the power system need(s) in question.



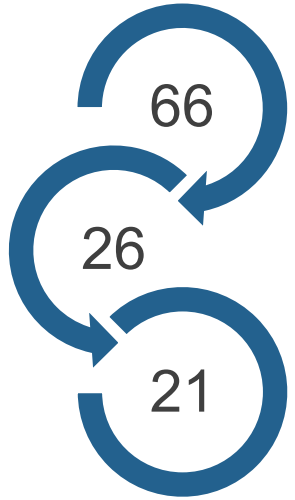
Mapping flexibility solutions

I. Statistics on projects mapped
II. Mapping results on research on flexibility solutions

Data sources

- **66 research projects** on flexibility consisting of **105 demonstrations and use cases**
- Mapped in the **flexibility framework** and **clustered into flexibility solutions**
- Based on
  - Reports and project lists from ENTSO-E, DNV-GL, ETIP SNET and Horizon2020 Bridge
  - Cooperation with the TSO-DSO group and their mapping
  - Information about research projects from websites, deliverables, reports and direct communication with project experts

Research projects mapped



Research projects covered

Deep dives in projects

Flexibility solutions mapped

The scope of the mapping

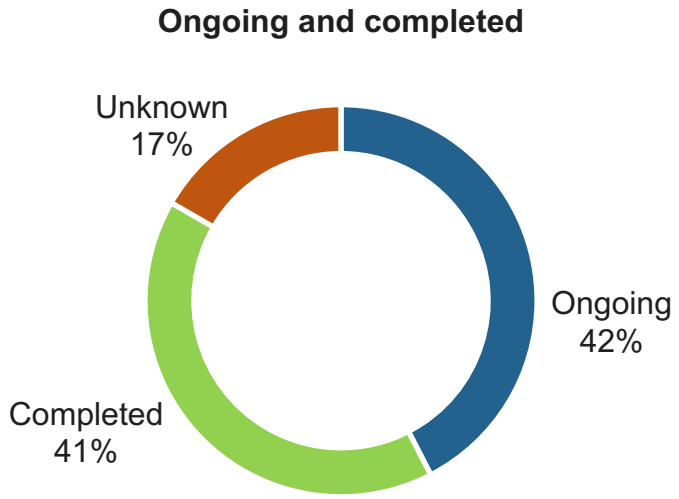
The research projects covered by this mapping satisfy the following criteria:

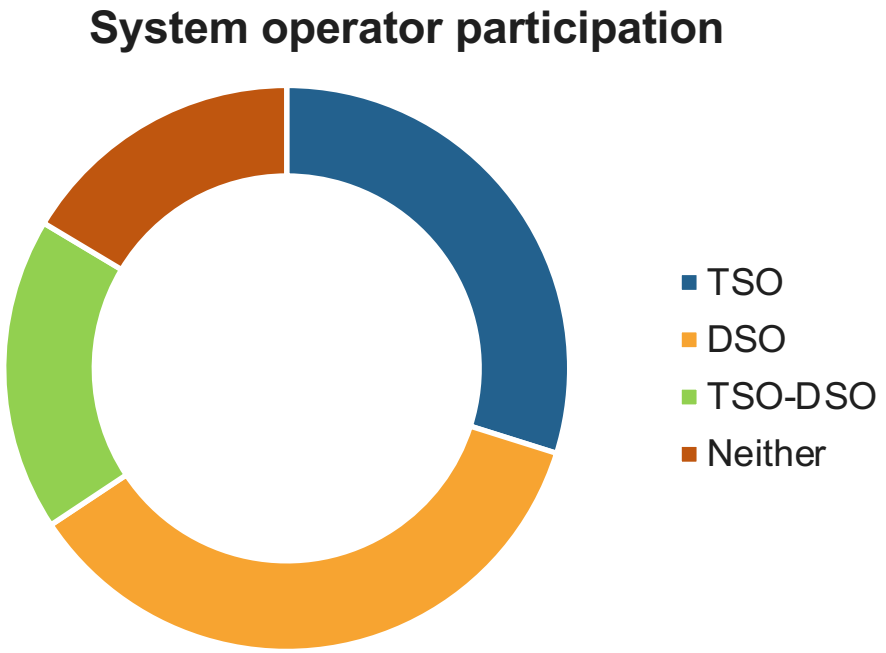
- European
- Ongoing, or completed after 2015
- Covering services in the flexibility framework through researching either
  - a flexibility source and need (e.g. battery for frequency balancing services)
  - flexibility instrument and need (e.g. a flexibility market for congestion management)

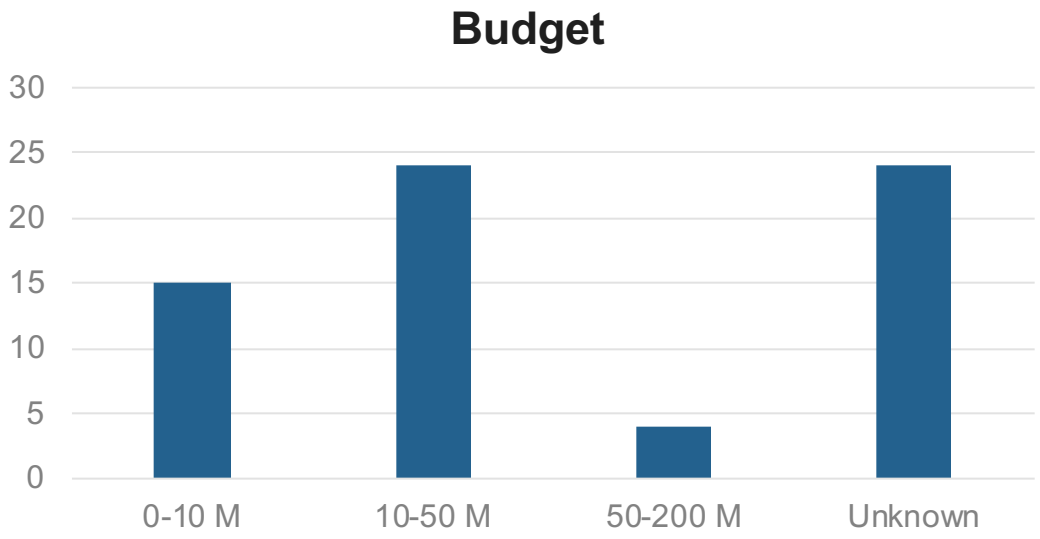
This mapping does not cover all projects

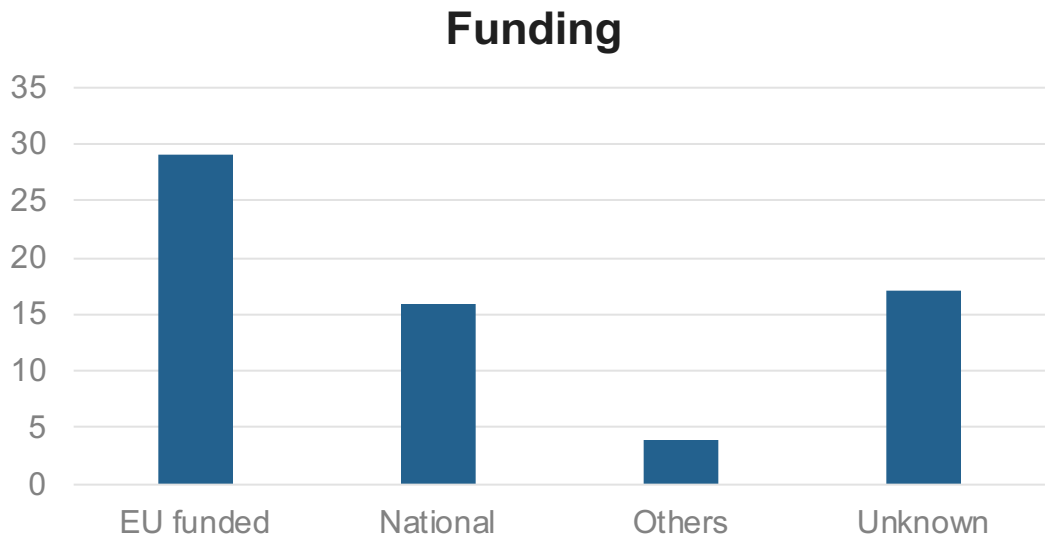
The research projects chosen were limited by the scope of the framework, the time available and lists in our key sources. Research into grid flexibility and data exchange were omitted, and **some relevant projects may not be covered.**

Statistics on projects



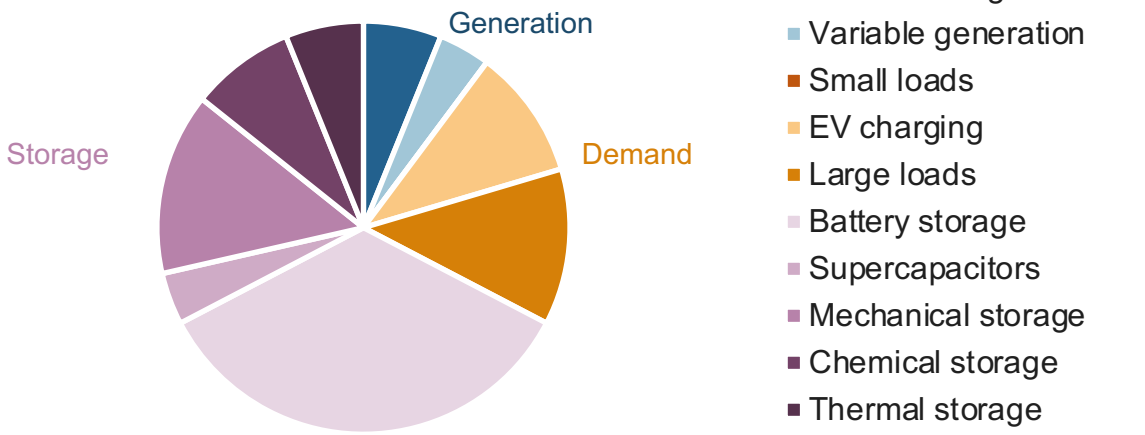




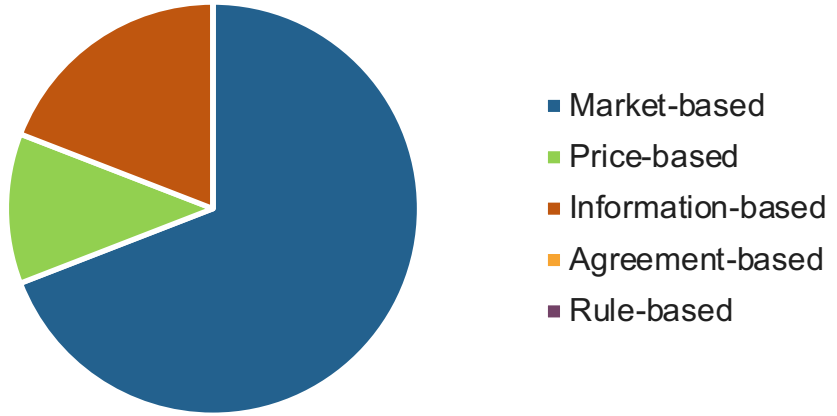


Distribution of flexibility solutions

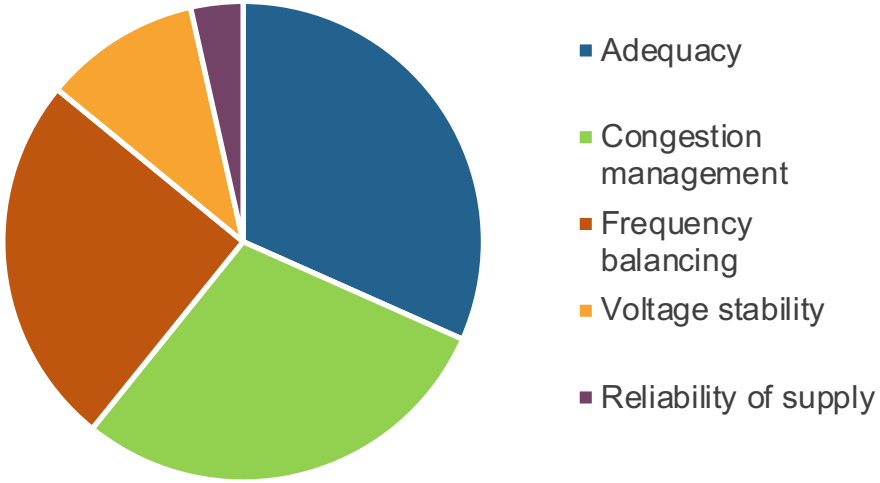
Source



Instruments



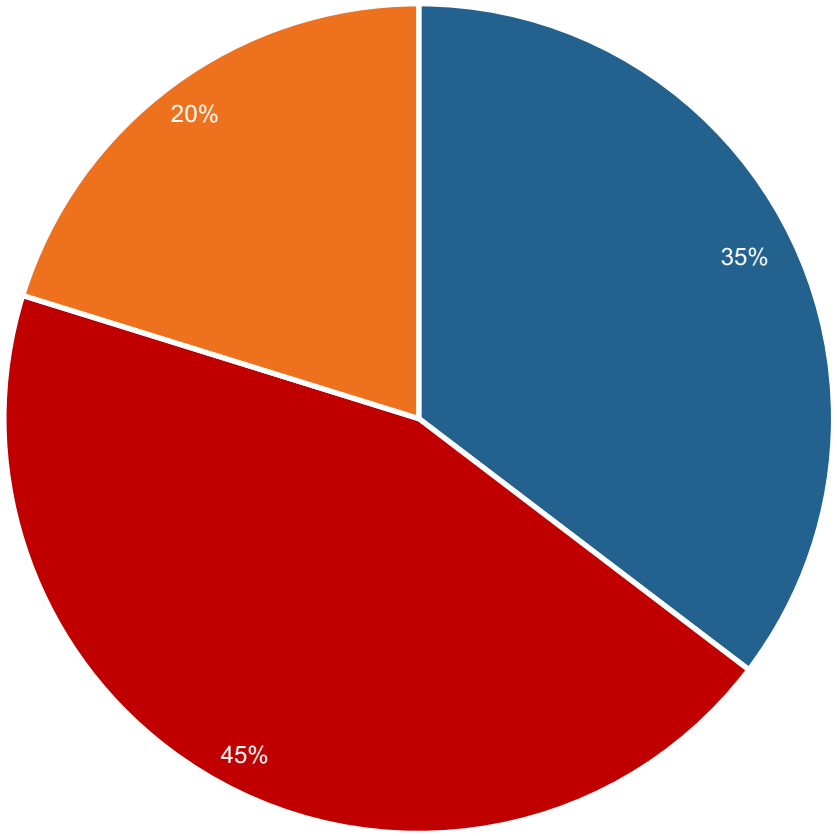
Needs



Source: Includes the share of demonstrations/projects which research source and not instrument, i.e. those covered by “technical solutions”.
Instruments: Includes the share of demonstrations/projects which research instruments and not sources, i.e. those covered by “market-based” and “other instrument-based solutions”.
Needs: Includes all demonstrations/projects.

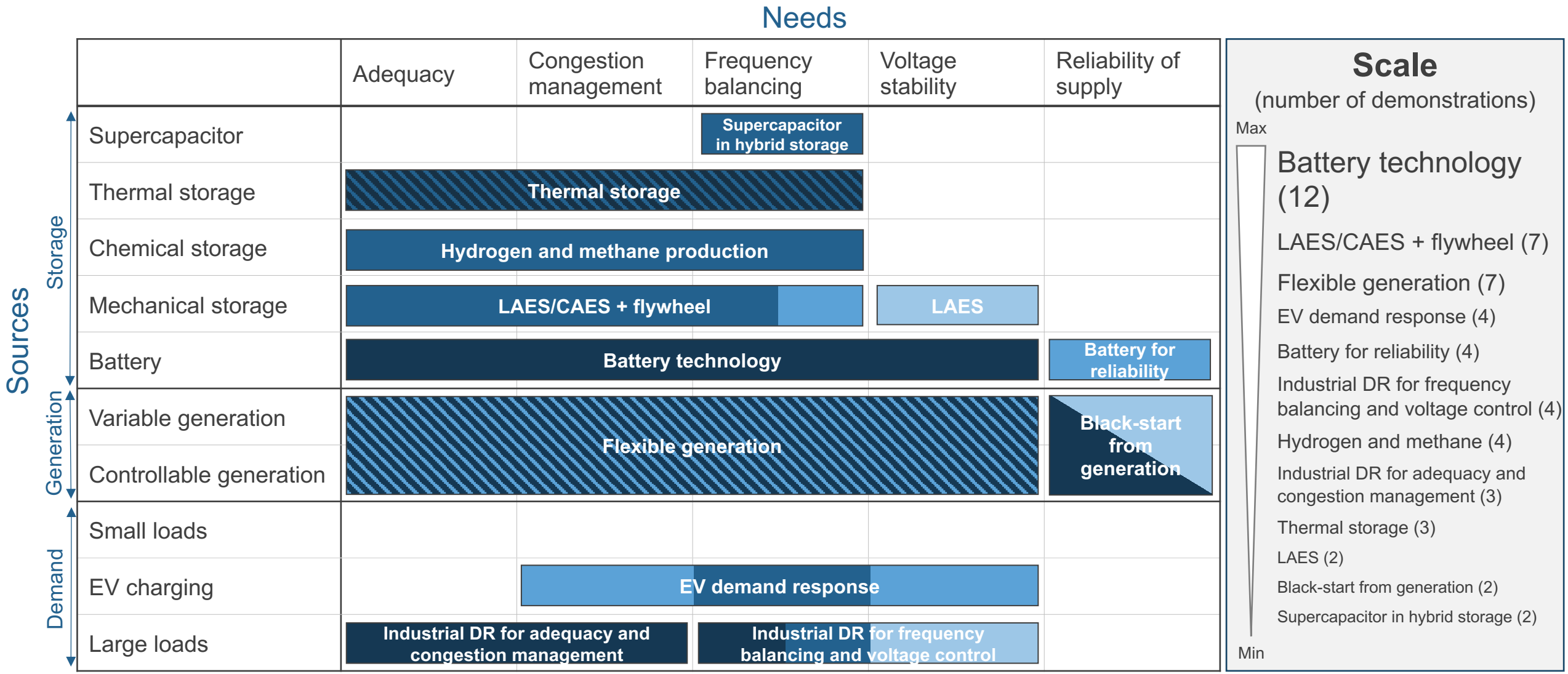
Structure of mapping

All projects and demonstrations have been mapped into at least one solution. This shows the share of projects and demonstrations in each of the three matrices.



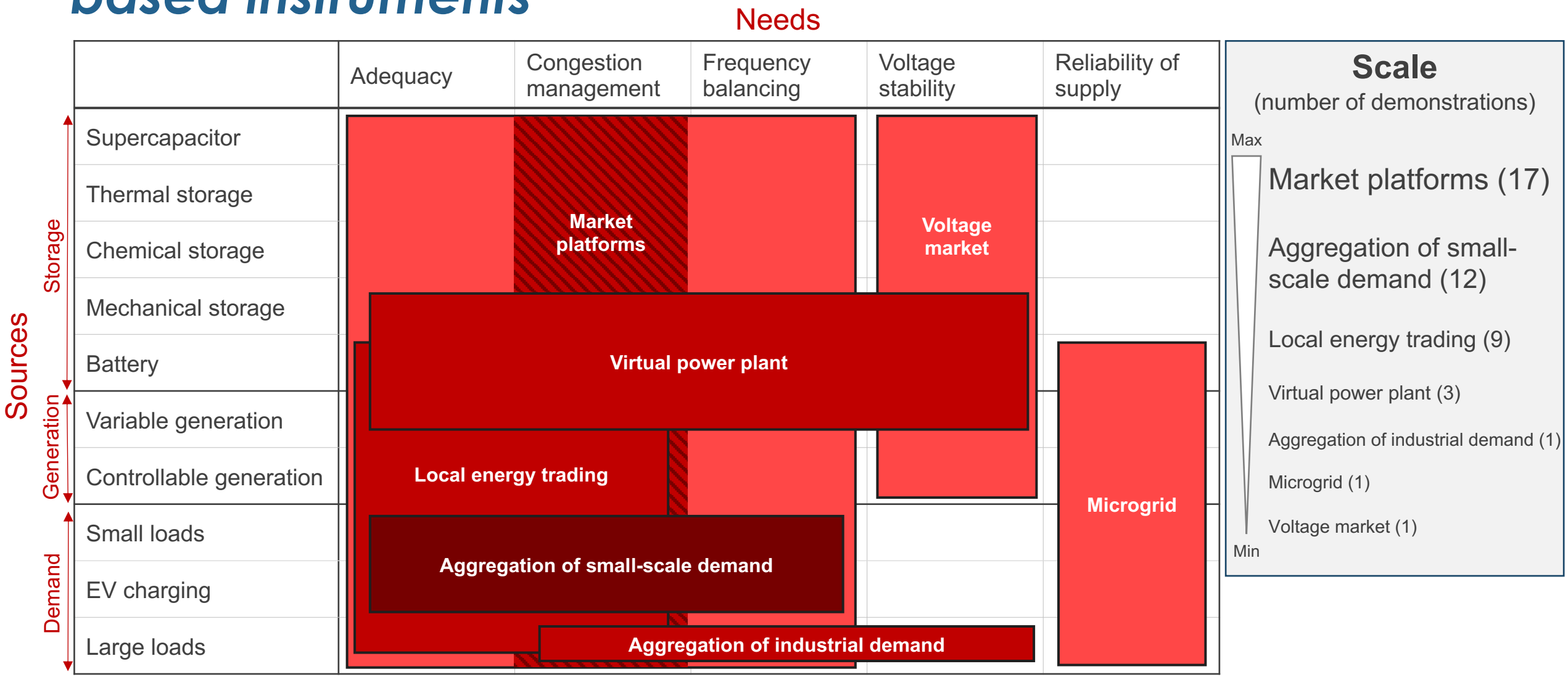
- **Technical flexibility solutions:** how a source technically can provide services to address a flexibility need
  - *Are non-instrumental solutions*, i.e. do not cover how sources can be accessed or incentivised
- **Market/incentive-based flexibility solutions:** how markets can provide incentives for provision of flexibility services and/or how generation, demand or storage can be organised to provide products on markets
- **Other instrument-based solutions:** any other solution that does not focus on the flexibility source itself, but rather how to organise or create incentives for its provision of flexibility
  - This matrix covers all four remaining instruments in the framework: price-, information-, agreement- and rule-based instruments.

Mapping research on flexibility solutions – *technical*



TRL 1 (building competence) TRL 2-3 (research) TRL 4-5 (development) TRL 6-7 (demonstration) TRL 8-9 (implementation)

Mapping research on flexibility solutions – *Market based instruments*



TRL 1 (building competence) TRL 2-3 (research) TRL 4-5 (development) TRL 6-7 (demonstration) TRL 8-9 (implementation)

Mapping research on flexibility solutions – *Other instruments*

Information-based
Price-based
Rule-based
Agreement-based

Needs

Sources

	Adequacy	Congestion management	Frequency balancing	Voltage stability	Reliability of supply
Storage: Supercapacitor					
Storage: Thermal storage					
Storage: Chemical storage					
Storage: Mechanical storage					
Storage: Battery					
Generation: Variable generation					
Generation: Controllable generation					
Demand: Small loads	Demand response to information				
Demand: EV charging	Demand response to price				
Demand: Large loads					

Scale
(number of demonstrations)

Max

Small-scale demand response to information (13)

Small-scale demand response to price (6)

Min

TRL 1 (building competence) TRL 2-3 (research) TRL 4-5 (development) TRL 6-7 (demonstration) TRL 8-9 (implementation)

9: Battery technology (storage for voltage stability, frequency balancing, congestion management and adequacy)

Description:

The solution consist of utilising the fast and versatile nature of batteries to provide ancillary services to DSO and TSOs. The primary services are frequency balancing, voltage support and congestion management. The battery types that are addressed in this flexibility solution are medium size batteries and aggregated small domestic batteries. It is also possible to address adequacy by adjusting charging and discharging to peak in an hourly perspective so that the demand curve is more stabilised.

Partners
TSO
DSO
TSO-DSO
Power exchange
ESCO

Scope

Local

Countries:

France, Italy, Germany, United Kingdom, Spain, Austria, Belgium, Ireland, Slovenia

Related solutions:

- Market platforms
- Virtual power plant
- Local energy trading
- Flexible generation

Covered dimensions in the flexibility framework:

Source		Instrument	Need
Gene-ration	Controllable	Market/incentive-based	Voltage stability
Gene-ration	Variable		
Demand	Small loads	Price-based	Frequency balancing
Demand	EV charging		
Demand	Large loads	Agreement-based	Congestion management
Storage	Battery		
Storage	Supercapacitor	Rule-based	Adequacy
Storage	Mechanical		
Storage	Chemical	Information-based	Reliability of supply
Storage	Thermal		

TRL 8 – implementation

While battery technology is capable of addressing all the needs mentioned, the projects research how to address barriers to flexible participation in the power system. However, it is currently not profitable. The efficiency and the life time of batteries are insufficient for this purpose. Regulatory and technical barriers prevent batteries from working together with other components in the power system, such as local generation and demand forecasts. Various pilots and demonstrations address potential solutions to these barriers.

Reference projects/demos:

- ELSA Pilot 1, 2, 3, 4
- INVADE
- The Smart Grid Battery Storage Project Prottes
- OSMOSE WP4 & WP7
- REnnovates
- STORY Pilot 5
- NETfficient
- SENSIBLE

Enablers and technology:

- Energy consumption/production forecast
- Algorithm/control system to control and map the available flexibility in the batteries.
- Inclusive market design
- Removal of regulatory barriers which prevent medium-scale batteries (fees for charging/discharging)

Conclusions

Summary of results

- Most of the research mapped addresses:
  - **technical solutions** (e.g. battery storage) or
  - **market incentives** and valorisation of flexibility
- Some research on variable prices and information-based instruments
- Little research mapped on regulation- or agreement-based instruments
  - Possible explanations:
    - Not within the domain of R&D?
    - Omitted projects in the mapping?
    - Lack of research?

Dominant areas of mapped research:

- **technical solutions** addressing frequency balancing, congestion management or adequacy, particularly from **storage**
- **market-based instruments** addressing inclusion of additional sources of flexibility (particularly smaller-scale demand, generation and storage) into new or existing markets for frequency balancing, congestion management and/or adequacy
  - Market platforms: A dominant area of research. However, there seems to be much overlap of projects. Many projects cover very similar solutions, both in the commercial and regulated domains.

- Most of the gaps can be explained due to low technical fit of the solutions

Contact

The main work of mapping has been conducted by Tuva Eikås Hagen, Vegard Svensli Åsvestad and Maren Holthe Hedne (summer students at Statnett) under the supervision and with support of ENTSO-E RDIC WG3.

This work was conducted with valuable feedback and input from project coordinators, ENTSO-E and TSOs.

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BNI Flexibility Framework & Mapping

Way forward

BUSINESS NETWORK INNOVATION

Norela Constantinescu, Manager R&D ENTSO-E

5 December 2019

entsoe

Reliable Sustainable Connected

Where do we want to land in 2030?

2030+

- 2030 Vision: a ‘system of systems’
- Seamless integration of markets and operations

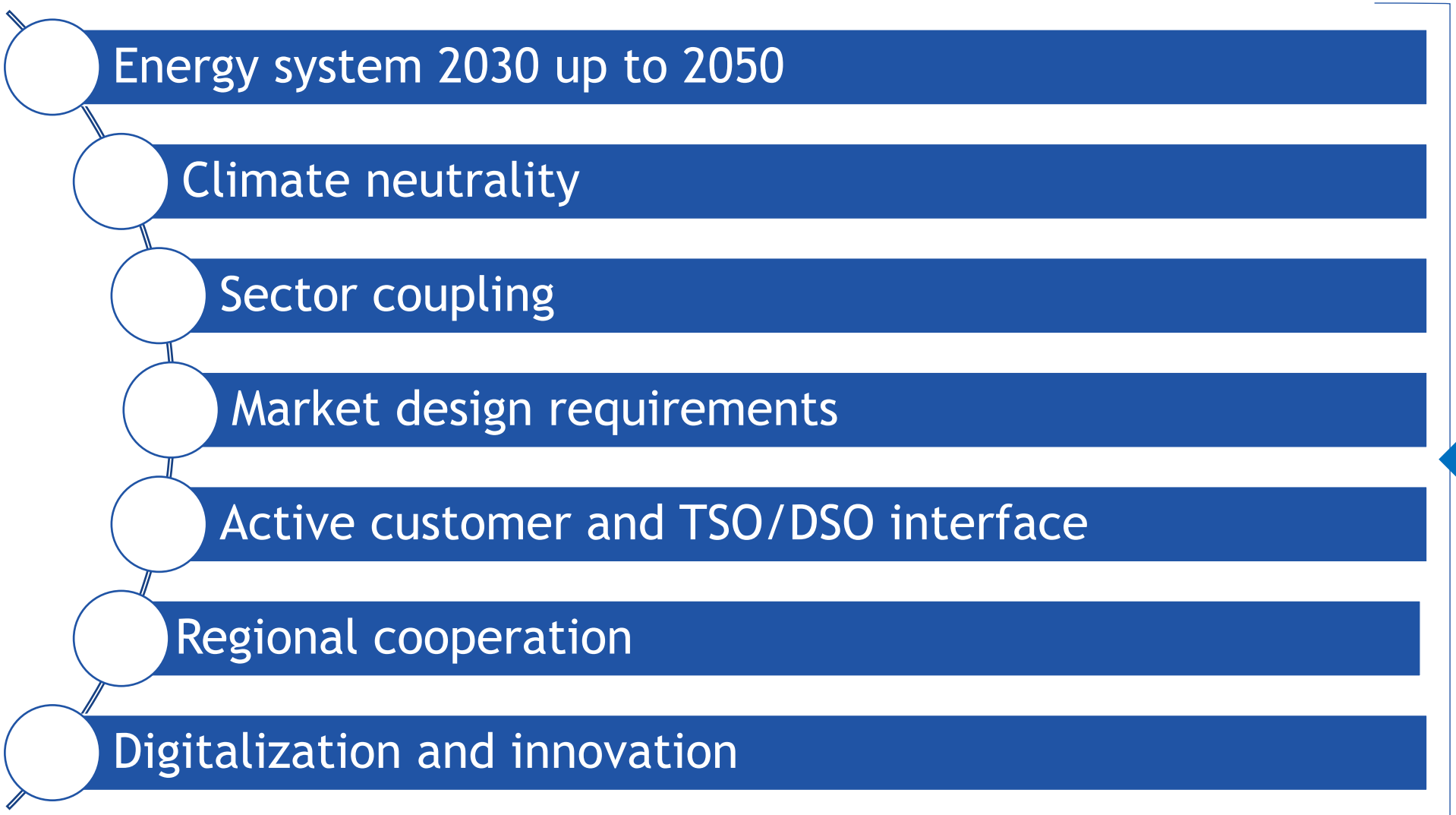
2025+

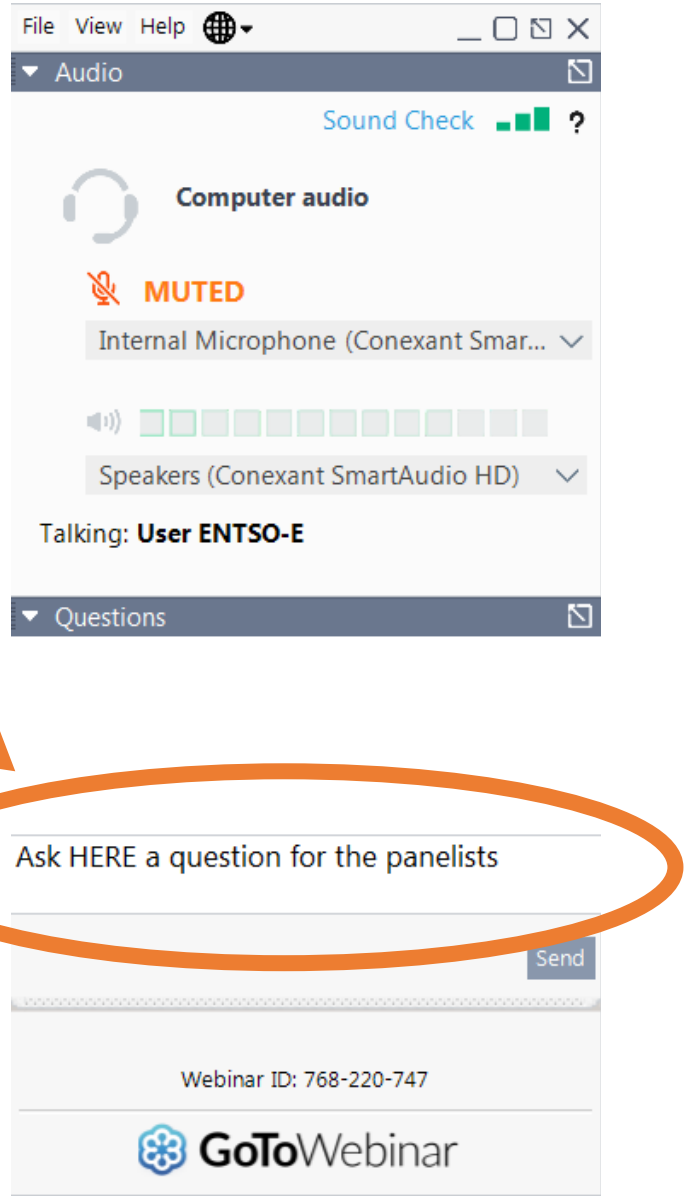
- Sector coupling & sectorial integration
- Digital tools & platforms
- Research & Innovation
- Enhanced regional coordination

2020+

- Network Codes and Guidelines implementation
- Clean Energy Package
- TSO-DSO cooperation

How do we get there?

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