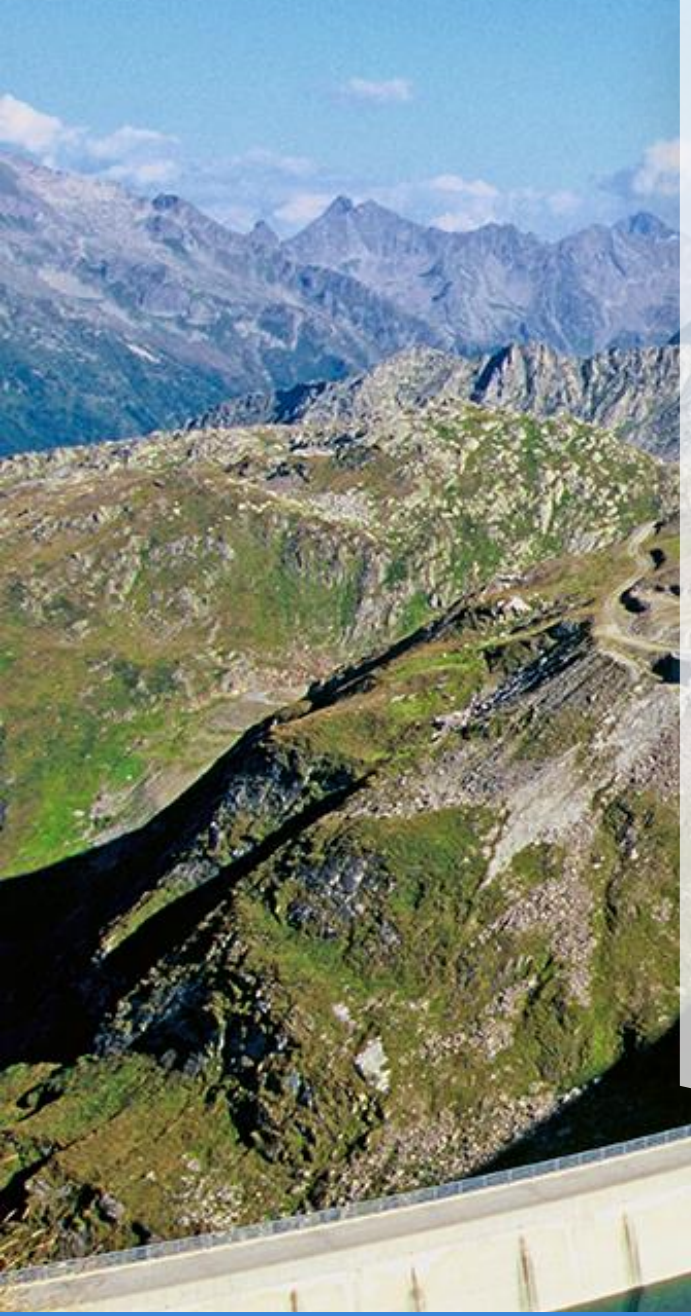


ETIP HYDROPOWER

GIULIO LA PERA

ENTSO-E

Giulio La Pera is currently serving as TYNDP (Ten-year Network Development Plan) Project Manager at ENTSO-E, the TYNDP study provides a pan-European vision of the future power system and investigates how power links and storage can be used to make the energy transition happen in a cost-effective and secure way. Before his current role, Giulio has been involved in the Location Marginal Pricing Study as part of the Bidding Zone Review Project, modelling Europe's electricity system.

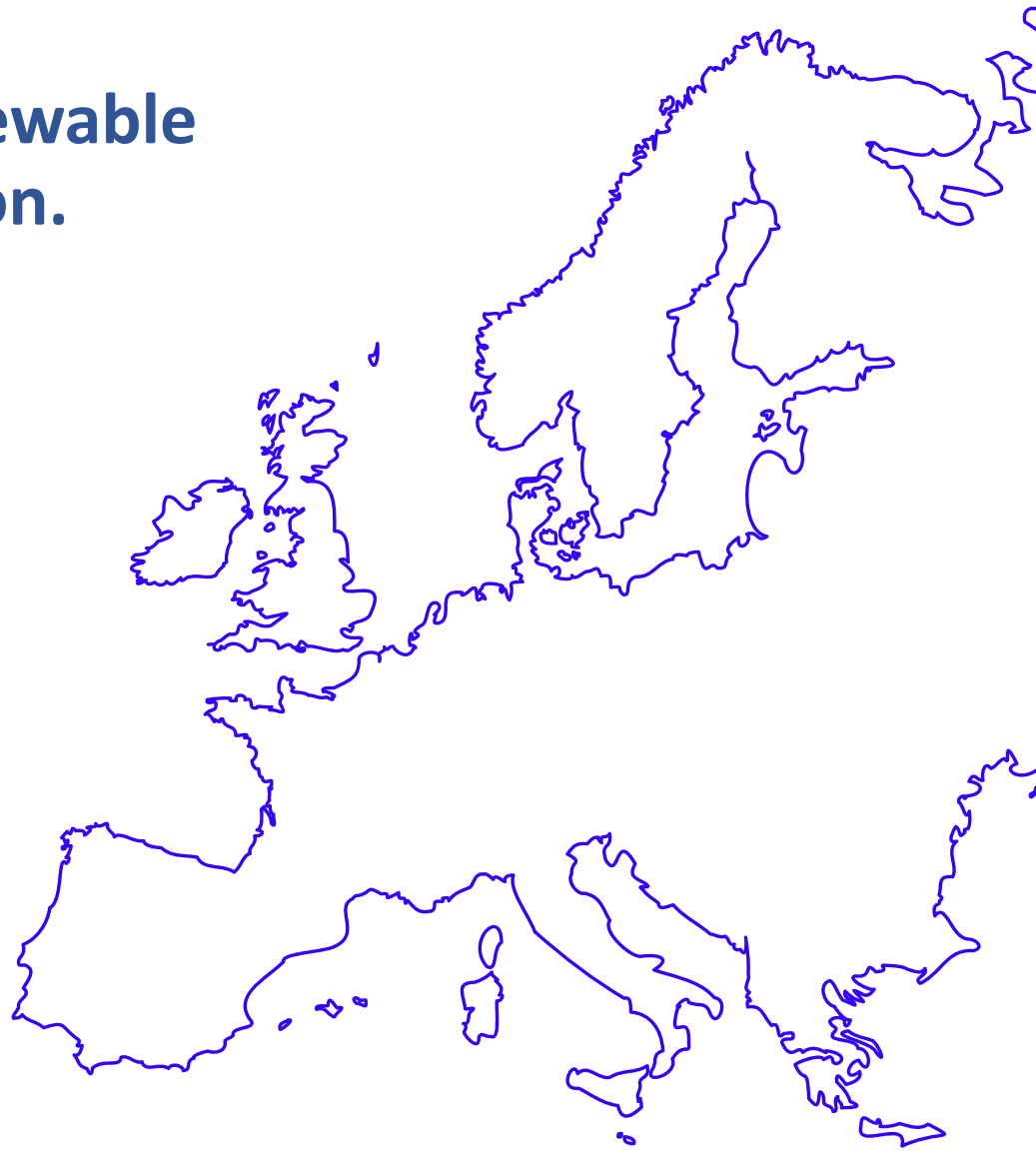
With an Energy Engineering academic background, Giulio explored the management of hydroelectric pumping storage in the Italian Electricity Market for his for his master's thesis. This research, focusing on multiday time horizons from the perspective of Transmission System Operators (TSOs), has since been published as a scientific paper.

Funded by
the European Union

What hydropower and pumped-hydro storage development goals for 2030 and 2040 are required as essential part for Europe's renewable energy mix ensuring a safe energy transition.

entsoe

European Network of Transmission
System Operators for Electricity



The TYNDP is the European electricity infrastructure development plan.

It provides a pan-European vision of the future power system and investigates how power links and storage can be used to make the energy transition happen in a cost-effective and secure way.

The Process behind the Ten Year Network Development Plan at ENTSO-E

Process of European Projects of Common Interest led by the European Commission

Defining up to three most plausible futures, which we call **Scenarios**

Project collection and identification

Projects of common Interest Process

Identification of the needs based on our scenarios

Cost benefits analysis of projects

Purpose of TYNDP Scenarios

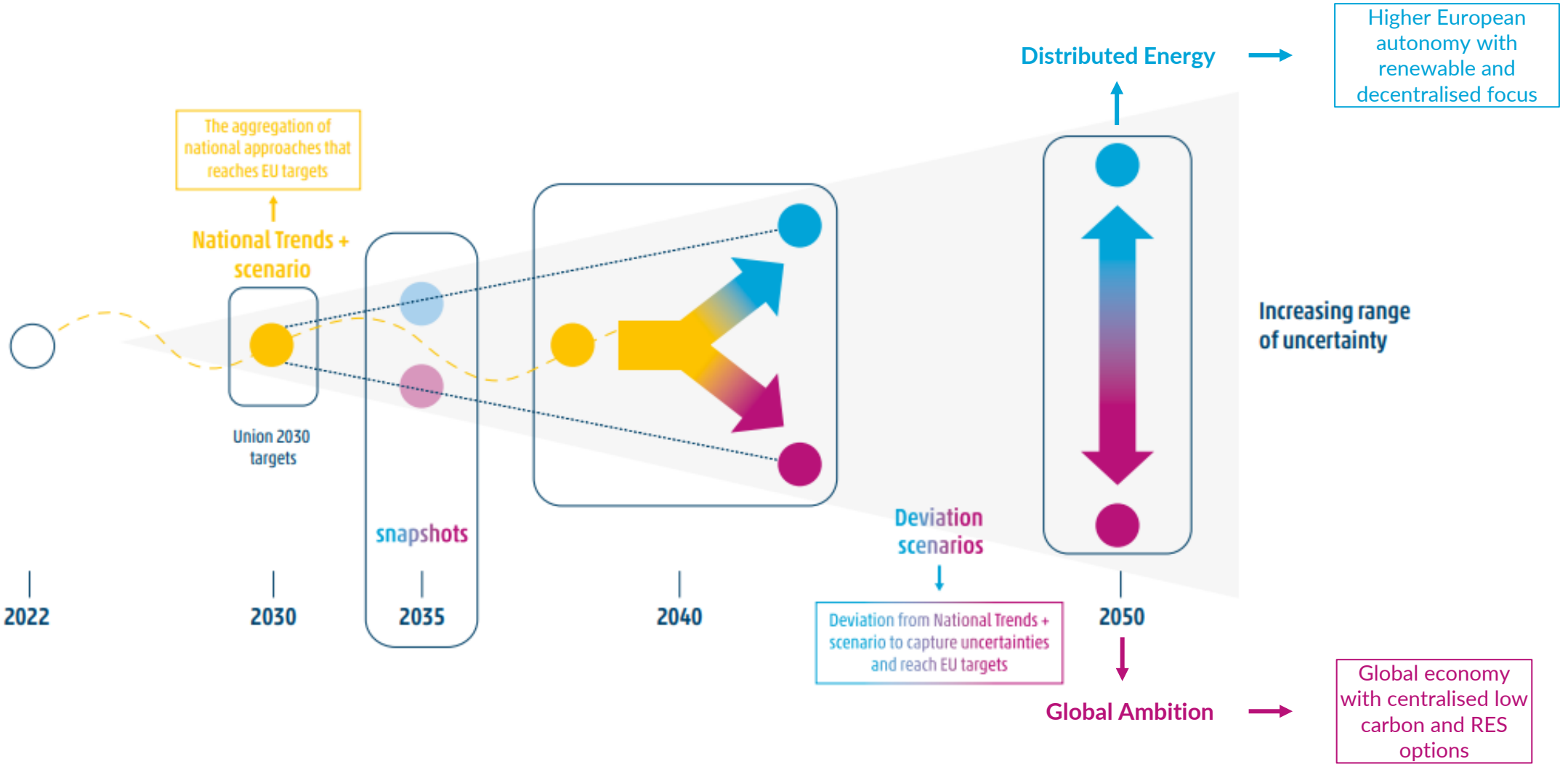
TYNDP scenarios are designed for TYNDP infrastructure assessment
What will be the impact of decentralized energy production?
How to be sure that infrastructure supports RES development?
How can EU energy & climate targets materialize?
Can it deliver in terms of Security of Supply, Market Integration and Competition?

TYNDP scenarios are meant for analysis and information
- not for predictions/forecasting

TYNDP scenarios complementary to EC's **Impact Assessment** scenarios – with focus on assessment of infrastructure readiness vis-à-vis possible - contrasted - futures

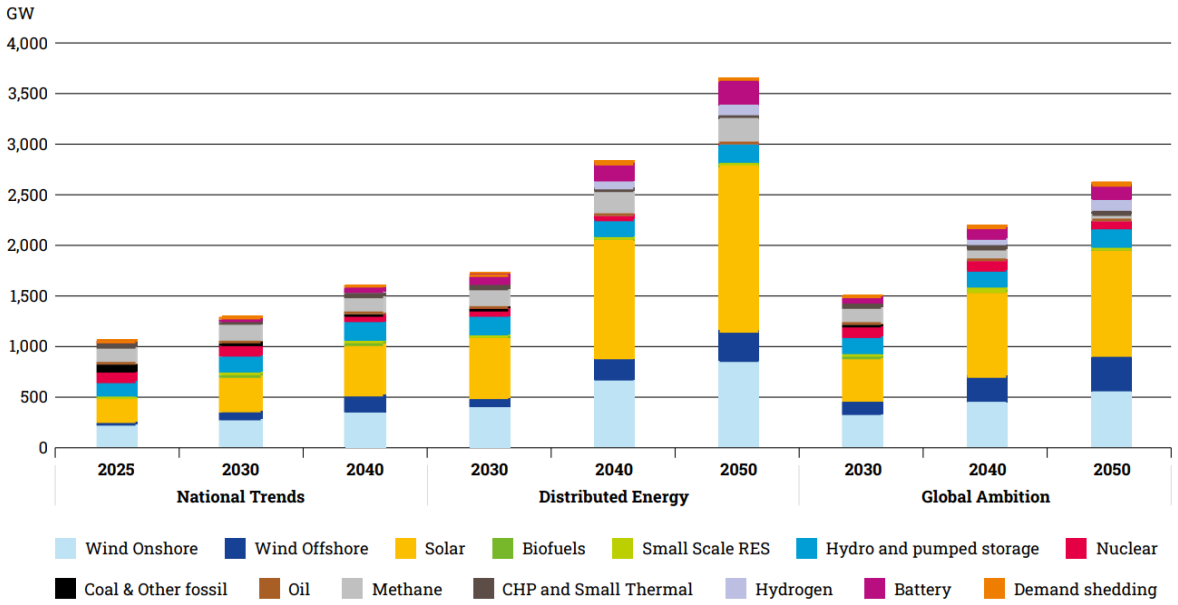
43

TYNDP Scenarios cover uncertainty in the evolution of infrastructure

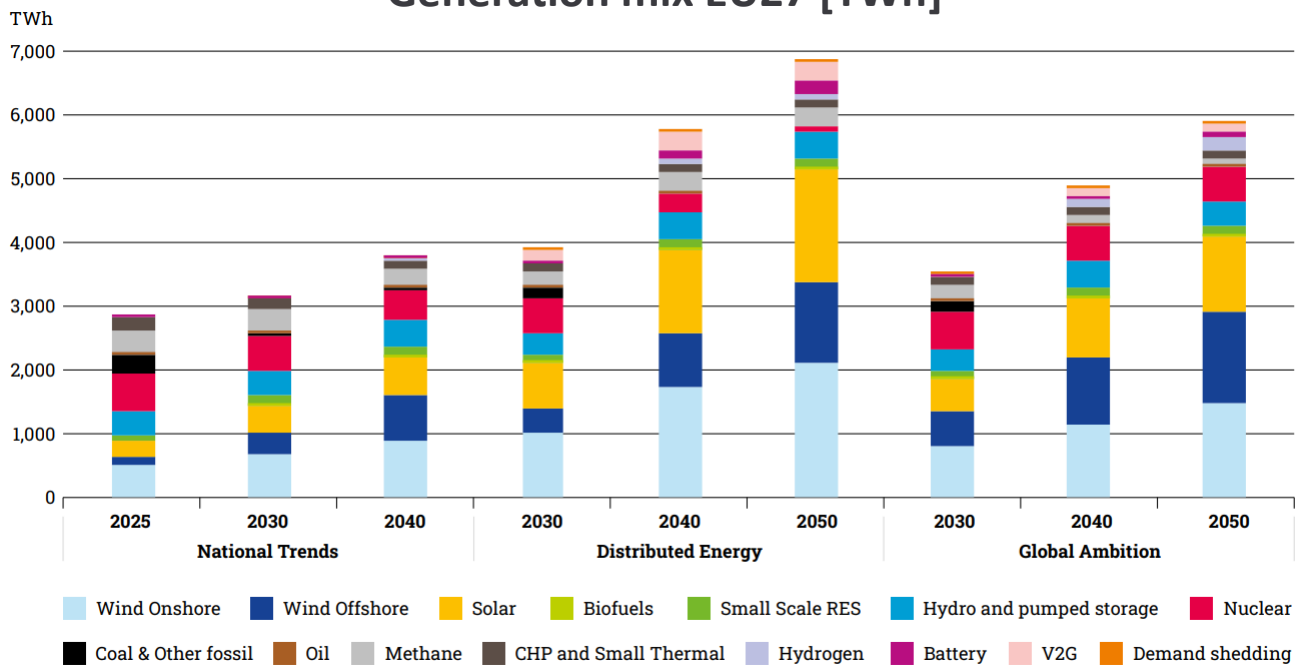


Hydro and pumped storage represent a key flexibility element across all scenarios and time-horizons

Capacity mix EU27 [TWh]*

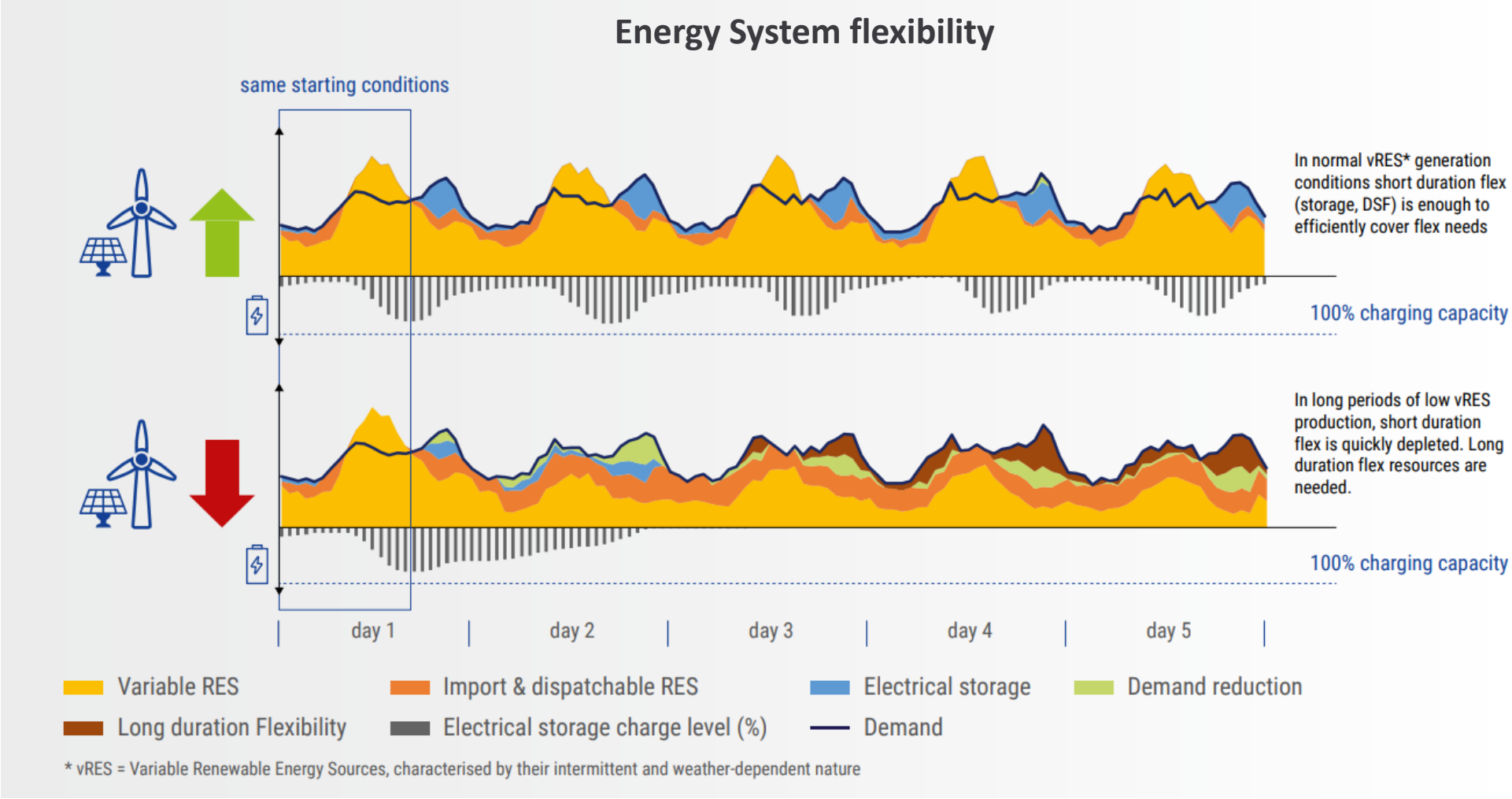


Generation mix EU27 [TWh]*



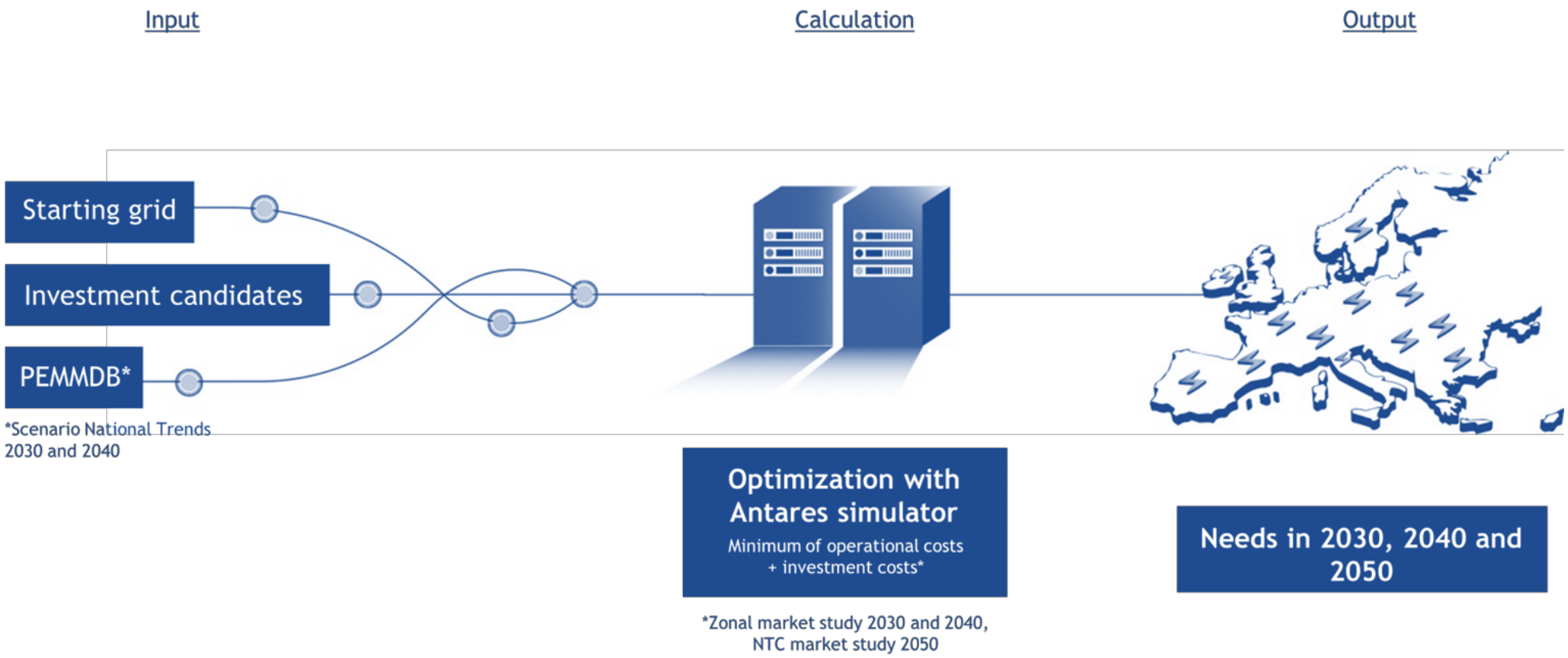
*Includes prosumer PV, hybrid and dedicated RES for electrolysis

Hydro and pumped storage represent a key flexibility element across all scenarios and time-horizons



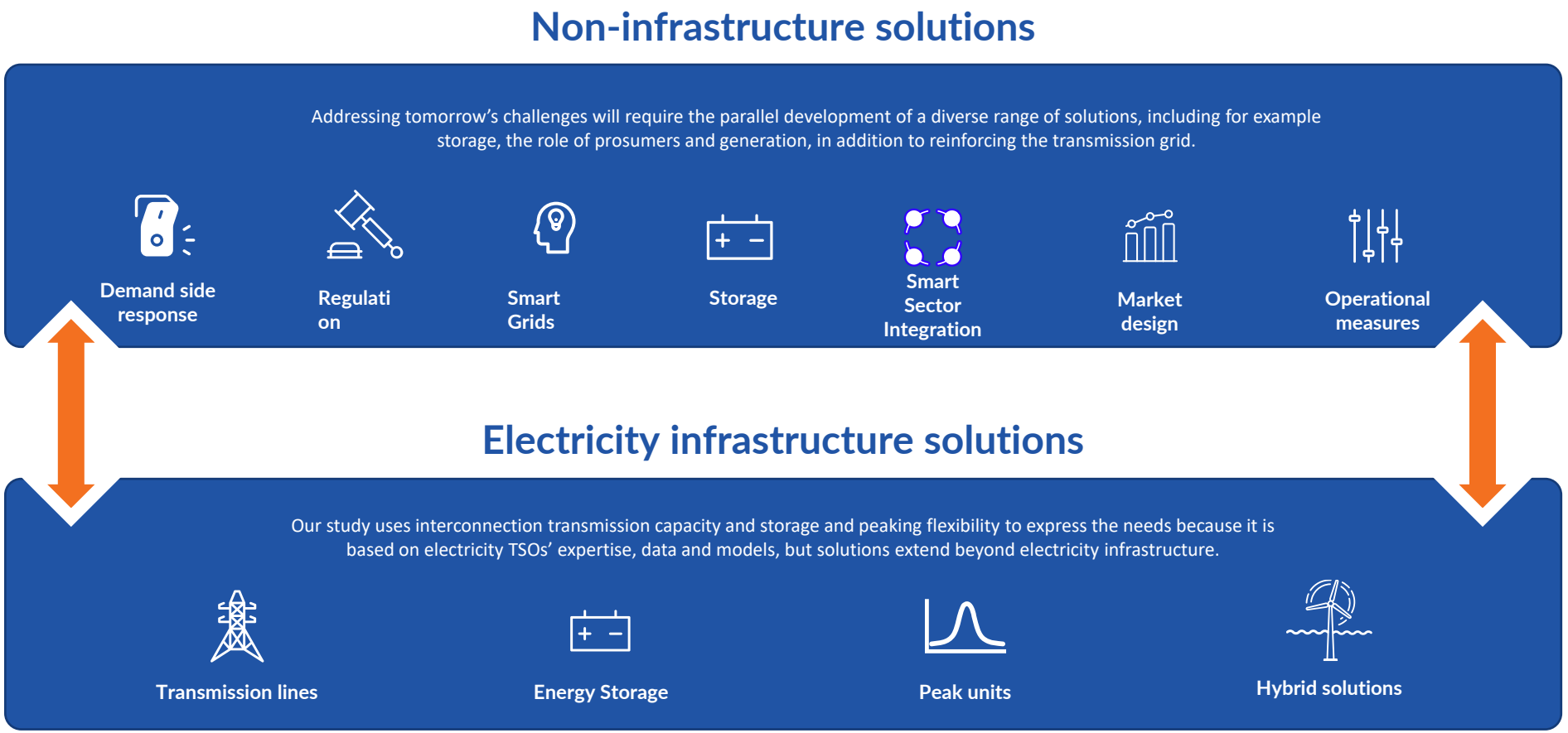
Identification of System Needs (IoSN)

Study process overview



Coordinated planning will be needed across sectors.

Gaps and opportunities for Europe's power system in 2030 and 2040



Opportunities for increased cross-border transmission, storage and peaking capacity exist all over Europe

Needs for cross-border electricity transmission, storage and peaking capacity in Europe in 2040

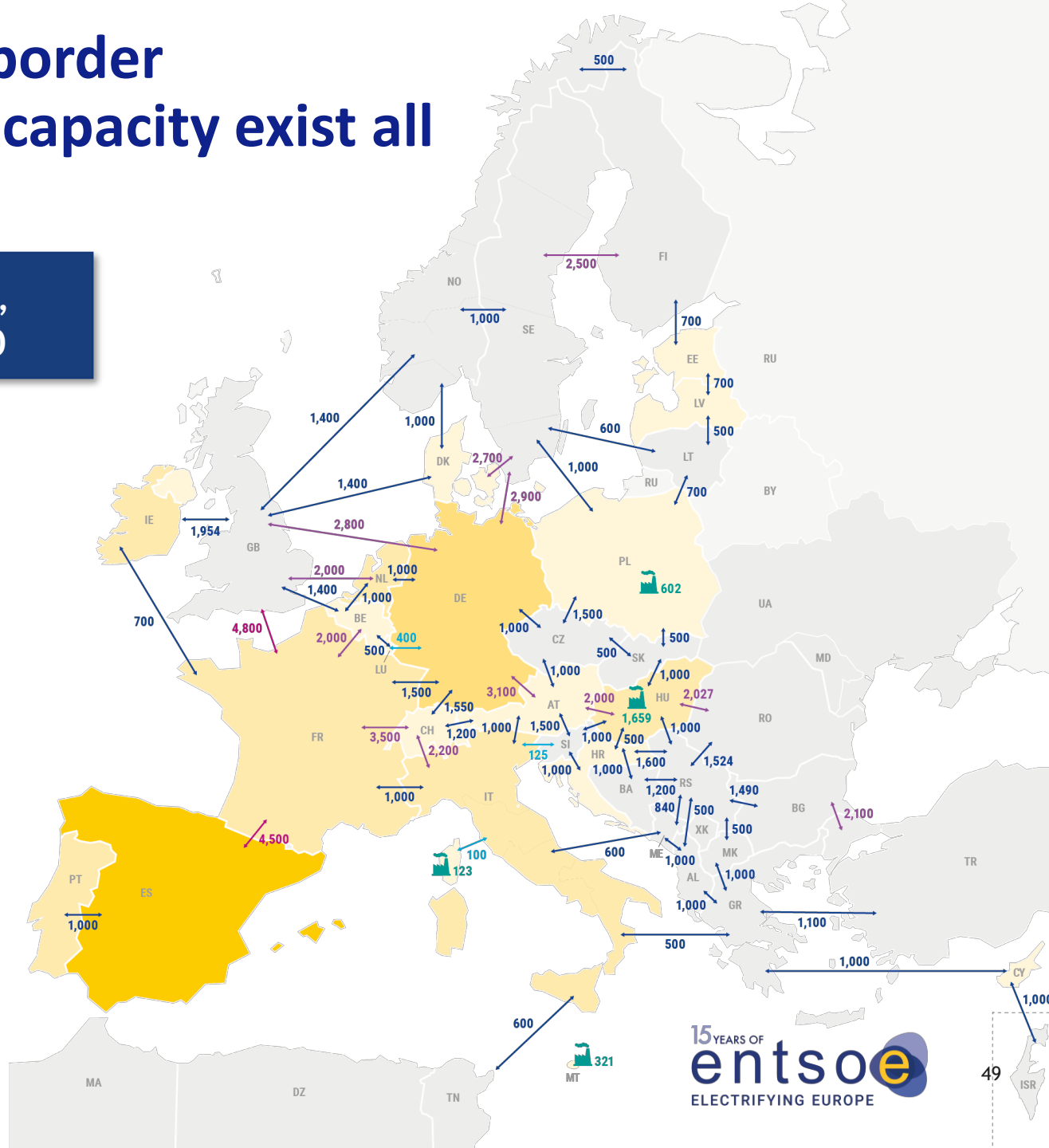
CROSS-BORDER CAPACITY INCREASES NEEDS IN MW (ADDITIONAL TO THE STARTING GRID 2025)

- < 500 MW
- 500 → 2,000 MW
- 2,000 → 4,000 MW
- > 4,000 MW

STORAGE NEEDS IN MW (ADDITIONAL TO BATTERY CAPACITIES IN NT2030 AND TO 2040 CAPACITIES FOR OTHER STORAGE TECHNOLOGIES)

- < 1,000 MW
- 1,000 → 5,000 MW
- 5,000 → 10,000 MW
- > 10,000 MW

CO_2-FREE PEAKING UNIT NEEDS PER COUNTRY IN MW



How addressing system needs benefits Europe

What would happen in 2040 if…

We stopped investing in the power system in 2025?

- EU Energy bill rising to **132 Billion euro per year**
- System **instability** and risk of **blackout**
- **78 TWh of renewable energy curtailed each year**
- **Dependence on gas with 366 TWh** of gas-based power generation per year
- **Grid not sufficient** → Leads to no decarbonisation

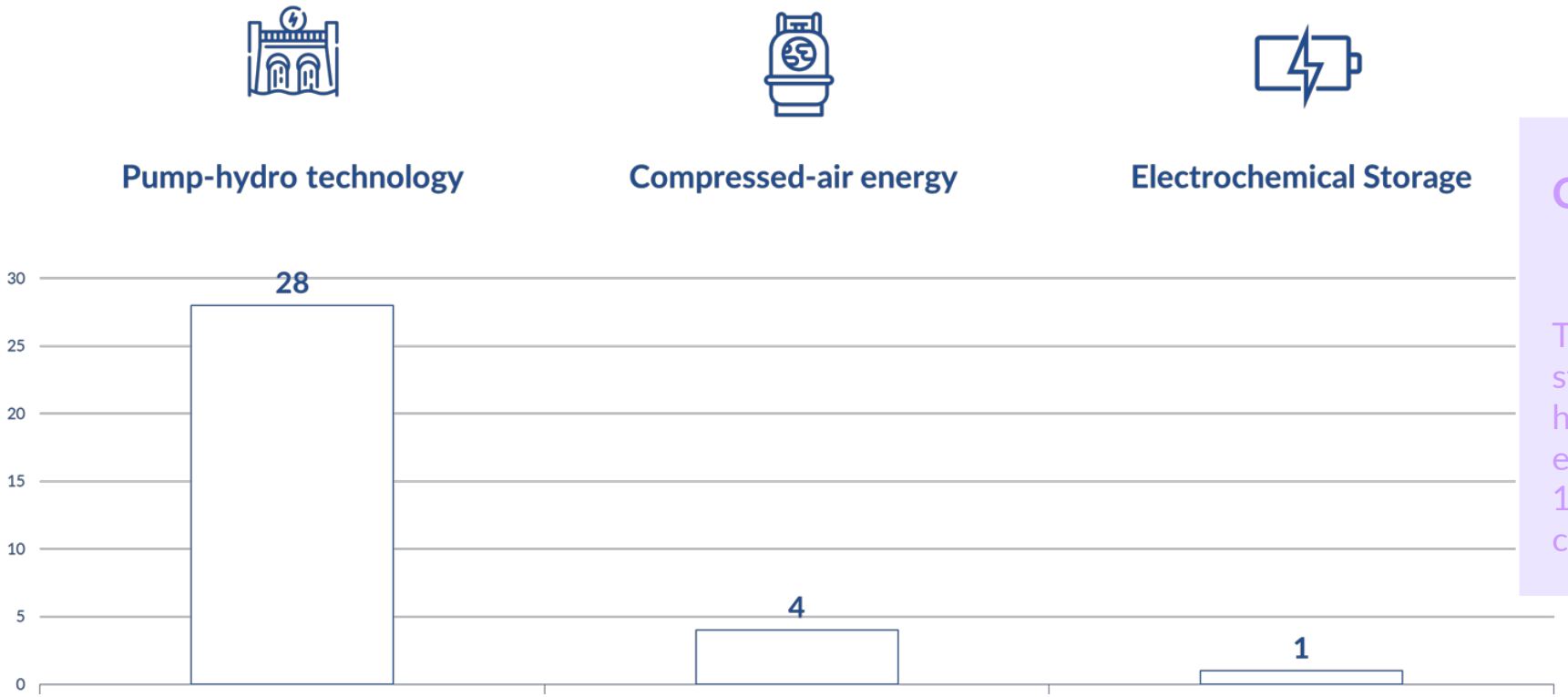
What would happen in 2040 if…

We addressed system needs?

- Investing 6 Billion euro per year cuts generation costs by 9 Billion each year
- **Ensuring stability** and security of electricity supply in Europe
- **Avoiding the curtailment of 42TWh** of renewable energy each year
- Gas-based power generation is **reduced by 75TWh per year**
- **Grid welcoming the expected development of renewables** → CO2 emissions cut by 31Mton per year

How addressing system needs benefits Europe

31 Mton of CO2 emissions avoided each year in 2040

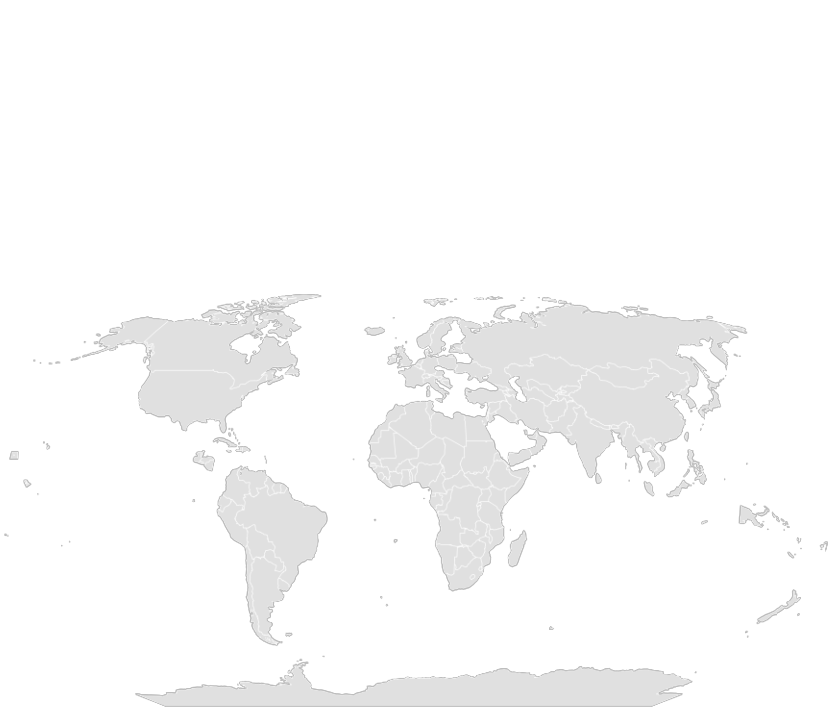


Context

The TYNDP 2024 portfolio includes 33 storage projects, of which 28 use pump-hydro technology. 4 compressed-air energy storage projects and 1 electrochemical storage project complete the portfolio.

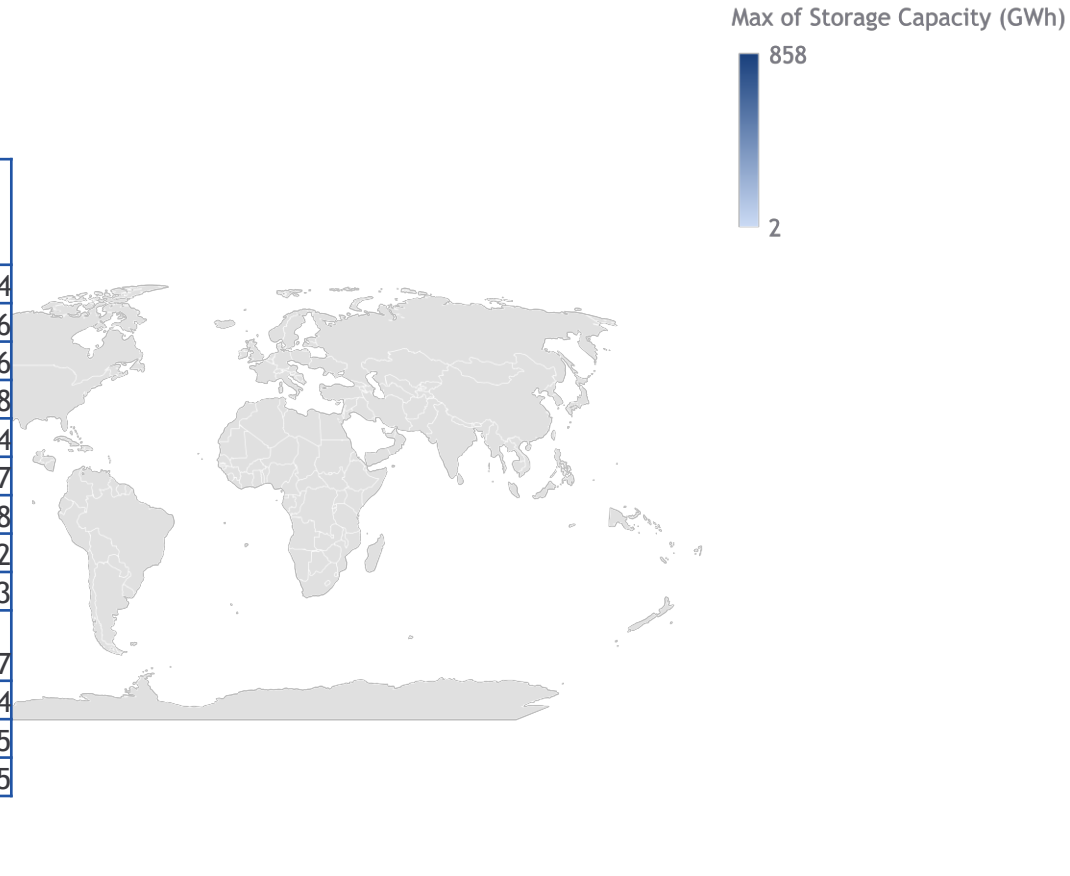
Project portfolio for TYNDP 2024: Location of storage projects

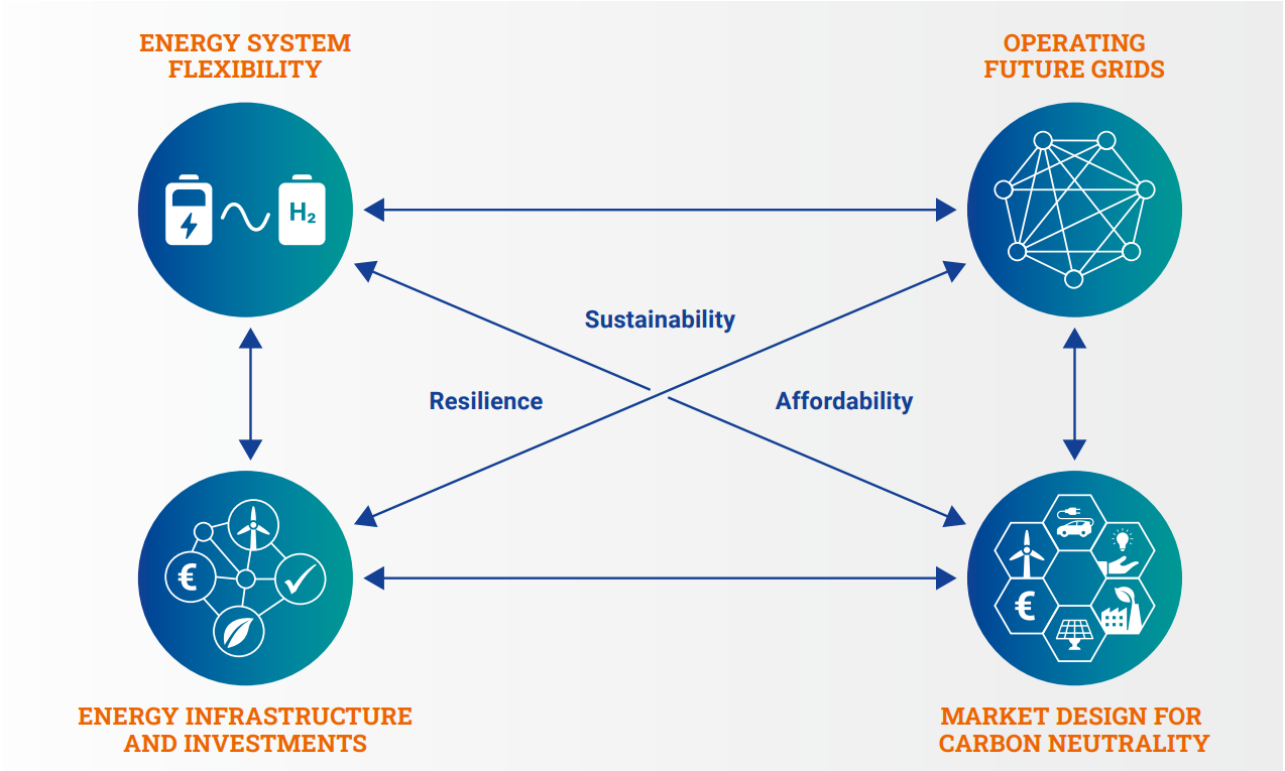
Number of projects



Capacity (GWh)

	Number of Projects	Capacity
Austria	1	64
Bulgaria	3	86
Denmark	1	16
Estonia	2	858
Finland	1	4
Germany	4	27
Greece	4	8
Ireland	1	2
Italy	4	3
Netherlands	2	27
Slovakia	1	4
Slovenia	1	5
Spain	10	75





	Source \ Need	Periods of vRES shortage	Balancing/ congestion management	Stability/ inertia	Voltage control	Reliability/ restoration
Generation	Fossil thermal generation	↓	↓	↓	↓	↓
	Hydrogen power generation	●				○
	Dispatchable RES (hydro, bio)	●	○	○	○	●
	Variable generation		●	●	●	○
Demand	Smart charging EVs/small DSR	○	●	●	○	○
	Large DSR	○	●	●	○	●
Storage	Chemical batteries/V2G		●	●	●	●
	Supercapacitators			○		
	Hydro pumping storage	○	●	●	●	●
	Flywheels			○		
	LAES/CAES, thermal storage	○	○	○		
Coupling	Power-to-hydrogen		●	○	○	
	Power-to-heat		○	○		
Grid	Interconnections (incl. HVDC & conversion stations)	●	●	○	●	○
	Grid flexibilities (power flow, voltage control)		●	●	●	●

↓ Phase-out by 2050 ● Most promising ○ Contributing