TYNDP 2024

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Key findings

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Agenda

- Introduction
- Scenarios
- Identification of System Needs (IoSN)
- Gaps and opportunities
- Project collection and identification
- Cost benefits analysis of projects

About ENTSO-E

500.000 km of transmission lines

520 million citizens

- ENTSO-E, established in **2009,** represents **40 TSOs from 36 countries**
- Represents TSOs at the European level.
- Helps TSOs implement and monitor common rules and EU legislation.
- Enhances cooperation among members

Security of **power system**

Optimal functioning and development of **electricity markets**

Climate-neutrality by 2050

The Ten-Year Network Development Plan (TYNDP) is one of ENTSO-E's legally mandated system development studies

Uncertainty

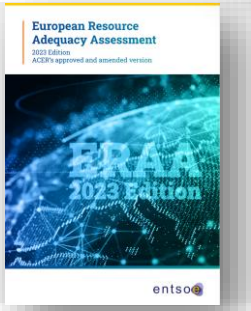
A pan-European vision of the future power system for a cost-effective and secure energy transition

Purpose: Support long-term investment decisions.

Scenarios/Inputs: Builds on national estimates under various long-term assumptions/scenarios.

Uncertainty: High/Very high.

10 to 30 years



Purpose: Guide policy-makers' decisions on investments and regulatory interventions.

Scenarios/Inputs: National best estimates for demand and energy mix with robustness check.

Uncertainty: Moderate until 5th year & higher beyond 5 years.

2 to 10 years

Purpose: Flag short-term risks for system adequacy so that involved stakeholders at national, regional and pan-European level coordinate to ensure security of supply.

Scenarios/Inputs: TSOs' estimates based on contextual factors.

Uncertainty: Low.

Weeks to months ahead

Time

The Process behind the TYNDP at ENTSO-E

1 | SCENARIOS

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

2 | NEEDS

Identification of the needs based on our scenarios. Includes Infrastructure Gaps Report and Offshore Network Development Plans

3 | PROJECTS

Project collection and identification

4 | COST BENEFIT

Cost benefits analysis of projects

Union List process led by the European Commission

Projects of Common Interest (PCI) and **Projects of Mutual Interest (PMI) Process**

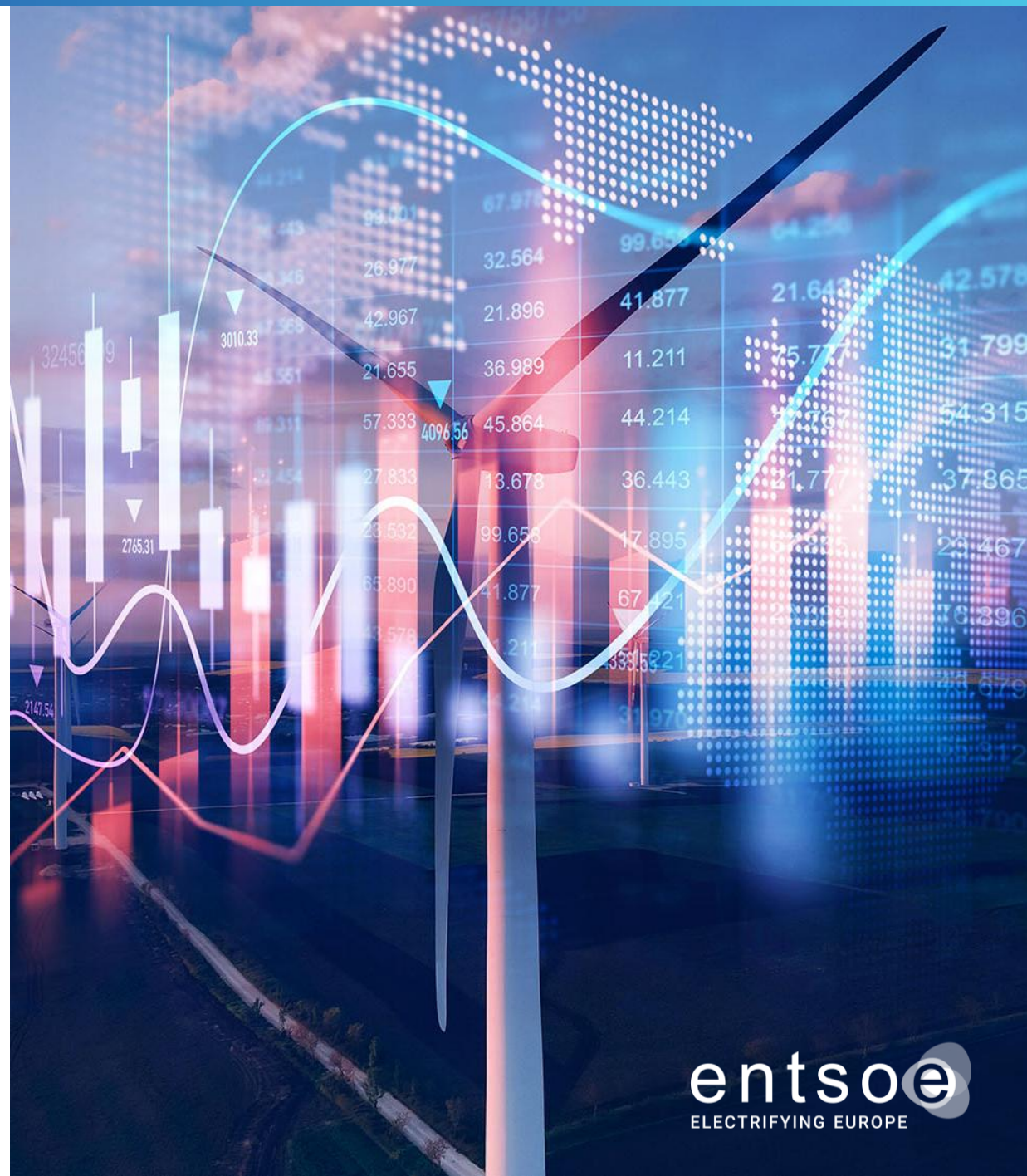
5 | SELECTION

Scenarios

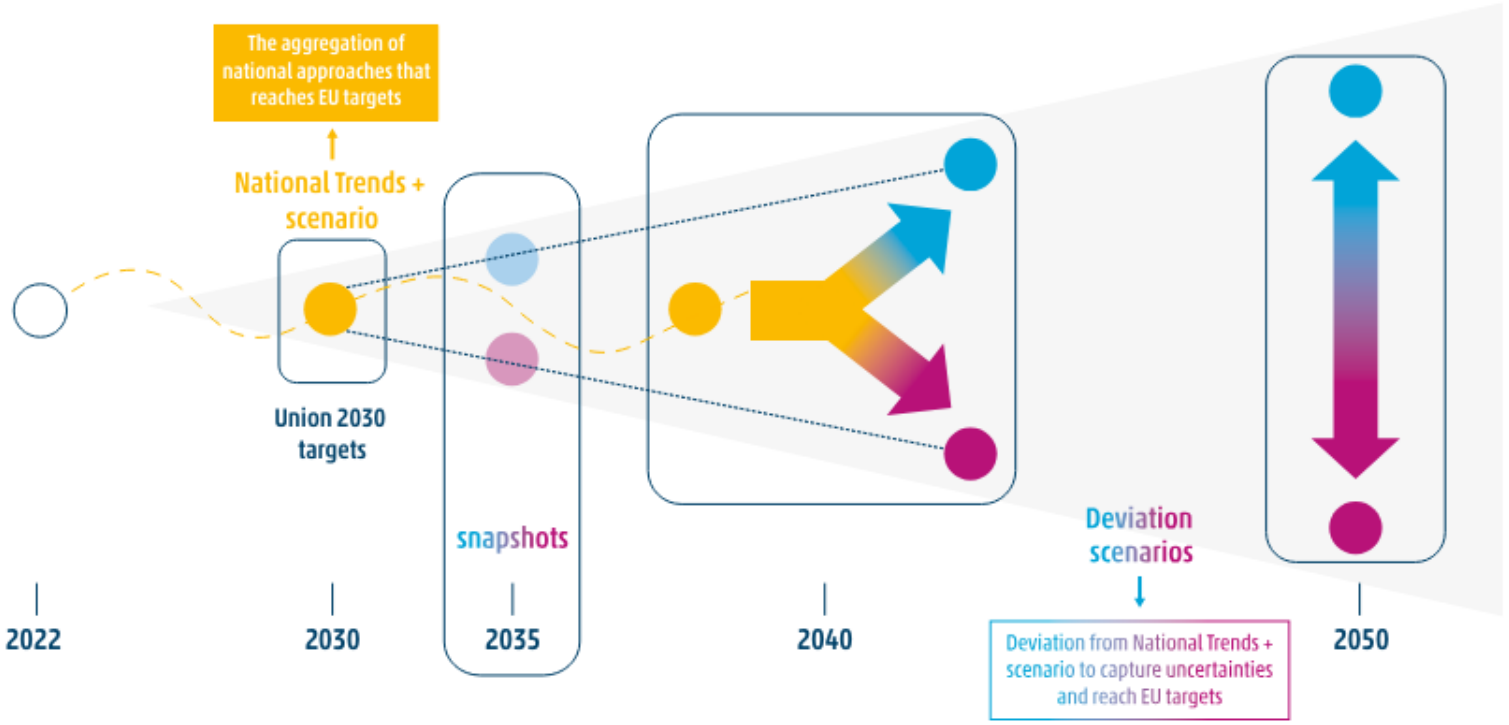
1 | SCENARIOS

2 | NEEDS

3 | Projects



TYNDP 2024 scenario framework



Increasing range of uncertainty

Download the complete Package

Identification of System Needs (IoSN)

Based on our scenarios

1 | SCENARIOS

2 | NEEDS

3 | Projects

IoSN

Study process overview

Input

2030 grid

Investment candidates

- Cross-border capacity increases
- Storage
- Offshore corridors identified by the ONDP

PEMMDB*

* Scenario National Trends 2030 and 2040, Distributed Energy 2050

Calculation

Optimisation with Plexos and Antares simulators

Minimum of operational costs + investment costs*

* NTC study 2030, zonal study 2040, simplified zonal 2050

Output

Economic opportunities and infrastructure gaps in 2030, 2040 and 2050

IoSN

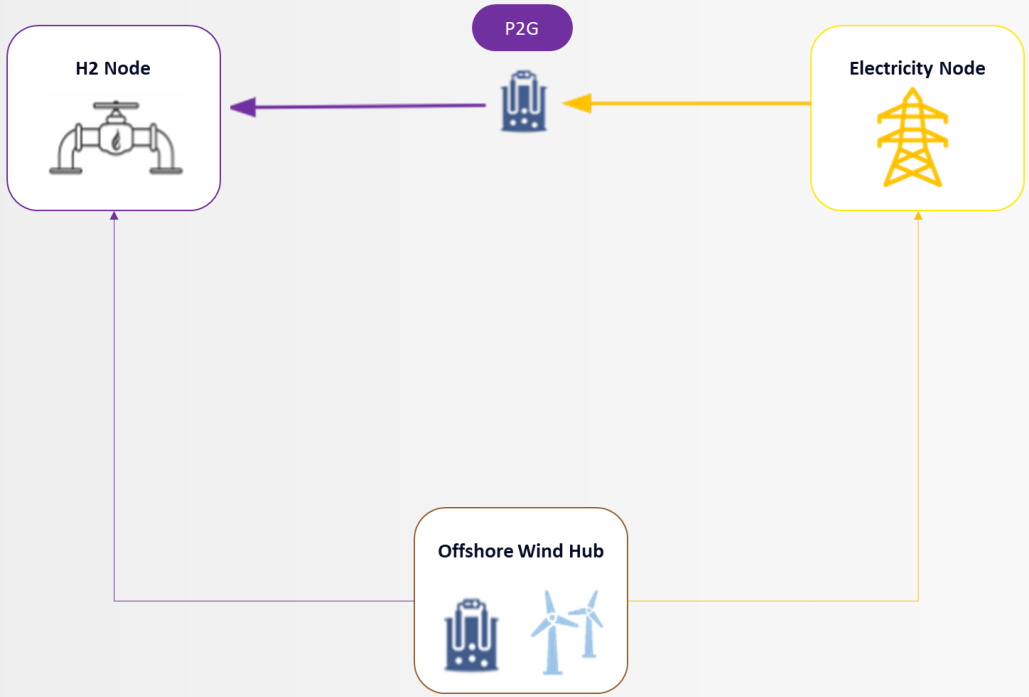
General Market Modelling Approach

Hydrogen Market

SMR Capacity

H2 storage

H2 Demand



Electricity Market

Generation Capacity

Infrastructure

Demand

Target of the modelling approach

The main objective of the modelling approach of the IoSN 2024 is to represent the electricity system with adequate granularity and take in to account the potential impact from the sector integration data coming from the Scenarios.

The model has not explored the co-optimization of electricity and H2 needs.

TYNDP 2024

Gaps and opportunities

for Europe's power system in 2030, 2040 and 2050

Gaps and opportunities for Europe's power system in 2030, 2040 and 2050

Coordinated planning will be needed across sectors.

Non-infrastructure solutions

Addressing tomorrow's challenges will require the parallel development of a diverse range of solutions, including for example storage, the role of prosumers and generation, in addition to reinforcing the transmission grid.

Demand side response

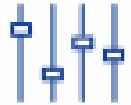
Regulation

Smart Grids

Energy Storage

Smart Sector Integration

Market design



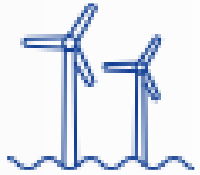
Operational measures

Electricity infrastructure solutions

Our study uses interconnection transmission capacity, storage and offshore hybrid solutions* to express the needs because it is based on electricity TSOs' expertise, data and models, but solutions extend beyond electricity infrastructure.

Transmission lines

Energy Storage



Hybrid solutions

* Offshore hybrid solution: interconnection with offshore generation connected to it

Gaps and opportunities for Europe's power system in 2030, 2040 and 2050

Identified needs in 2030 show the immediate economic interest of investing in Europe's grid

By 2030

The study finds that 88 GW additional to the 161 GW of cross-border capacity expected in 2030, and 56 GW of storage power, would be cost-efficient in 2030*.

Investment

This capacity increase represents about **5 billion euro of investment per year**.

Gains

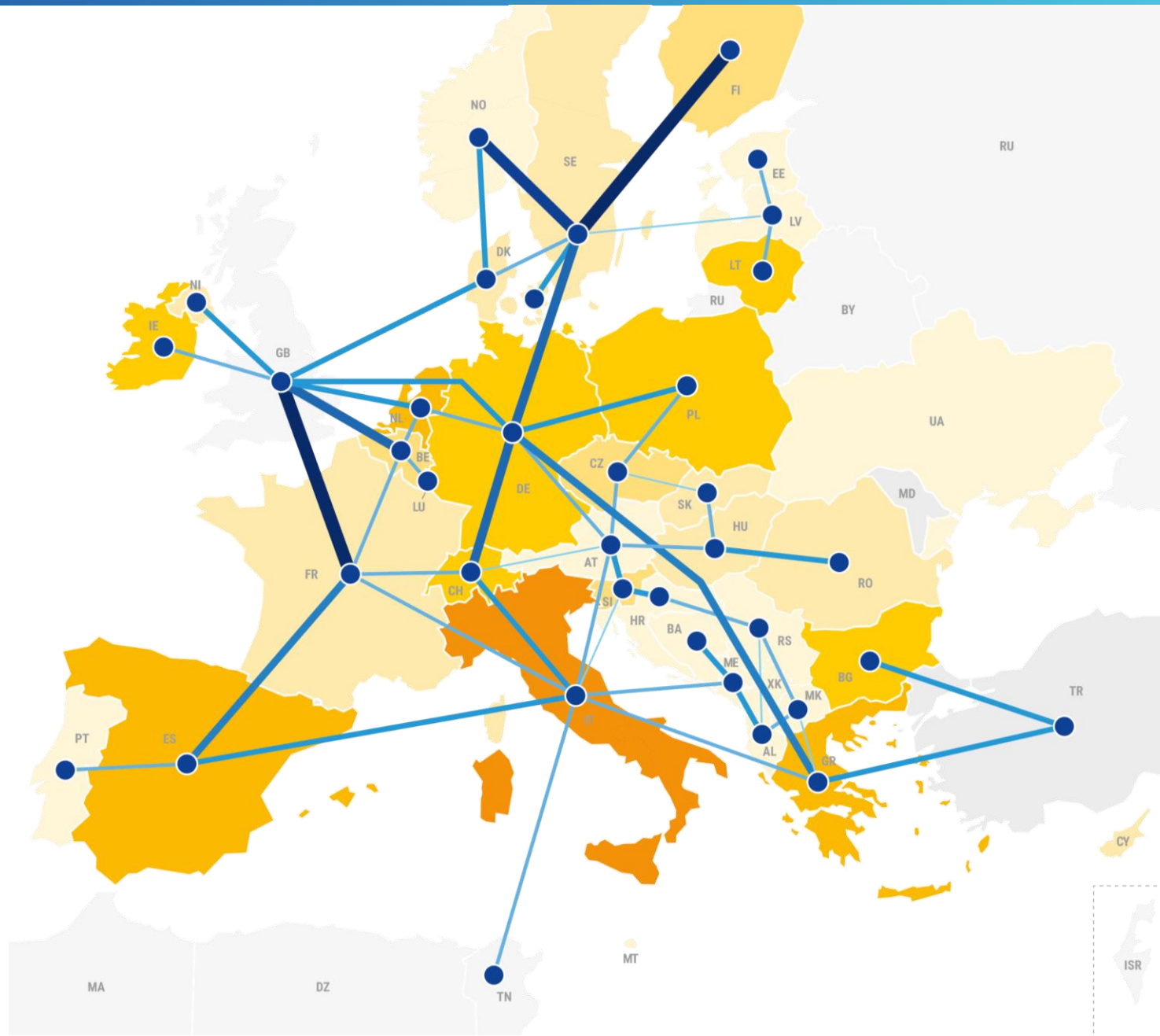
And would deliver a yearly **gain** in socio-economic welfare of **8 billion euro**.

* 2025 figures: 126 GW cross-border capacity; 24 GW storage capacity

2030 System Needs

With further investment in its electricity grid and storage infrastructure, Europe could reduce its system costs while going beyond its 2030 targets.

An additional 88 GW of complementary cross-border capacity and 56 GW of storage power would be cost-efficient to reinforce Europe's power system.



Gaps and opportunities for Europe's power system in 2030, 2040 and 2050

By 2040, each euro invested in the electricity grid translates into over 2 euros saved in system costs

By 2040

The study finds that 108 GW of additional cross-border capacity increases after 2030, **including 20 GW of offshore hybrid corridors** will be needed to support Europe's move towards a carbon-free power system. 227 GW of batteries will provide flexibility to the system.

Investment

This capacity increase represents an investment of **6 billion euro per year**.

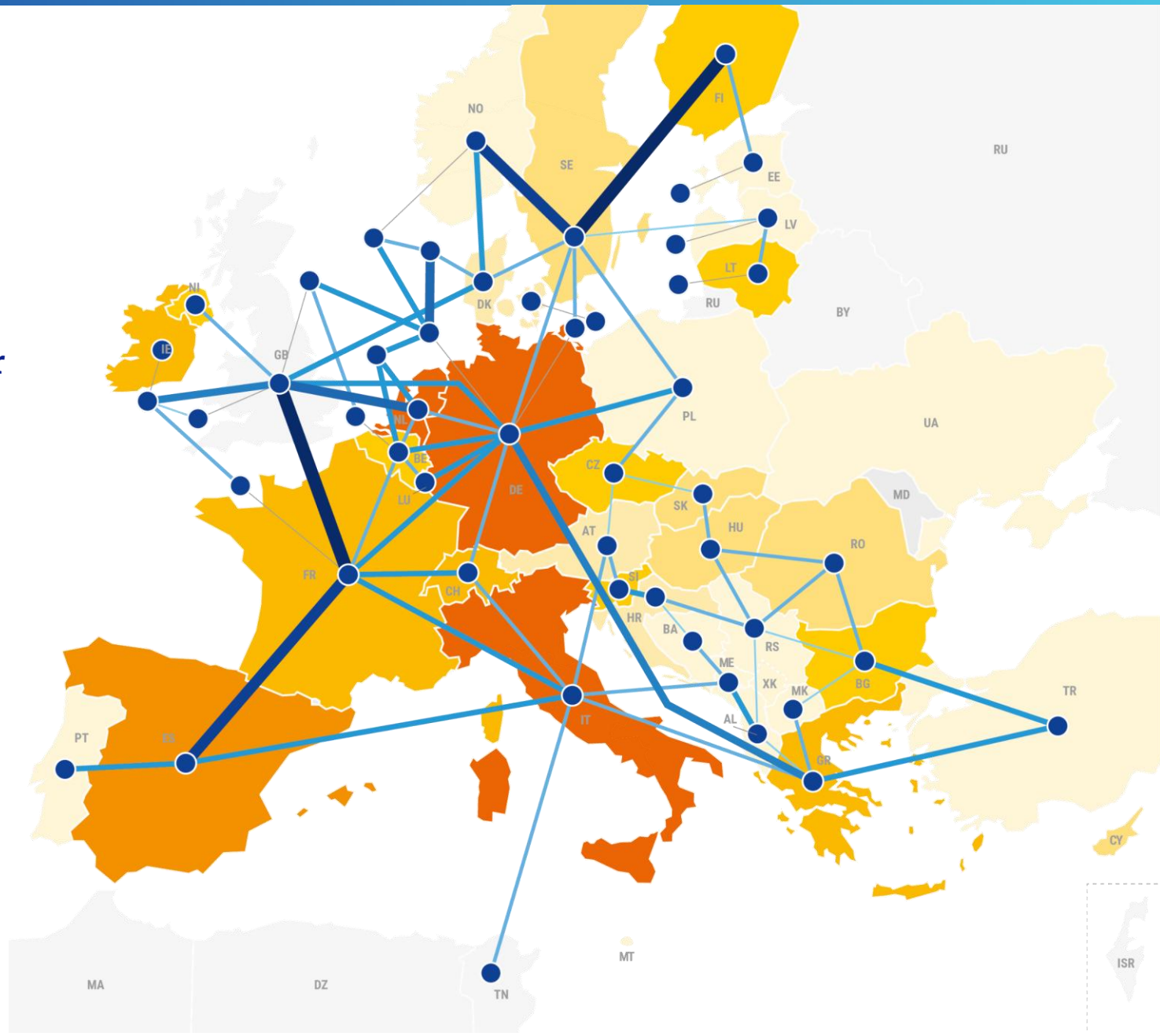
Gains

And would deliver a yearly **increase** in socio-economic welfare of **13 billion euro**.

2040 System Needs

By 2040 108 GW of additional cross-border capacity increases additional to the 2030 grid , including 20 GW of offshore hybrid corridors, would minimise the total costs of Europe's electricity system.

Each euro invested in the electricity grid translates into over 2 euros saved in system costs.



Cross-border capacity increases in 2040 (additional to 2040 starting grid)

- Home Market
- 1 – 500 MW
- 501 – 1,000 MW
- 1,001 – 2,000 MW
- 2,001 – 3,000 MW
- 3,001 – 4,000 MW
- 4,001 – 5,000 MW
- > 5,000 MW

Storage capacities per country in 2040

- 0 – 100 MW
- 101 – 500 MW
- 501 – 1,000 MW
- 1,001 – 5,000 MW
- 5,001 – 10,000 MW
- 10,001 – 20,000 MW
- > 20,000 MW

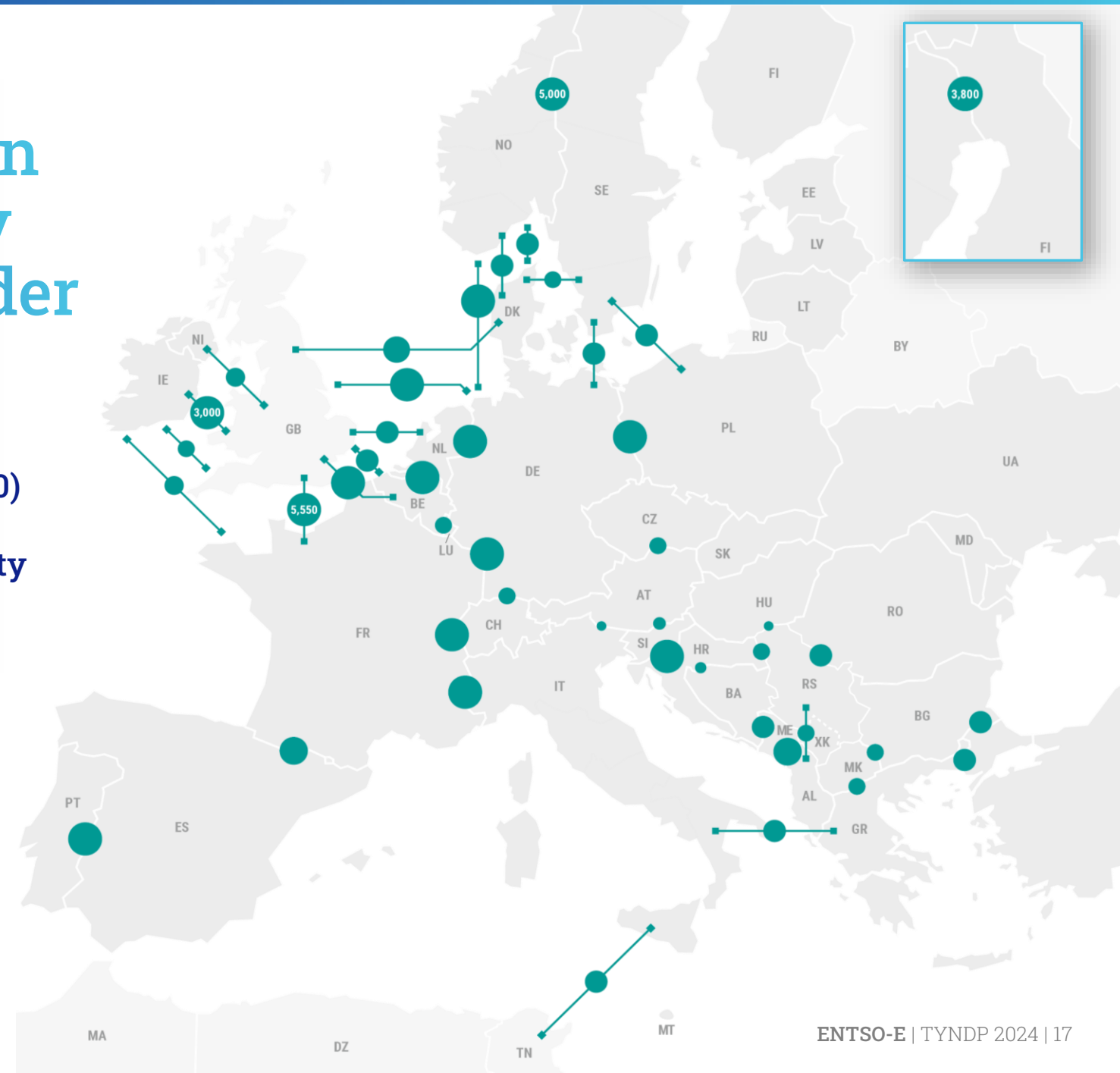
Existing transmission projects address only part of the cross-border needs in 2040

Comparing the TYNDP project portfolio (80 GW of cross-border capacity after 2030) with the optimized grid identified in 2040 (108 GW of additional cross-border capacity needed after 2030) shows a gap of 28 GW.

Infrastructure gaps

Difference between the identified needs in 2040 and existing transmission projects by that time horizon (MW). The bigger the circle, the bigger the opportunity for new solutions to increase cross-border capacity.

100 500 1,000 1,500 ≥2,000



How addressing system needs benefits Europe

What would happen in 2040 if …

We stopped investing in the power system after 2030?

EU Energy bill rising to 49.5 Billion euro per year

System instability and risk of blackout

473 TWh of renewable energy curtailed each year

Dependence on fossil fuels with 263 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 13 Billion each year

Ensuring stability and security of electricity supply in Europe

Avoiding the curtailment of 130 TWh of renewable energy each year

Fossil fuels' power generation is reduced by 58 TWh per year

Grid welcoming the expected development of renewables → CO_2 emissions cut by 31 Mton per year

Project collection and identification

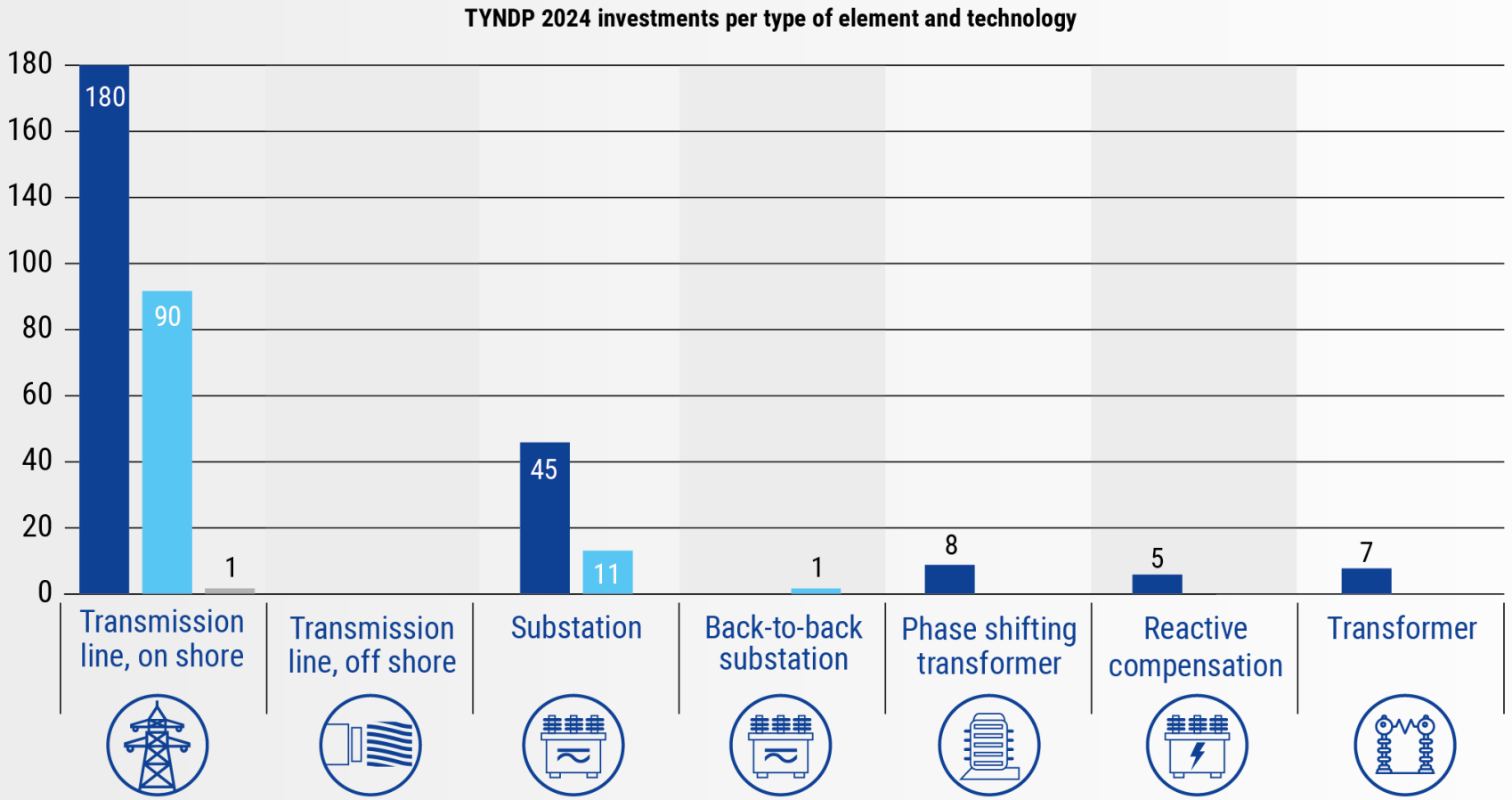
2 | NEEDS

3 | Projects

4 | COST BENEFIT

Project collection

Project portfolio: 178 Transmission projects (348 investments)



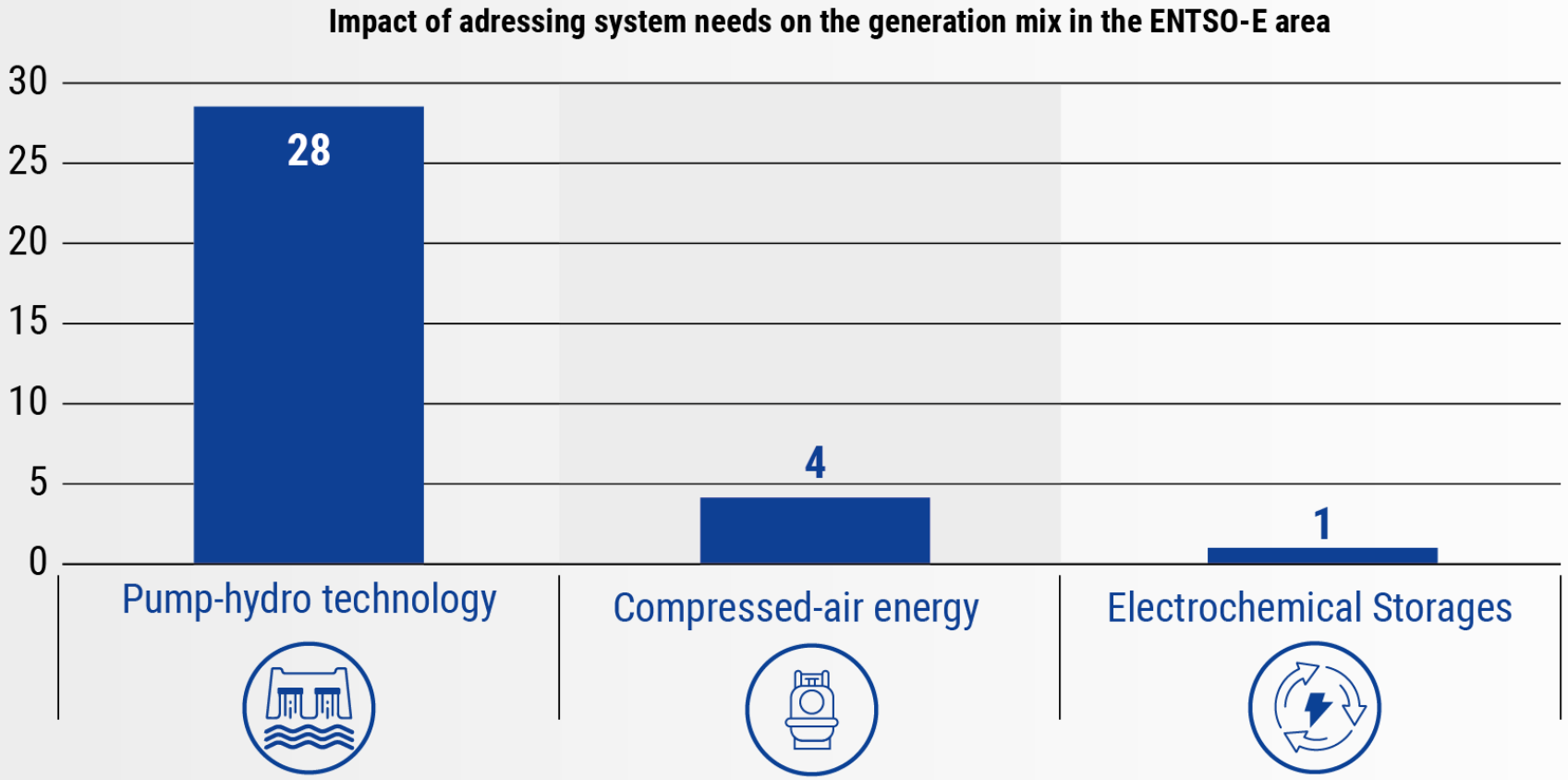
Context

TYNDP 2024's portfolio includes over **61,000 km** of potential additional cables and lines. Of these, **19,000 km (42%) are AC**, while **42,000 km (58%) are DC**.

A significant part of DC lines comes from offshore infrastructure, which ist expected to drive higher investment in subsea DC cables.

Project collection

Project portfolio – 33 Storage projects



Context

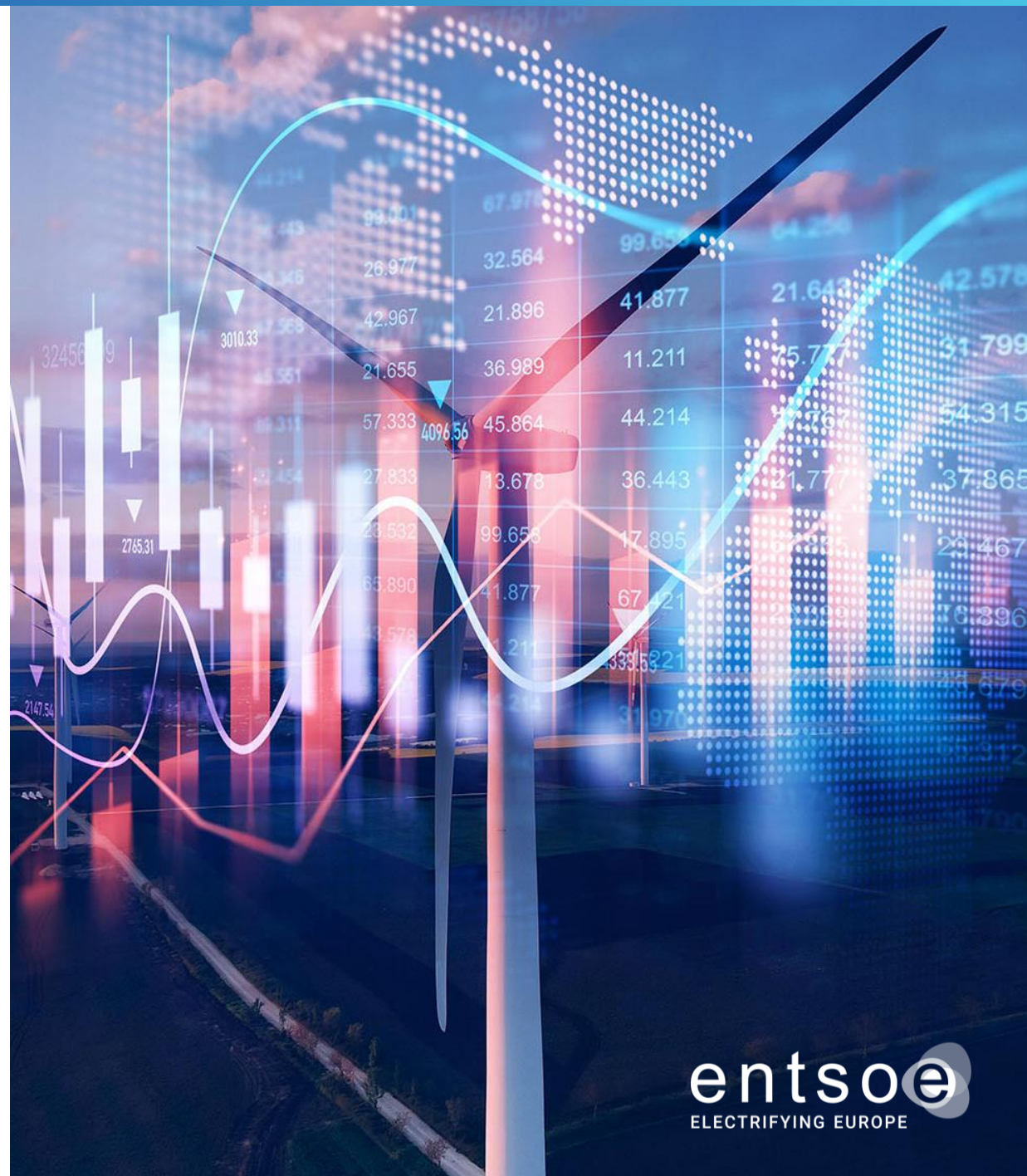
The TYNDP 2024 portfolio includes 33 storage projects, of which 28 use pump-hydro technology, 4 compressed-air energy storage projects and 1 electrochemical storage projects complete the portfolio.

Only one of the projects has started the construction phase, while 7 are under consideration. 3 are in planning but has not completed the permitting phase, and 22 are in permitting.

Cost benefits analysis of projects

3 | COLLECTION

4 | COST BENEFIT



Cost Benefit analysis

Cost Benefit Analysis: General Principle

2030 grid (for the 2030 CBA) or 2035 grid (for the 2040 CBA)

Basis against which analysis are conducted.

Includes the capacity available in 2025 and all projects currently under construction or in advanced stages and that are expected to be commissioned until 2030.

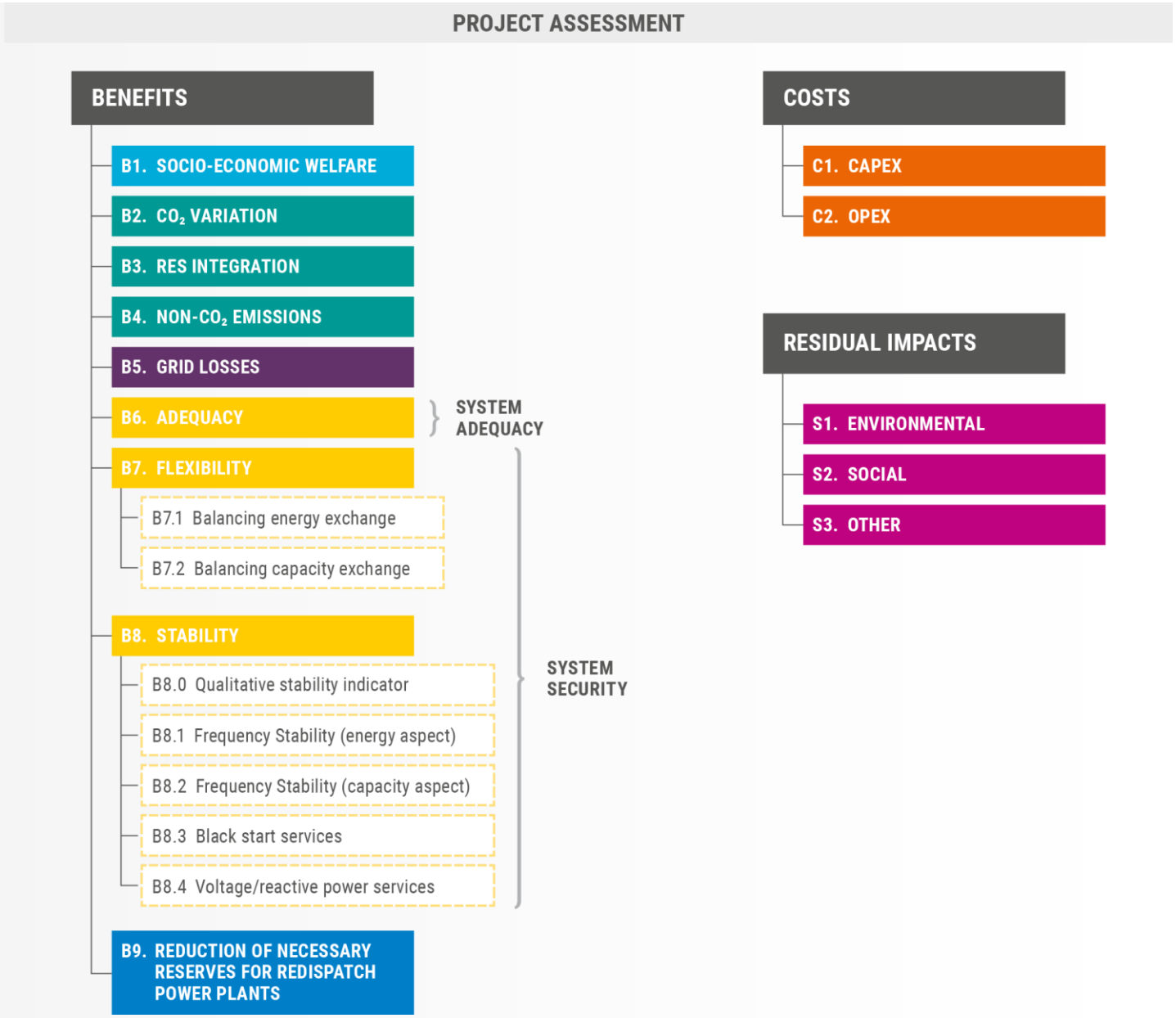
Project already included in 2030 grid? ▶ Remove project from 2030 grid

Compare cases with and without the analysed project to evaluate costs and benefits

Project not included in 2030 grid? ▶ Add project to 2030 grid

Cost Benefit analysis

What are the indicators we use?



Cost Benefit analysis

TYNDP 2024 Cost-benefit analysis of projects – Simulation details

MARKET STUDIES

- 211 projects
- 4 assessment teams
- 3 scenarios
- 3 comparisons
- 22,788 simulations
- 108 reference cases

NETWORK STUDIES

- 187 projects
- 3 scenarios
- 3 CO_2 variations
- 2 losses cases
- 3,366 simulations

SECURITY OF SUPPLY STUDIES

- 3 scenarios
- 35 climate years
- 500 iterations
- 35,500 simulations

B6 CBA Indicator

- 3 scenarios
- 205 projects
- 2 cases (with and without projects)
- 1,230 simulations

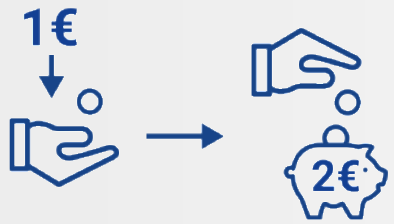
Each simulation is conducted for the entire continent over a year, ie. 8 760 hours.

> 500 million instant renderings of the European electricity system

Three key findings of TYNDP 2024

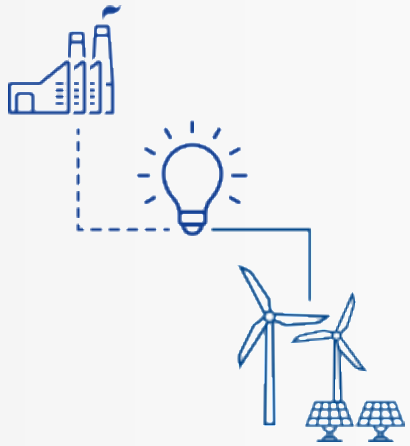
1

By 2040, each euro invested in the electricity grid translates into over 2 euros saved in system costs



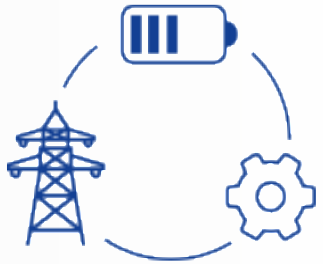
2

Addressing system needs reduces dependence on carbon-intensive power generation and on imports from non-EU countries



3

Existing infrastructure projects address only part of the identified needs. More projects are needed, and action must be taken to enable timely implementation of electricity infrastructure projects.



Collaboration and questions at

tyndp@entsoe.eu

Find the key messages and data you need to make a change on

tyndp.entsoe.eu

Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.

EXCELLENCE

We deliver to the highest standards. We provide an environment in which people can develop to their full potential.

TRUST

We trust each other, we are transparent and we empower people. We respect diversity.

INTEGRITY

We act in the interest of ENTSO-E

TEAM

We care about people. We work transversal and we support each other.
We celebrate success.

FUTURE THINKING

We are a learning organisation.
We explore new paths and solutions.

We are ENTSO-E