A power system for a carbon neutral Europe

entsoe VISION

Webinar 2

Operating and Building the Grids of the Future

DAY 2, 11 OCTOBER

#VisionEvent22

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Day 2, Webinar #1, 11 October

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INTRODUCTORY REMARKS

Tahir Kapetanovic

Chair of SOC, ENTSO-E

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ENTSO-E Vision for the future of the European Power System

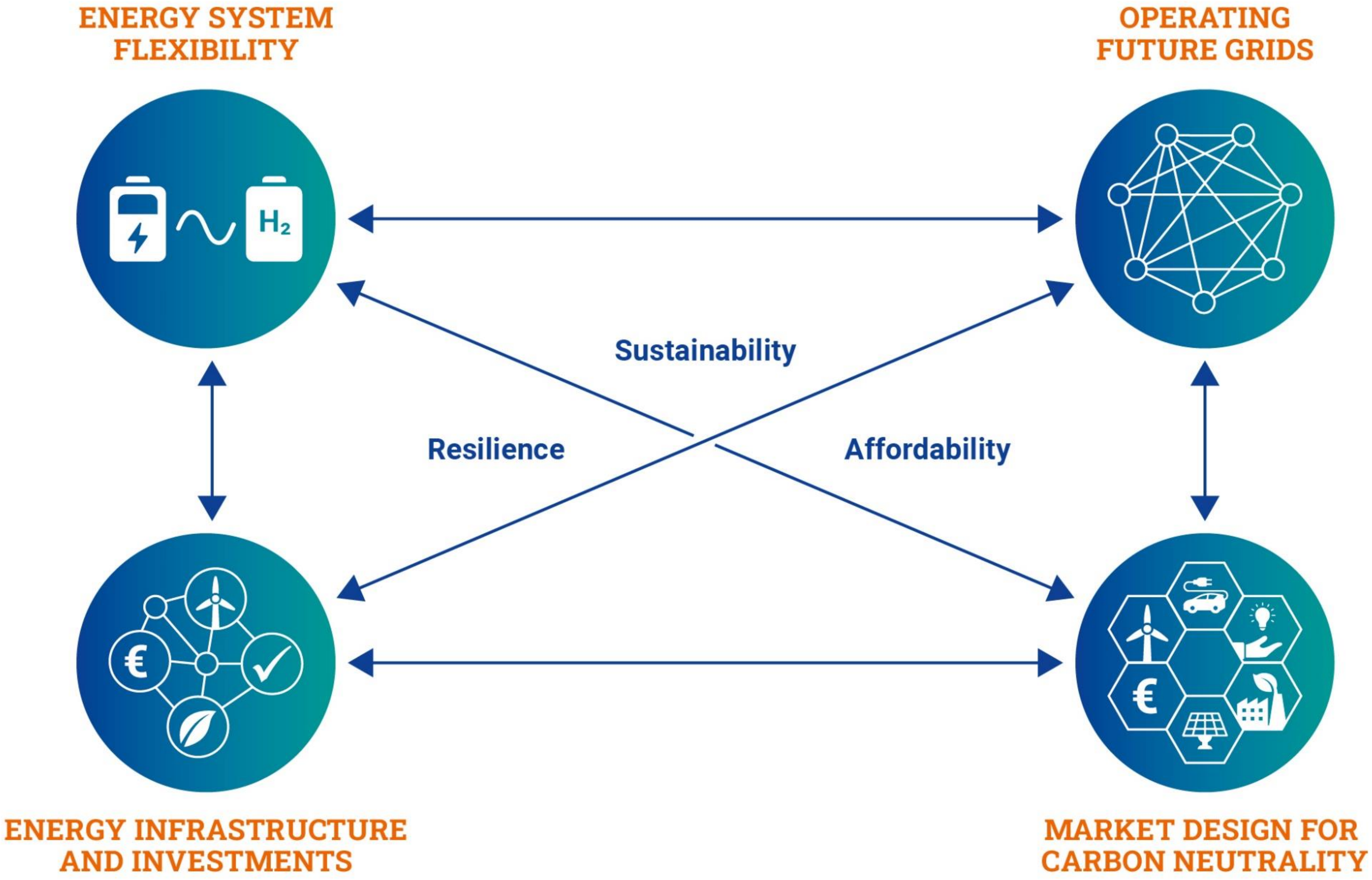
Guiding principle

- A shared political goal for a fully **carbon-neutral European economy**

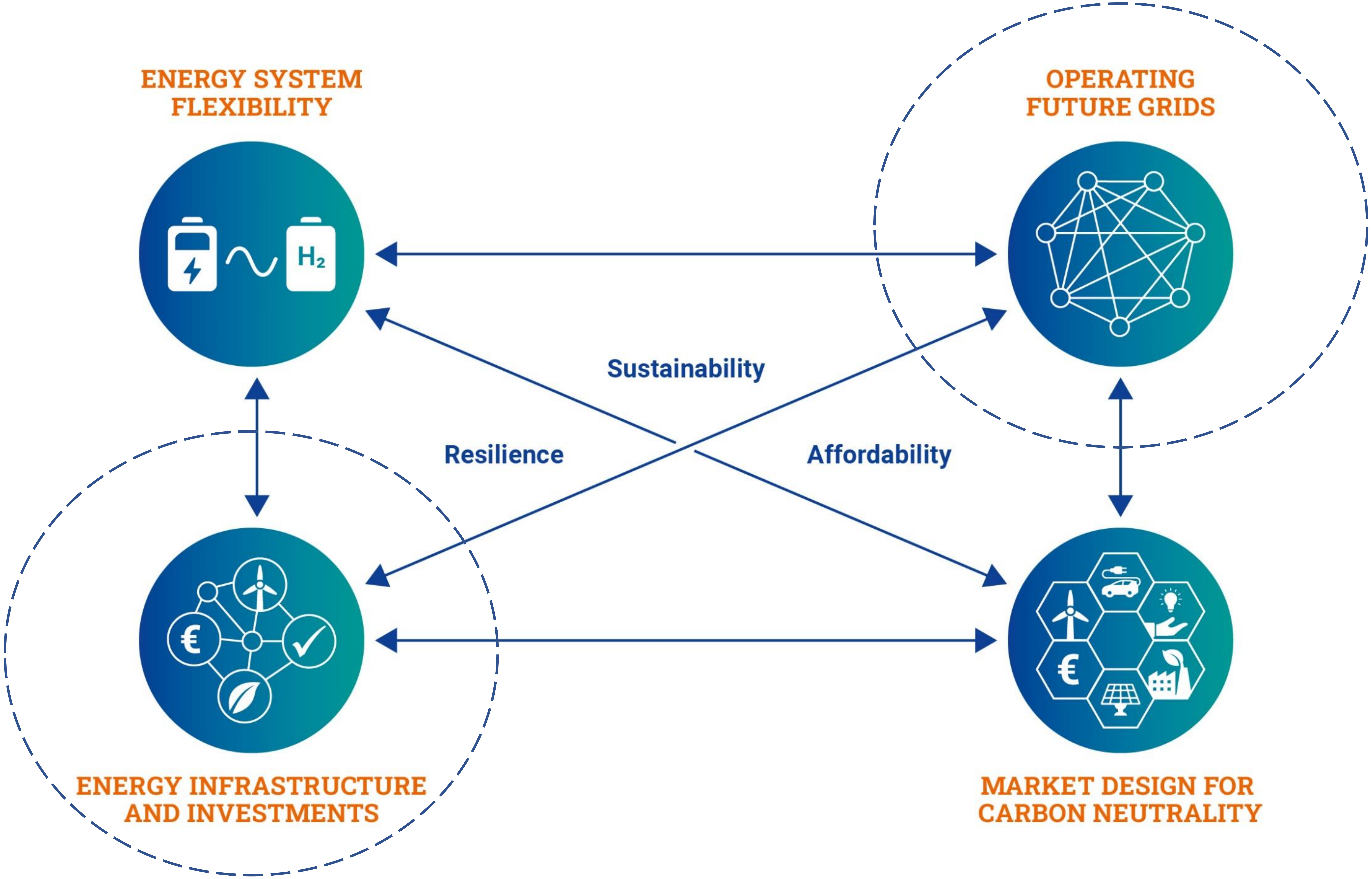
Our Vision

- A **comprehensive analysis** of what is necessary to achieve a power system fit for a carbon-neutral Europe
- As a contribution to the debate on the **European Energy Transition**
- Including **TSOs shared intelligence** on trends, scenarios, challenges, technology & innovation

A Vision based on 4 Key “Building Blocks”



A Vision based on 4 Key "Building Blocks"



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Presentations by ENTSO-E Vision Project Members

Operating and Building the Grids of the Future

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OPERATING THE GRIDS OF THE FUTURE

Martin Pistora, Danny Klaar

ENTSO-E Vision Project Team Members

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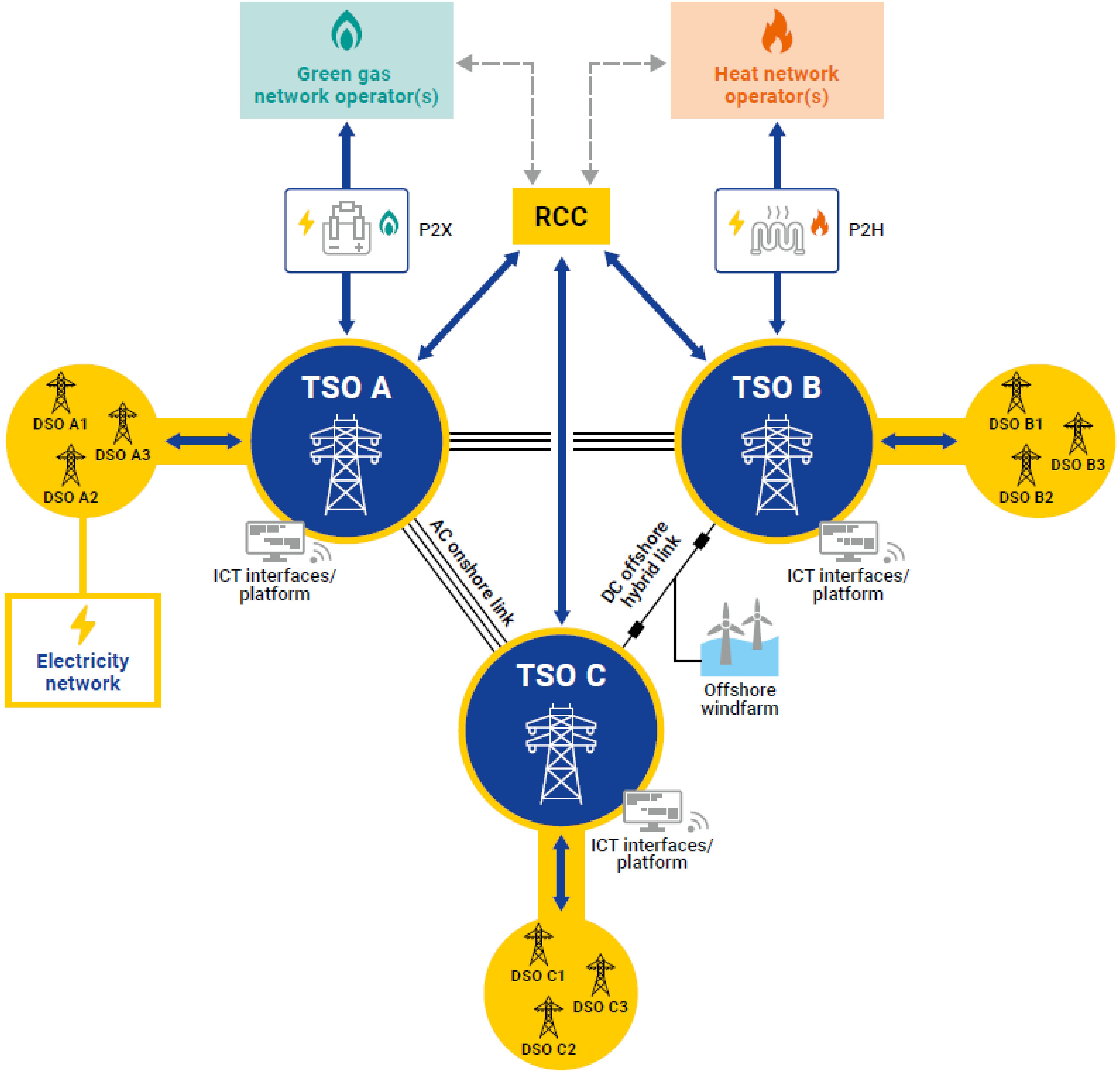
Characteristics of a Future Grid

Hybrid AC/DC system	Weather-dependent system
Power electronics interfaced devices	Significant increase of active devices
Stronger interconnections in the electricity system	New interfaces between sectors



Key Challenges and Key Enablers

KEY CHALLENGES

- Significant growth in grid complexity, increase in Power Electronic (PE) equipment
- Growing number of inter-connectors, sector coupling
- Climate change, new threat landscape
- Transformed operator environment, knowledge gap

KEY ENABLERS

- Increased grid visibility, forecasting capabilities and controllability
- Intelligent, automated control systems
- New concepts for improved coordination
- Risk-based methodology
- New and improved modelling techniques
- Joint training

Factors Impacting System Stability

Variable, Renewable Energy Resources

Conventional Power Electronics Interfaced Resources & Devices

Long Distance Transmission & Weak Connections

Long HVAC cables

Climate Change & Extreme conditions

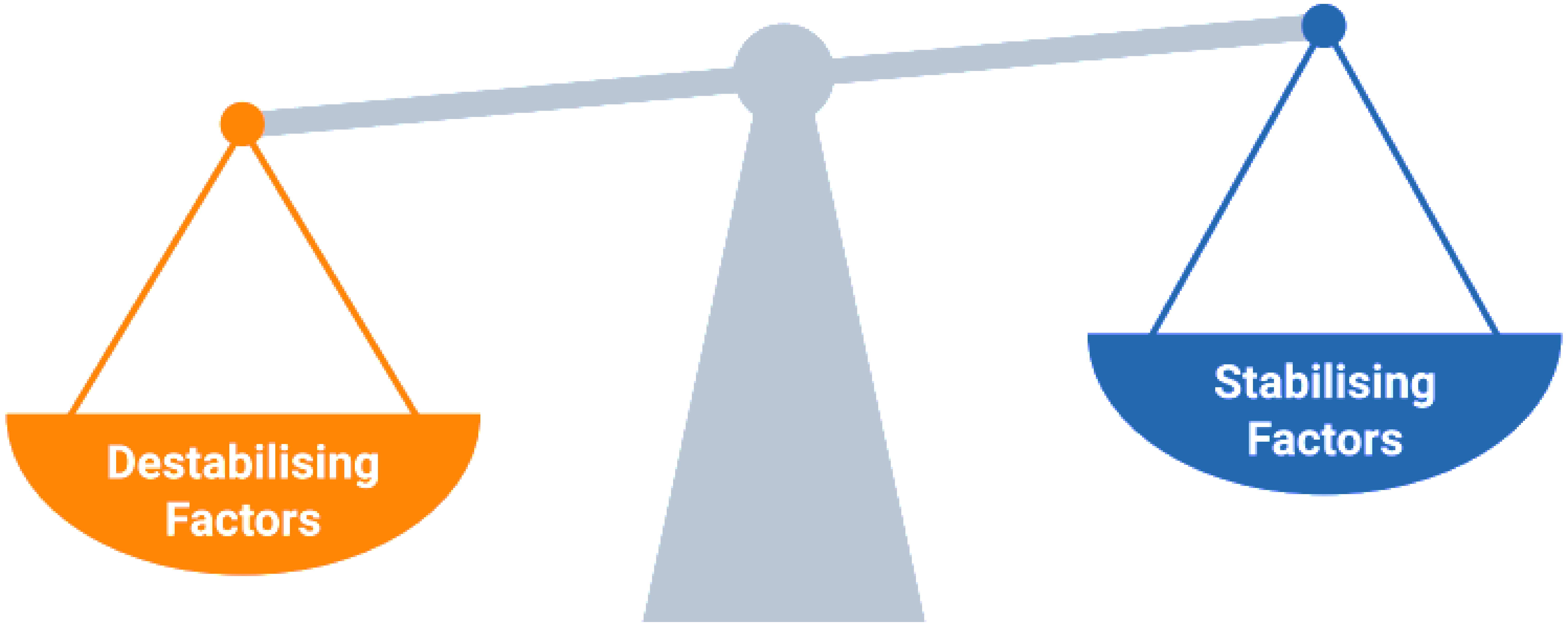
Advanced Monitoring & Control of Stability

Simulation Techniques & Models

Controllable Resources & Flexibility

Grid Forming Capabilities of Power Electronis & Interoperability

Synchronous Generation



Controlling the Future Grid

Visibility	• Extension of the observability area to other systems and sectors • Enhanced forecasting capabilities
Controllability	• Utilizing capabilities of the active devices • Sending commands to millions of devices • Ensuring control in normal and emergency states
Intelligent control systems	• Extending the initial response of the grid • Decision support for the human operators


Power System Stability Phenomena
Resonance stability
Converter driven stability
Rotor angle stability
Voltage stability
Frequency stability
New phenomena
Timeframe of milliseconds
Growing and changing phenomena
Timeframe of seconds

Factors impacting Resilience

Extreme weather conditions	Digitalization & Automation	Interoperability
Design of power system controls	Design of protection devices	Cyber security

Measures to enhance Resilience

Enhanced weather forecasting

Robust infrastructure across sectors

Cross-sector cooperation

Multi-sector risk awareness

New modelling techniques

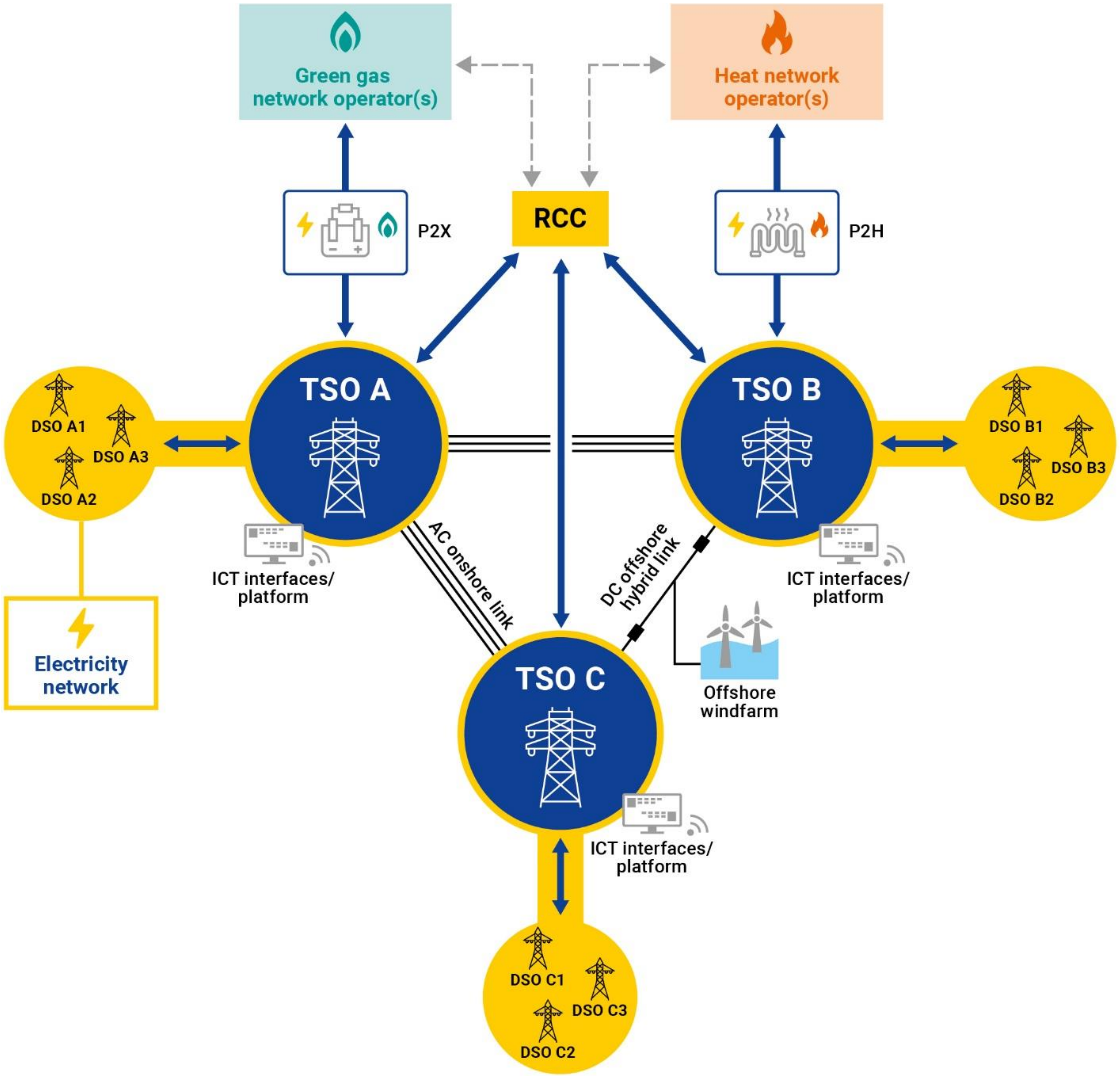
Training

Operation in a System of Systems

The future power system will be much more **complex** than today, with growing weather dependency, sector integration and large-scale flexibilities. It will need new approaches to **operate it safely and efficiently**.

In particular, the **operation of the transmission grid** will be done in close cooperation

- amongst **TSOs** at European and Regional level, assisted by RCCs
- with **DSOs** inside each control zone
- with other **energy sectors** integrated with the power system



Operating Future Grids – Recommendations

- The future will be a System of Systems, which means that TSOs, DSOs and other energy sectors shall cooperate to make the most efficient use of all types of flexibility resources and coordinate the planning and operation of the different systems.

- Within this system of systems, an adequate level of system resilience shall remain a priority for TSOs, other operators, policy makers and stakeholders.

- TSOs, DSOs, manufacturers and research centres should further develop knowledge and tools to optimize the operation of the systems including advanced modelling and decision support.

- TSOs and relevant operators of the System of Systems should increase cooperation with standardization bodies and IT vendors to create standard rules, protocols and digital platforms enabling interoperability and cross-sector overview.

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BUILDING THE GRIDS OF THE FUTURE

João Moreira, Miguel de la Torre

ENTSO-E Vision Project Team Members

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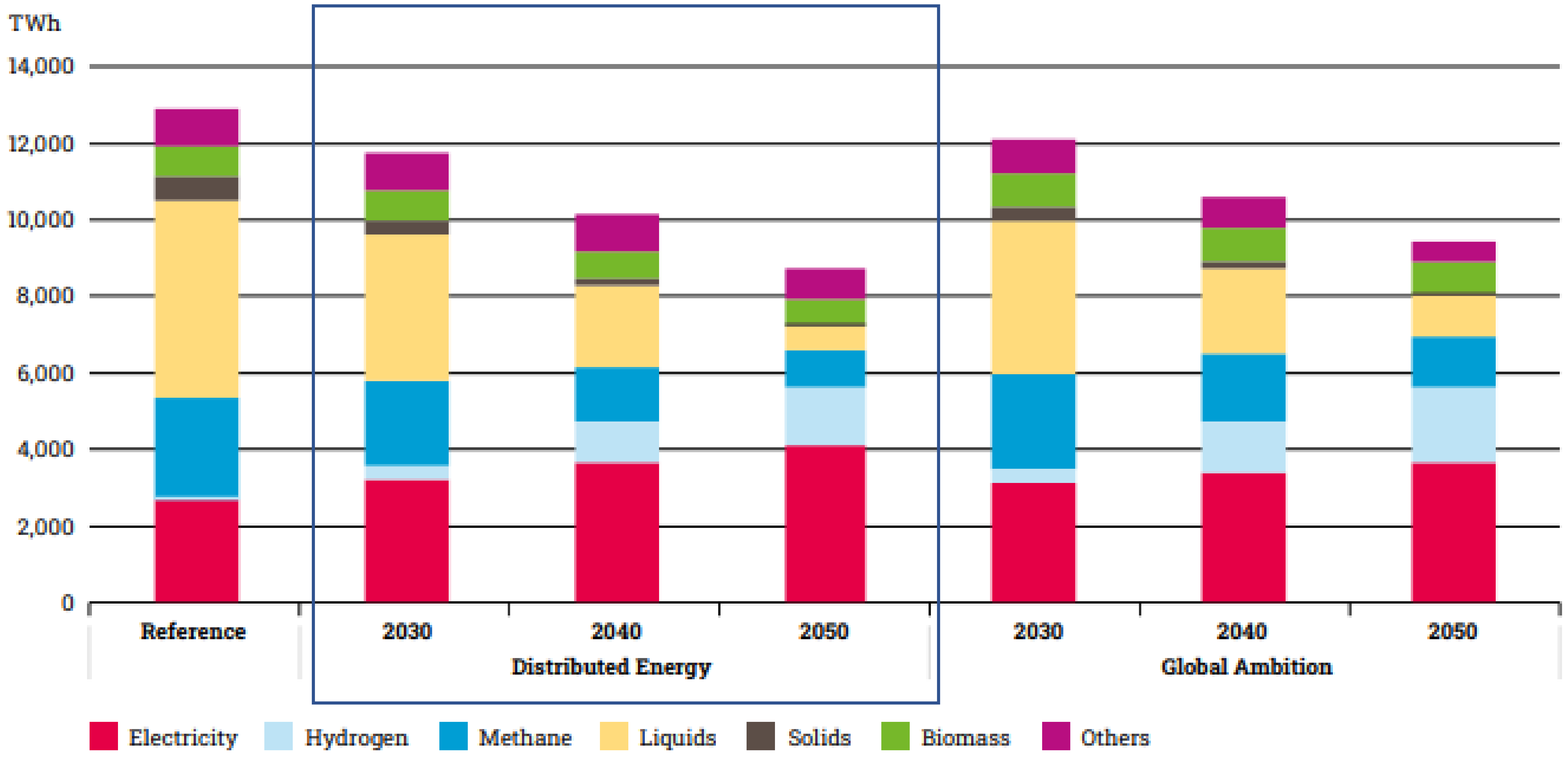
A carbon neutral Europe needs a much more electrified economy

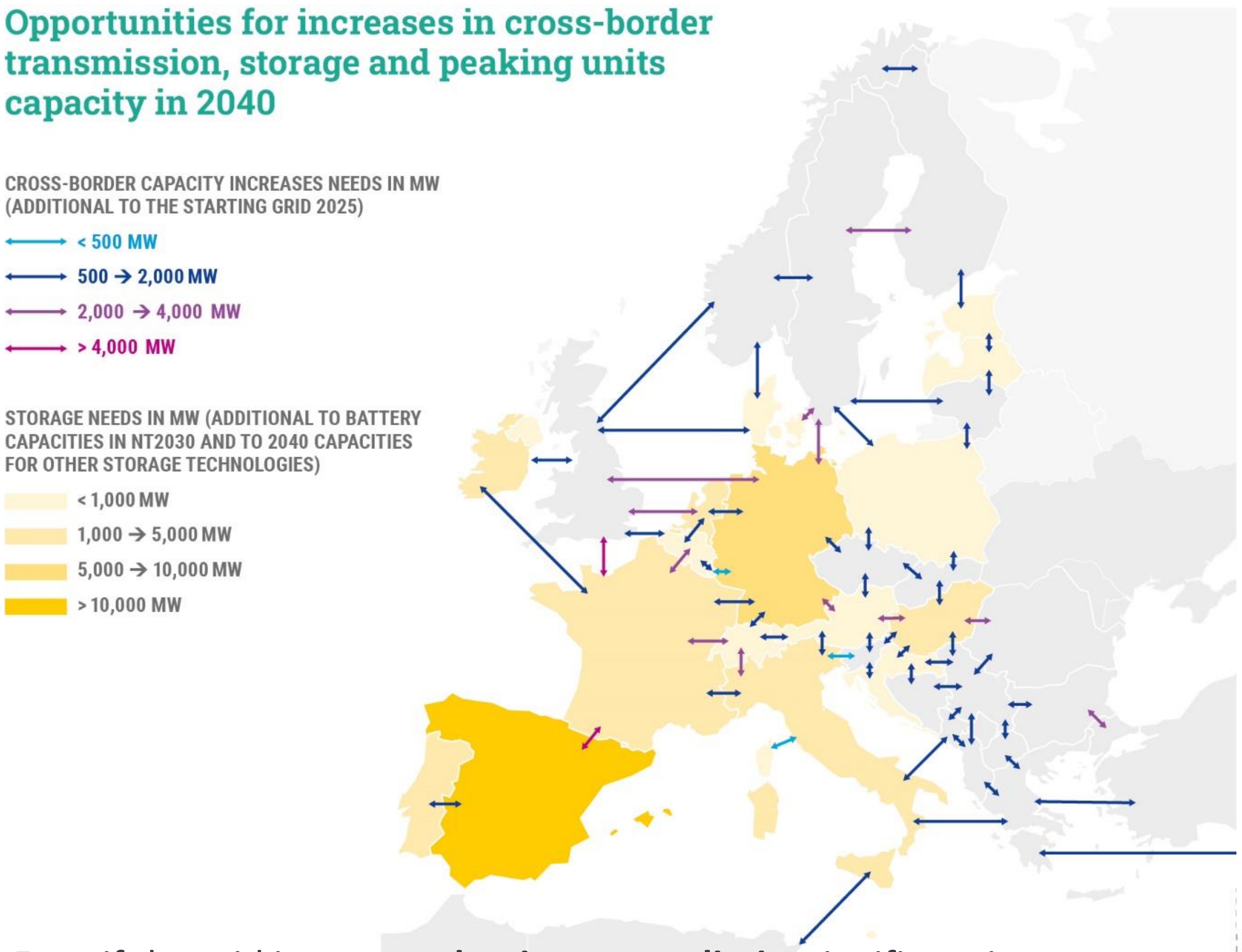
This Vision builds on the findings of the ENTSO-E Ten-Year Network Development Plan (TYNDP 2022) scenarios, demand and grid availability'.

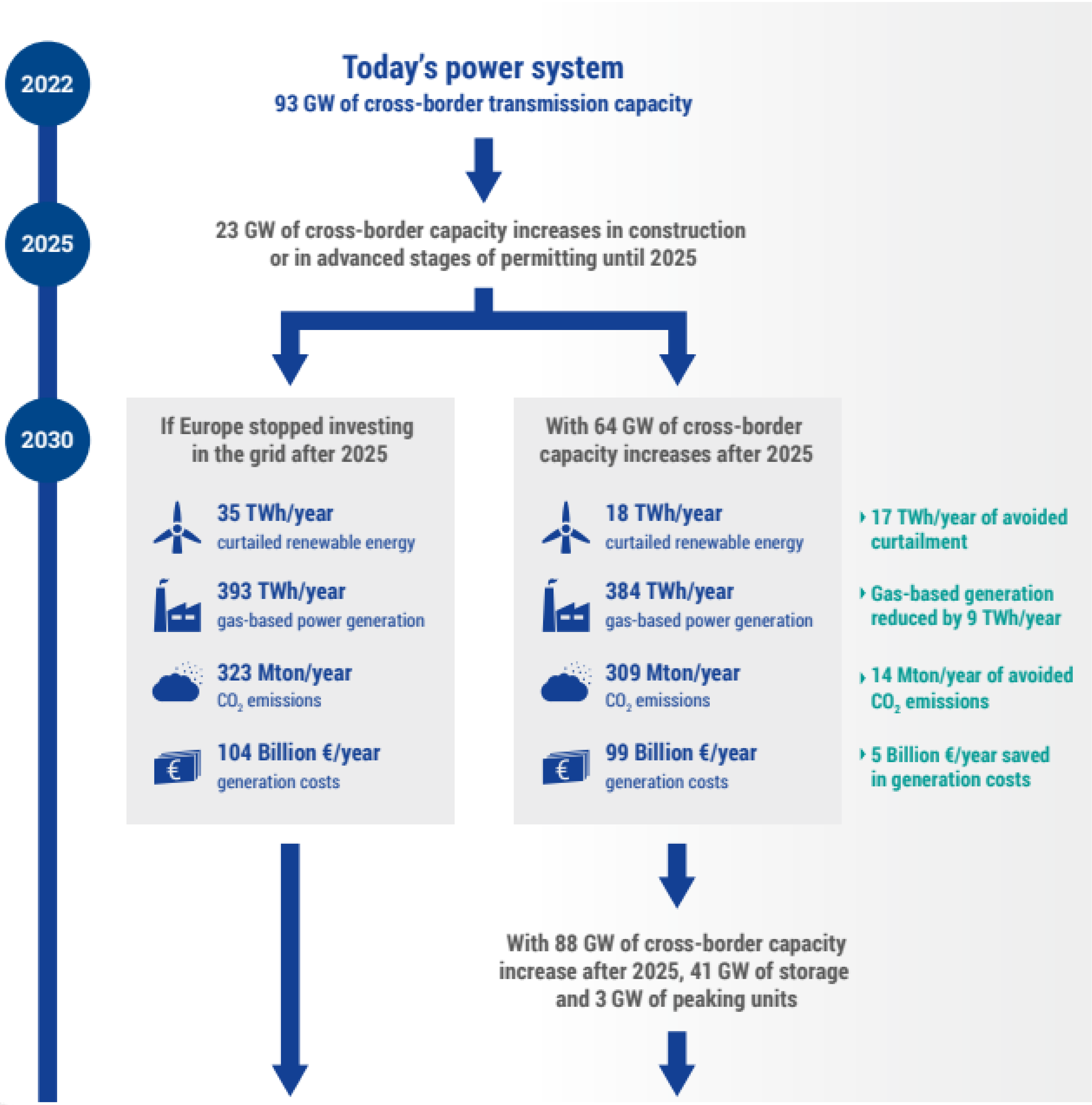


Final energy demand per carrier (energy and non-energy use for feedstock) for EU27. Scenario Building Report TYNDP2022.

What electricity grid needs in Europe are identified?

Investment Needs 2040 IoSN ENTSO-E TYNDP2022

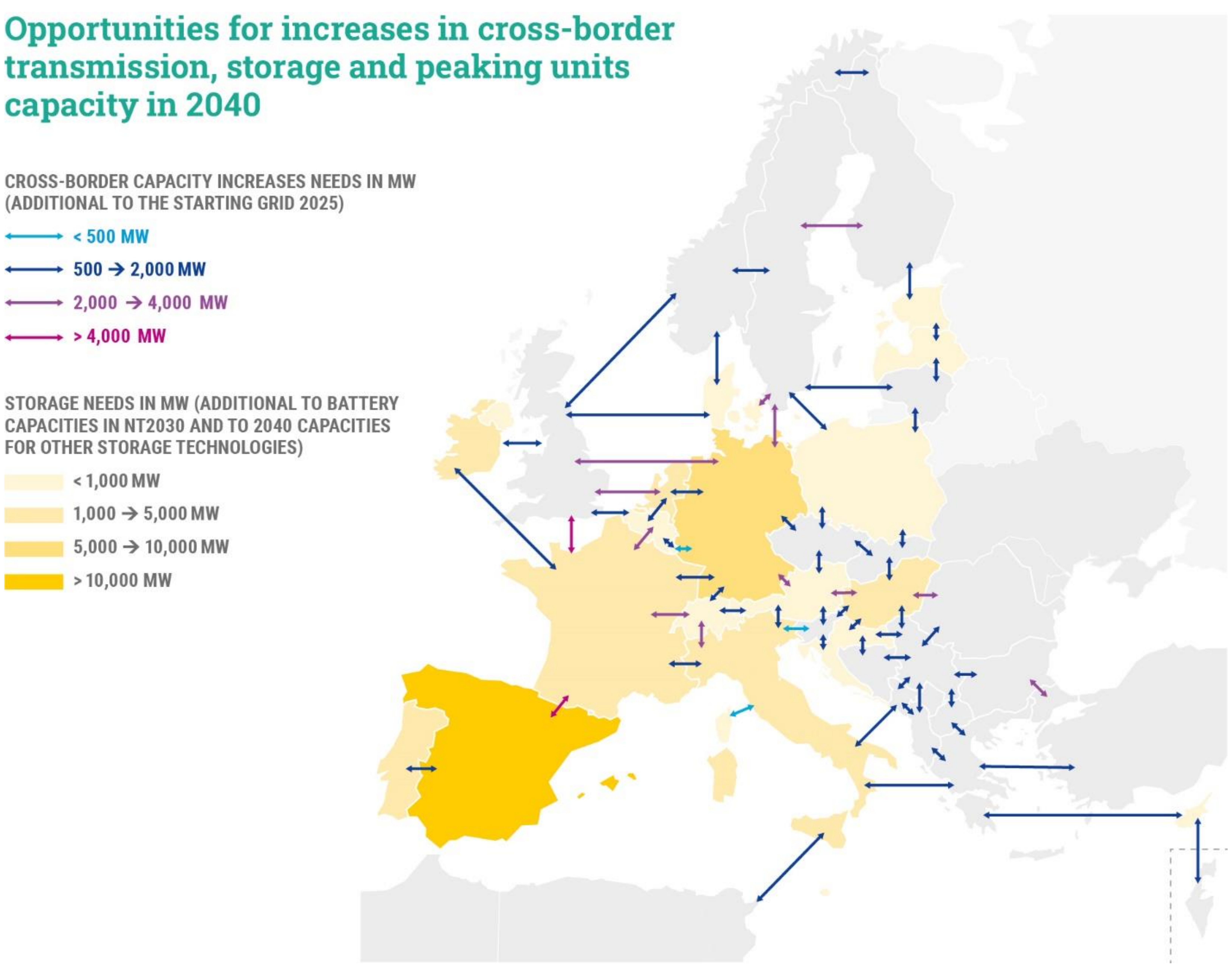


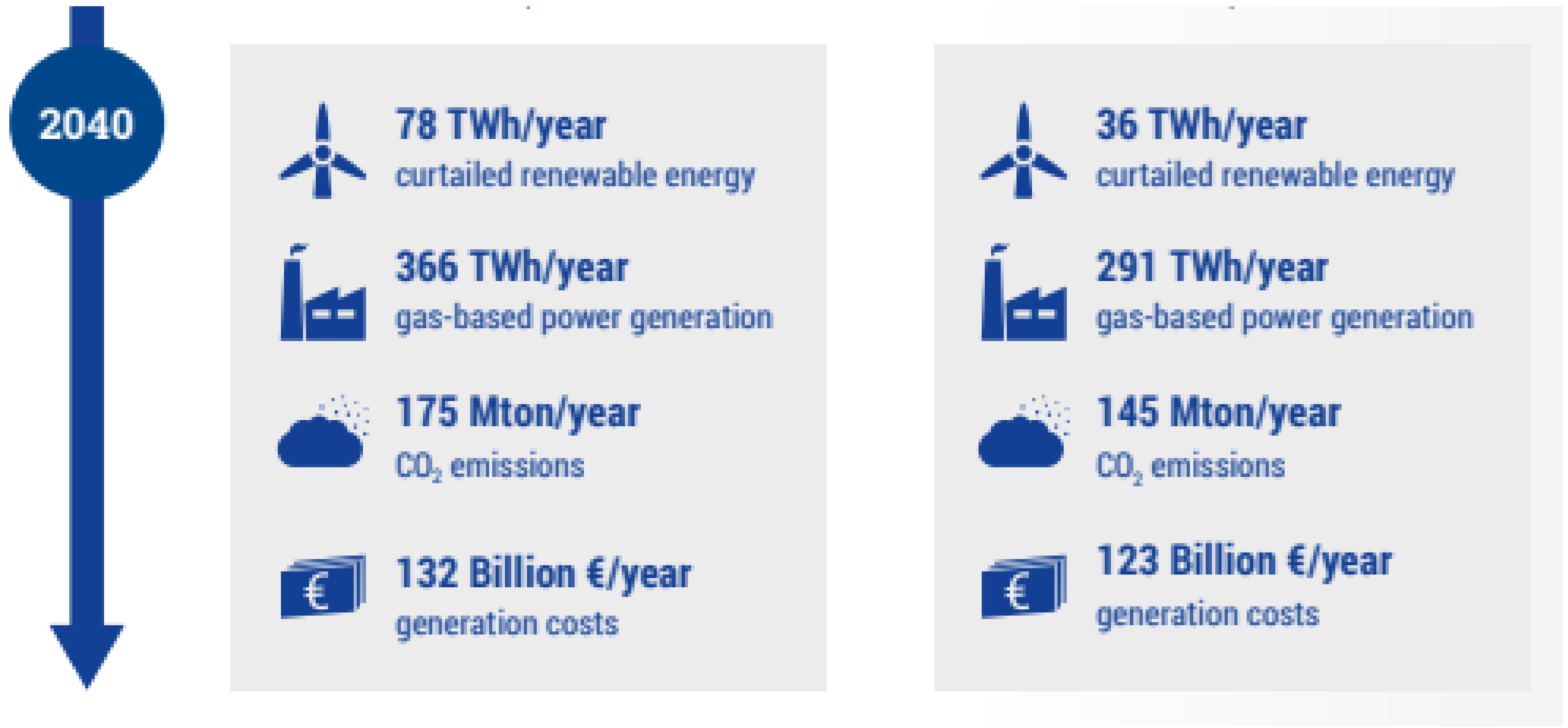


Even if the grid is **operated to its utmost limits** significant investments are still needed.

What electricity grid needs in Europe are identified?

Investment Needs 2040 IoSN ENTSO-E TYNDP2022

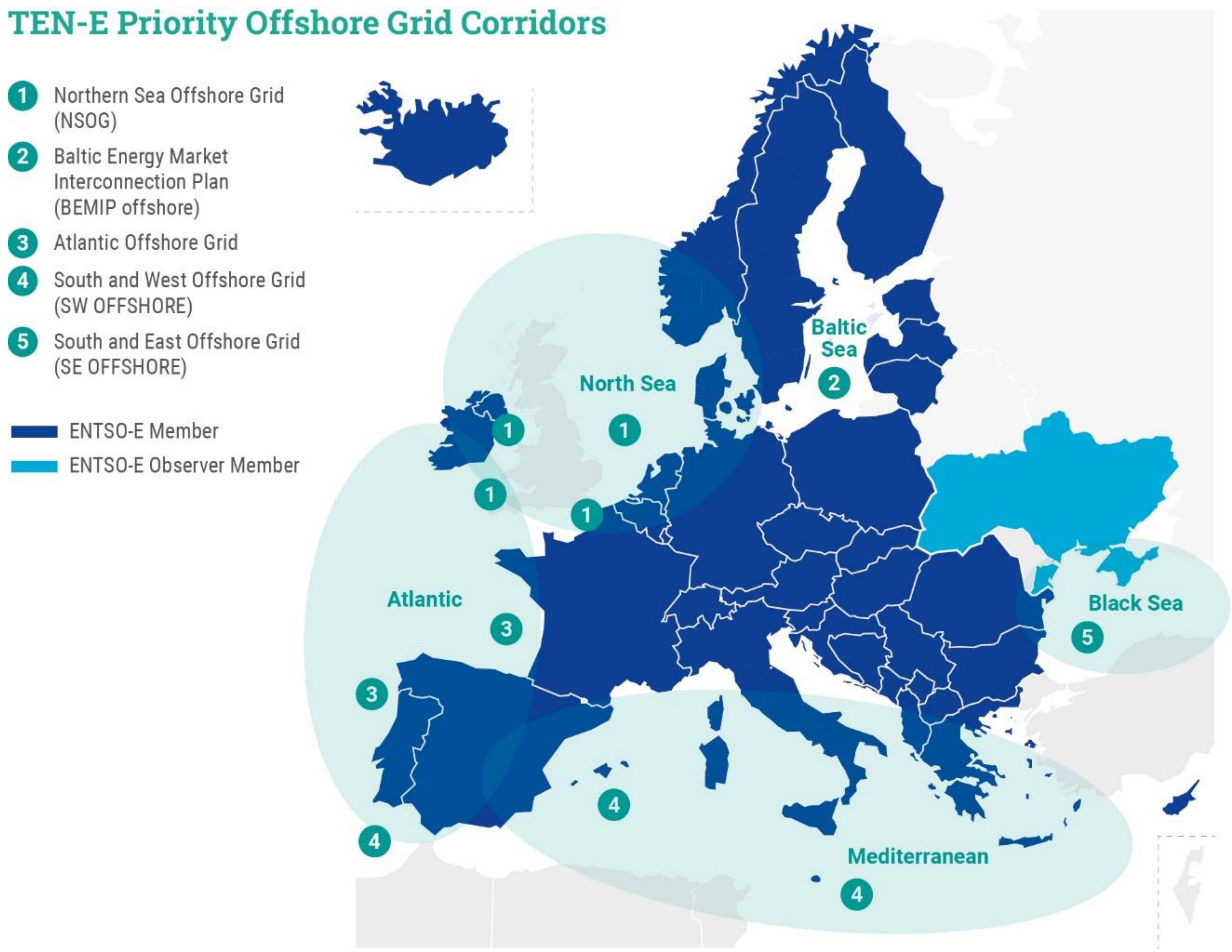




- 42 TWh/year of avoided curtailment
- Gas-based generation reduced by 75 TWh/year
- 31 Mton/year of avoided CO_2 emissions
- 9 billion €/year saved in generation costs

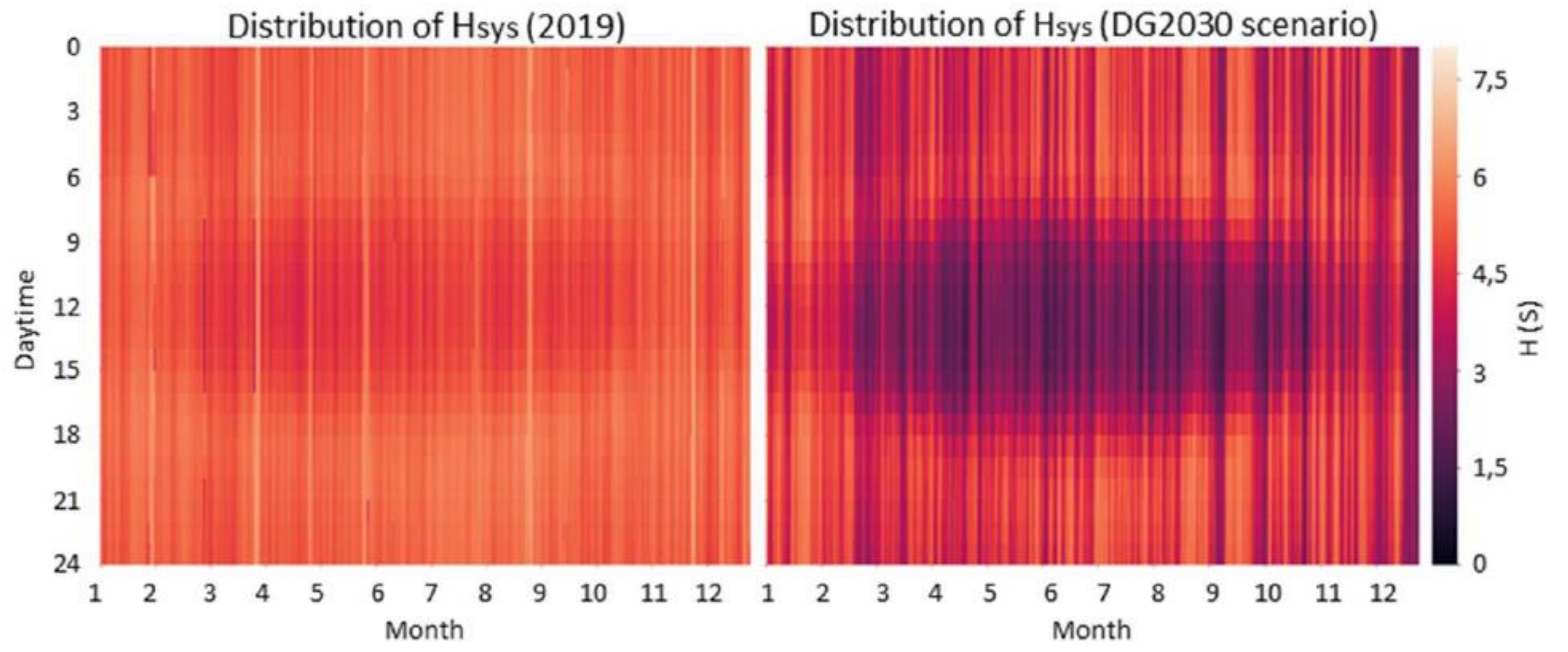
What electricity grid needs are identified?

The transmission system will evolve both onshore and offshore



Development of offshore grids through a **combination of sub-marine transmission infrastructure, radial connections, and multi-purpose solutions**: key contribution to decarbonization goals.

New investments **also needed to ensure stability management** along with new capabilities to be provided by grid users



Distribution of the total system inertia in the year 2019 and DG 2030 scenario (Inertia and Rate of Change of Frequency (RoCoF) Version 17 SPD – Inertia TF, ENTSO-E, 16. Dec. 2020)

Infrastructure Needs - Decarbonized electricity system key elements

NEW GENERATION MIX

- Increase in wind generation on shore and offshore
- Additional penetration of solar PV and evolution of batteries
- Phase out of conventional gas and coal-fired plants and nuclear in some countries

TRANSFORMATION OF THE LOAD

- Additional electricity share.
- New types of consumers
- Change and increase in the load peak
- Possible increase in the power flow inversion

EVOLUTION OF THE DISTRIBUTION SYSTEM

- Power flows
- Market services
- Smart grids

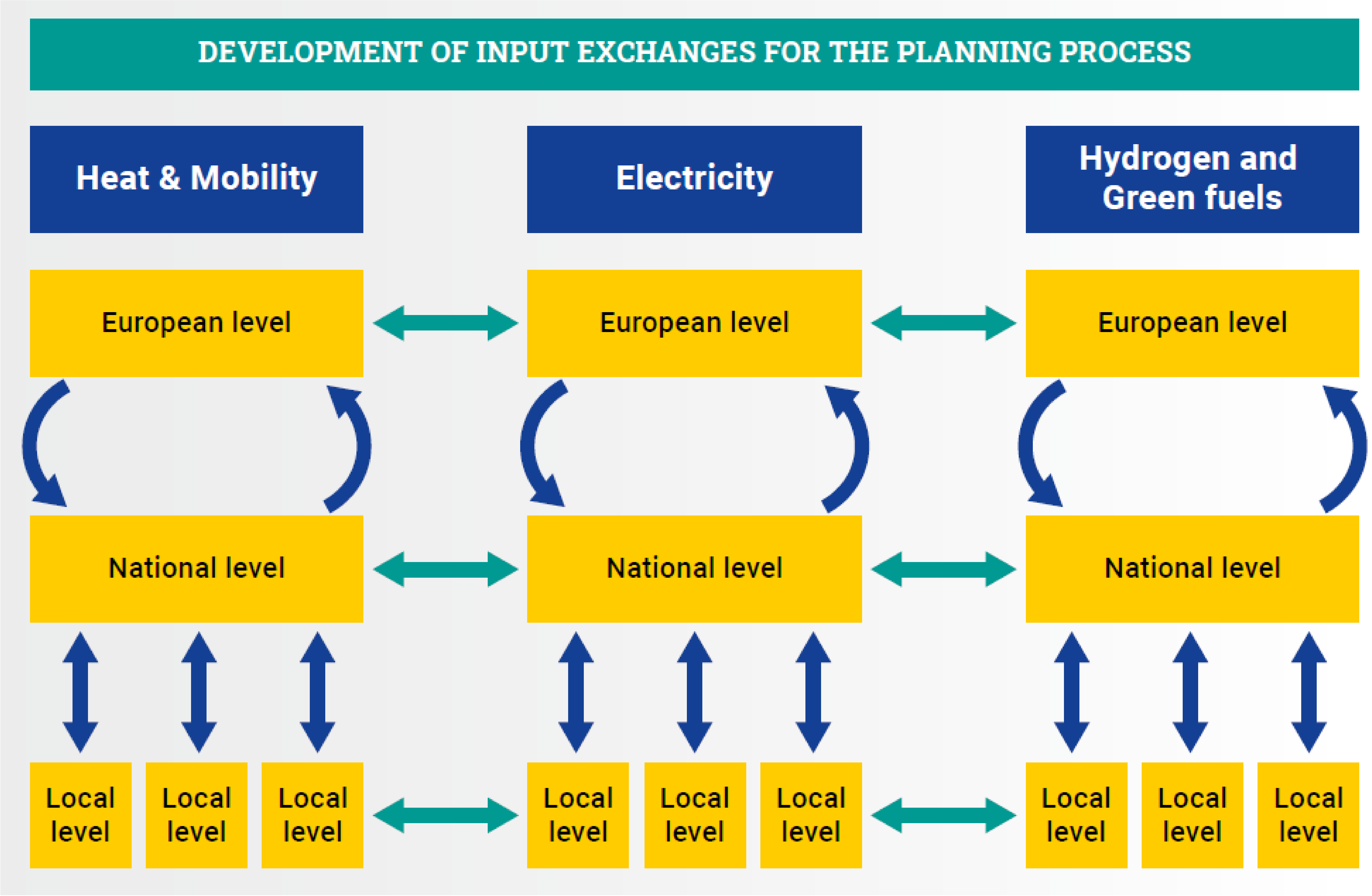
DEVELOPMENT OF THE TRANSMISSION SYSTEM

- Power electronics
- Interconnections and DC links
- Sector integration
- Resilience & security of supply

Energy Infrastructure & Investments – planning processes

Integrated planning processes to achieve a true System of Systems

- onshore and offshore
- across sectors (horizontal)
- across voltage levels (vertical)



Energy Infrastructure & Investments – a necessary condition

Improved regulatory framework and stakeholder engagement for timely development

- The regulatory framework should further **promote public acceptance and permitting** and incentivize effective and most importantly **timely infrastructure financing, development and innovation**.

- It is also necessary to have measures in place that guarantee **adherence to the planned timelines** through:
  - **maximum binding timelines**
  - **dialogue** between the promoter and the different authorities,
  - **silent consent provision** for some authorizations,
  - **introducing simplified environmental assessment** procedures for pre-existing assets.

- **Support from communities** hosting the infrastructure is crucial, also as final benefiters of a timely evolution of the energy transition.

Our Recommendations

1. The future will be a **System of Systems**, which means that:
   - TSOs, DSOs and other energy sectors shall cooperate to make the most efficient use of all types of flexibility resources, and coordinate the planning and operation of the different systems.

2. TSOs shall enhance the planning processes to increase **transparency** and **inclusiveness** for local communities and stakeholders.

3. The **regulatory framework** should evolve to value innovation, facilitate financing and permit fast and clear authorization processes that are respective of environmental requirements.

4. All proposals and actions for the future system shall take into consideration their impact on the **affordability** of the system for European consumers, as well as a **sustainability** assessment.

5. Given the scale and urgency of change, we all need to **act now** to make this future possible.

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Thank you for your attention

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REACTIONS FROM KEY STAKEHOLDERS

Moderated by: Edwin Haesen

Head of System Development, ENTSO-E

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CONCLUDING REMARKS

Gerald Kaendler

Chair of the System Development Committee, ENTSO-E

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Our Vision – what the future will look like

In a fully carbon-neutral economy, **electricity** will be the main and most efficient energy carrier, and it will need to be coupled with other energy sectors. The system of the future will be based on 3 key elements, all **essential** for a sustainable, resilient and affordable power system:

- **Carbon Neutral Energy Sources**, providing the bulk of the power generation, and for the most part weather-dependent.
- **System Flexibility Resources**, to efficiently complement the variability of generation and consumption, and to address the increase in overall system complexity.
- The **Power Grid**, connecting generators, consumers and flexibility resources across Europe, and enabling a fully integrated European Energy Market.

The future power system in Europe will be:

- A **System of Systems**, which will need strong cooperation between transmission and distribution, and amongst different energy systems. All operators will be key enablers and facilitators to make this future energy system work.
- At the same time more **European** and more **Local**, with TSOs providing a critical interface between both dimensions.

Our Vision – how do we get there

A Power System for a Carbon Neutral Europe is within our reach

Four key elements will need to change to make this new reality possible:

- The development of significant system **flexibilities**, both short and long duration, that will need to be timed with the phase-out of fossil fuel generation.
- An **operation** of the system that will rise up to the challenge of this much more dynamic System of Systems, including the management of flexibilities, through innovation and cooperation.
- A regulatory framework, planning and permitting procedures that will facilitate the timely deployment of the necessary **investments**, and encourage efficiency and innovation.
- A **market design** that must evolve to allocate value where it will be most needed for the energy system, while reflecting different consumers needs and preferences.

The scale of change is such that **we need to act now**.
To transform this vision into reality as soon as possible, we will need a strong cooperation across the whole energy industry, and a permanent dialogue with consumers, stakeholders and public authorities

TSOs, through ENTSO-E, propose this work as a basis to start building this future together

SEE YOU TOMORROW!