Overview of development of cross-border interconnections

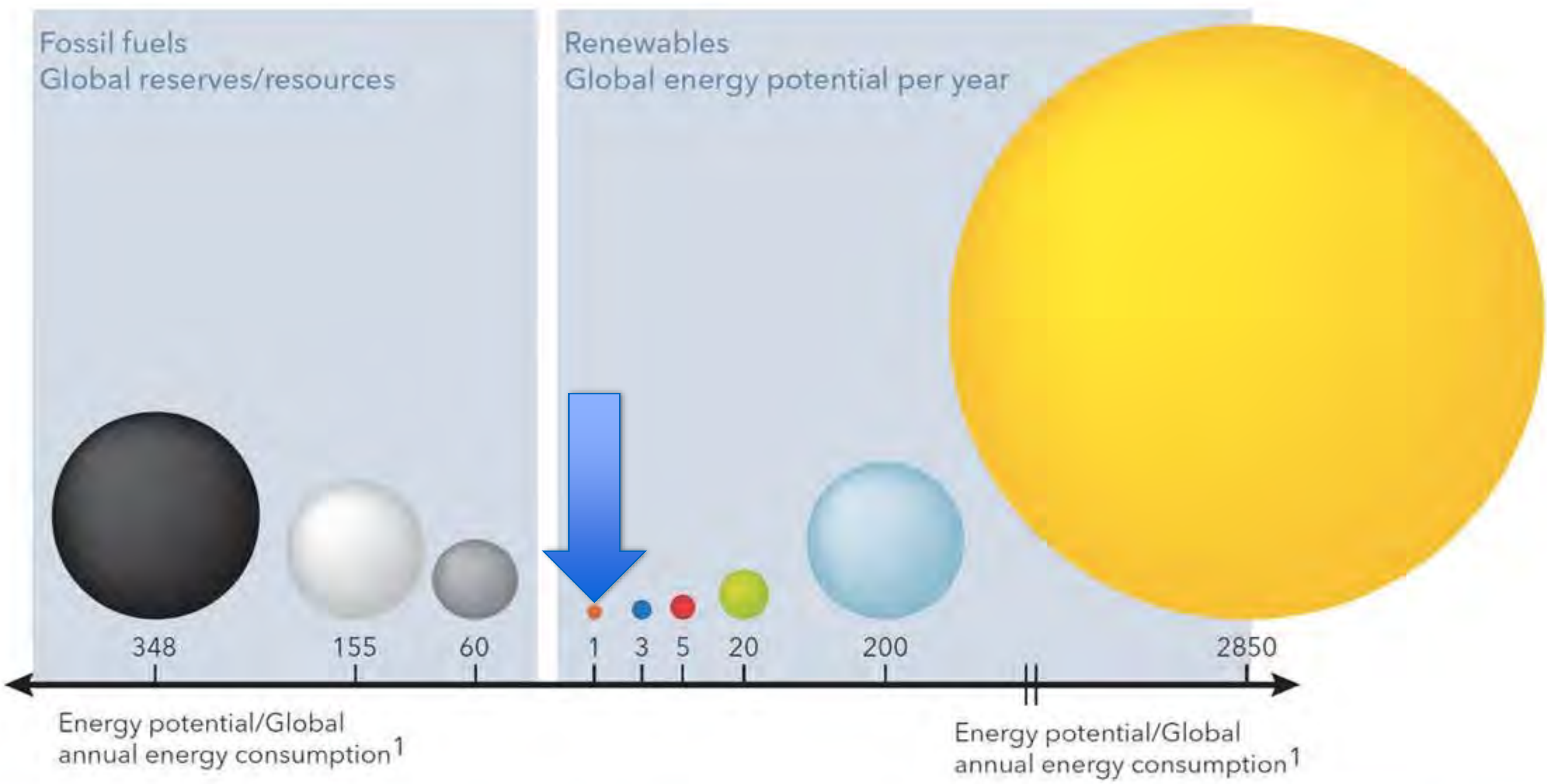
2017-10-30

Bo Normark

Senior Policy Advisor Renewable Energy Institute, Tokyo

Member of the Swedish Royal Academy of Engineering Sciences

Where will the energy come from ?



	Energy potential Reserves/Resources[2]	Thereof conventionally utilizable[2]
Coal	~ 135.000 EJ	
Natural gas	~ 60.400 EJ	~ 12.000 EJ
Crude oil	~ 23.000 EJ	~ 9.800 EJ

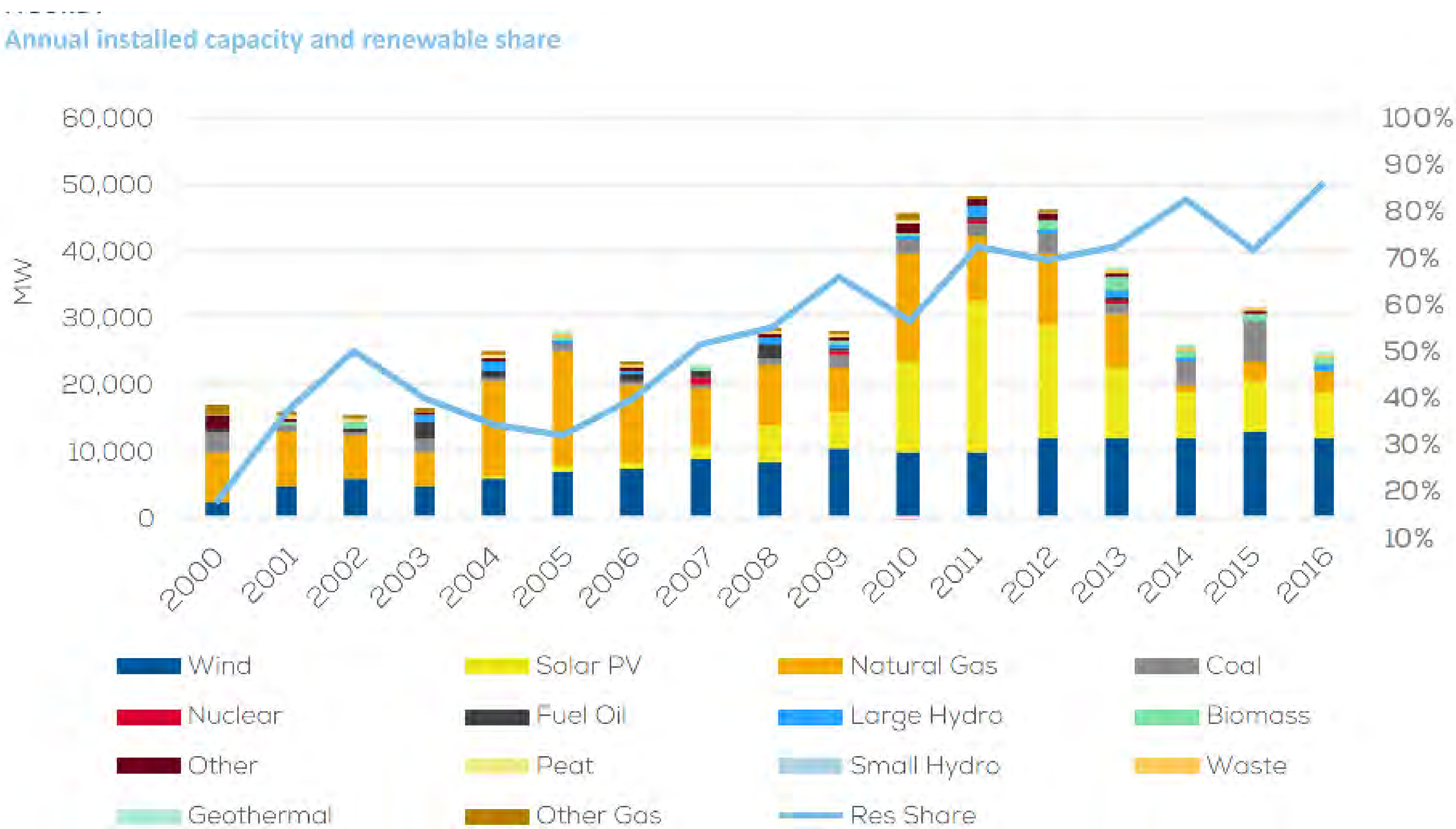
Global energy demand 2006: ~ 470 EJ

	Energy potential (amount of energy p. a.)[2]	technologically utilizable (state of the art)[2]
Solar radiation	~ 1.111.500 EJ	~ 1.482 EJ
Wind energy	~ 78.000 EJ	~ 195 EJ
Biomass	~ 7.800 EJ	~ 156 EJ
Geothermal	~ 1.950 EJ	~ 390 EJ
Hydro/tide power	~ 1.170 EJ	~ 78 EJ

Source: University of Twente

Europe has already decided

Today 90 % RES

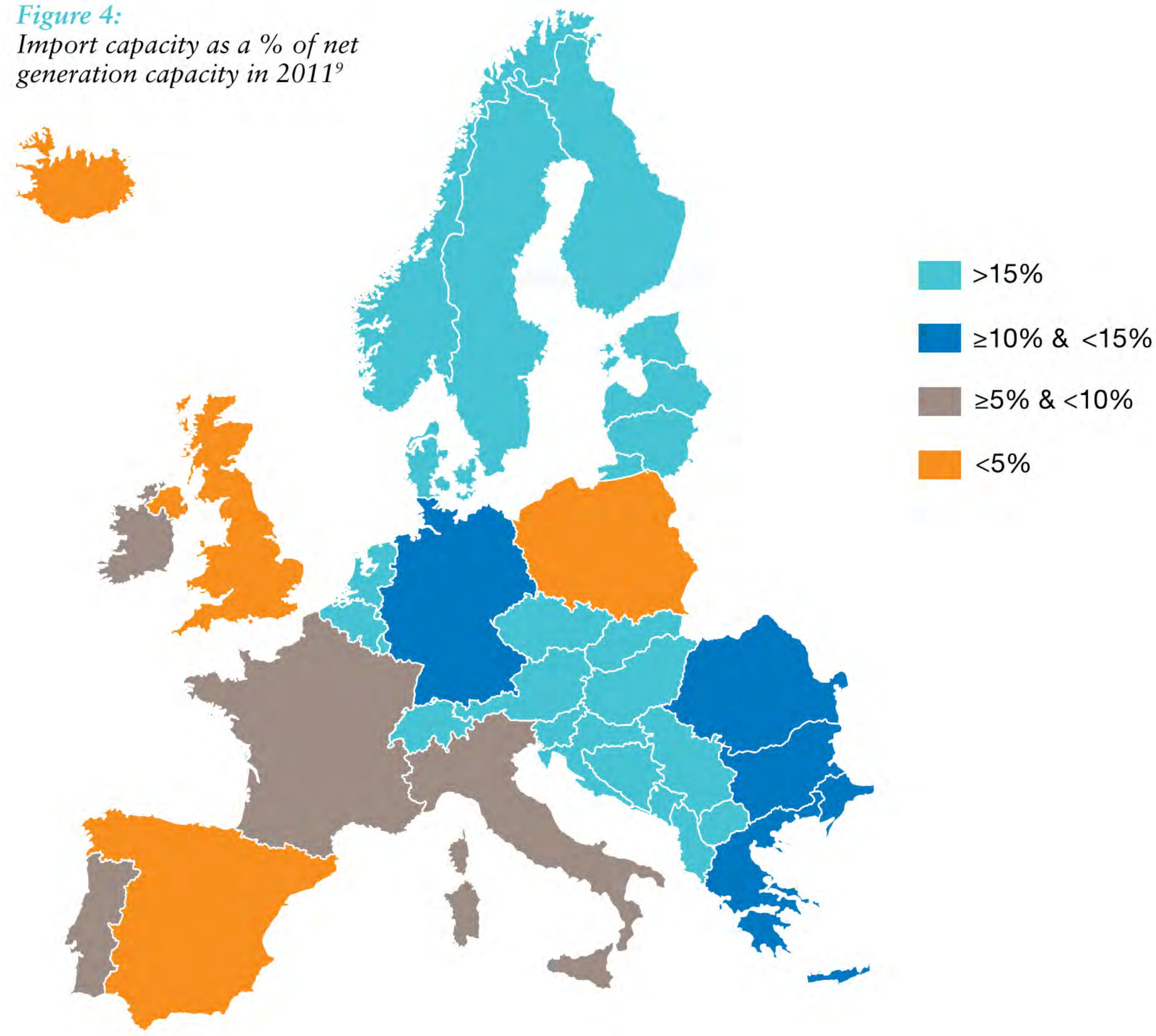


Source: WindEurope

The European power challenge

- **Strong expansion of variable renewable production**
- **Uncoordinated expansion of production**
- **Different incentive / tax systems**
- **Loop flows**
- **Unstable prices**

Figure 4:
Import capacity as a % of net generation capacity in 2011[9]



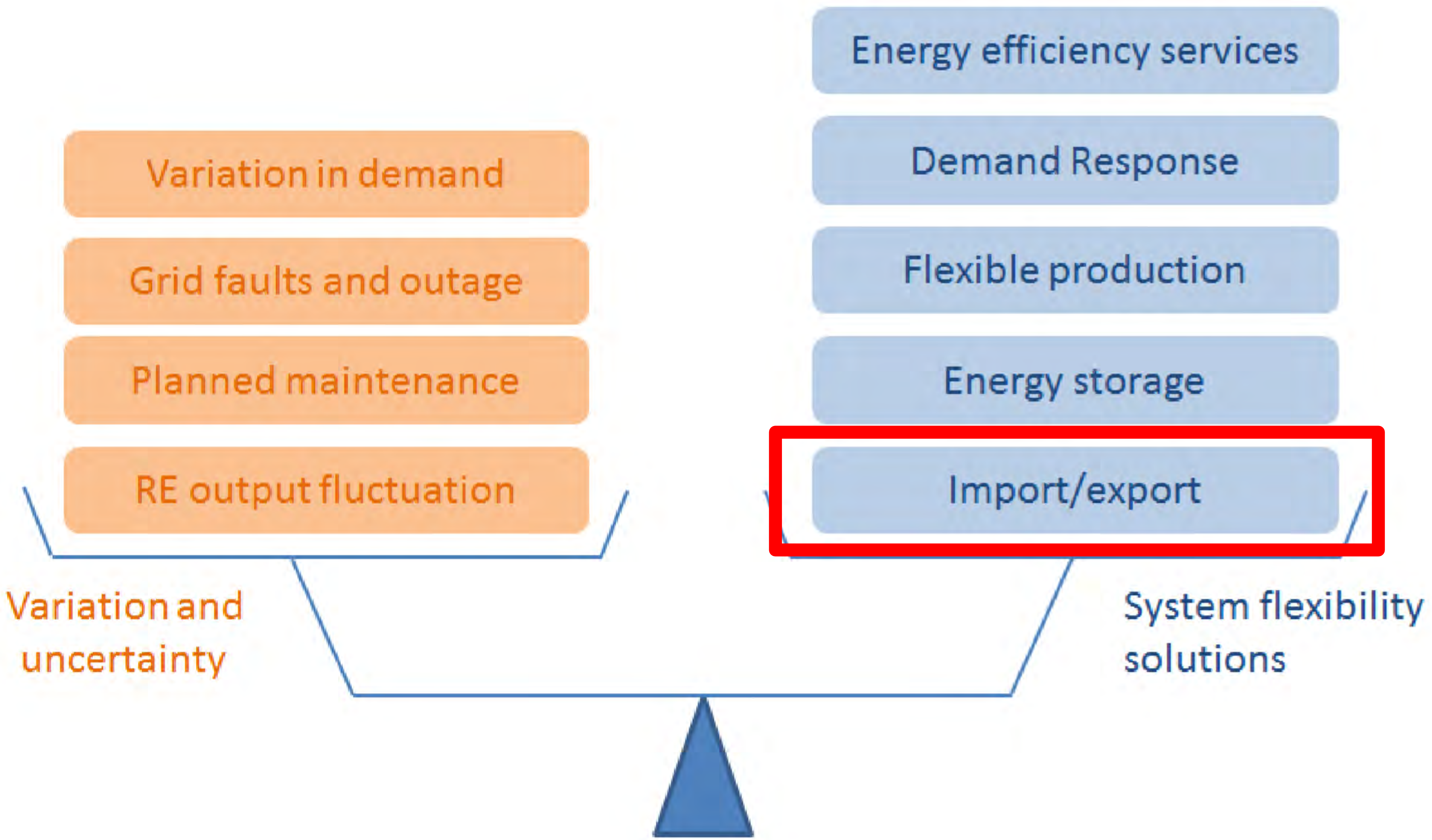
Cornestones in european energy policy

Develop a fully operational and interconnected Energy Union to enable energy diversification and guarantee security of supply.

Promote the integration of renewable energies so that 27 % of total energy consumption comes from renewable sources, hence reducing energy dependency.

Reduce greenhouse gas emissions by -40 % compared to 1990 levels.

The balance / variability challenge

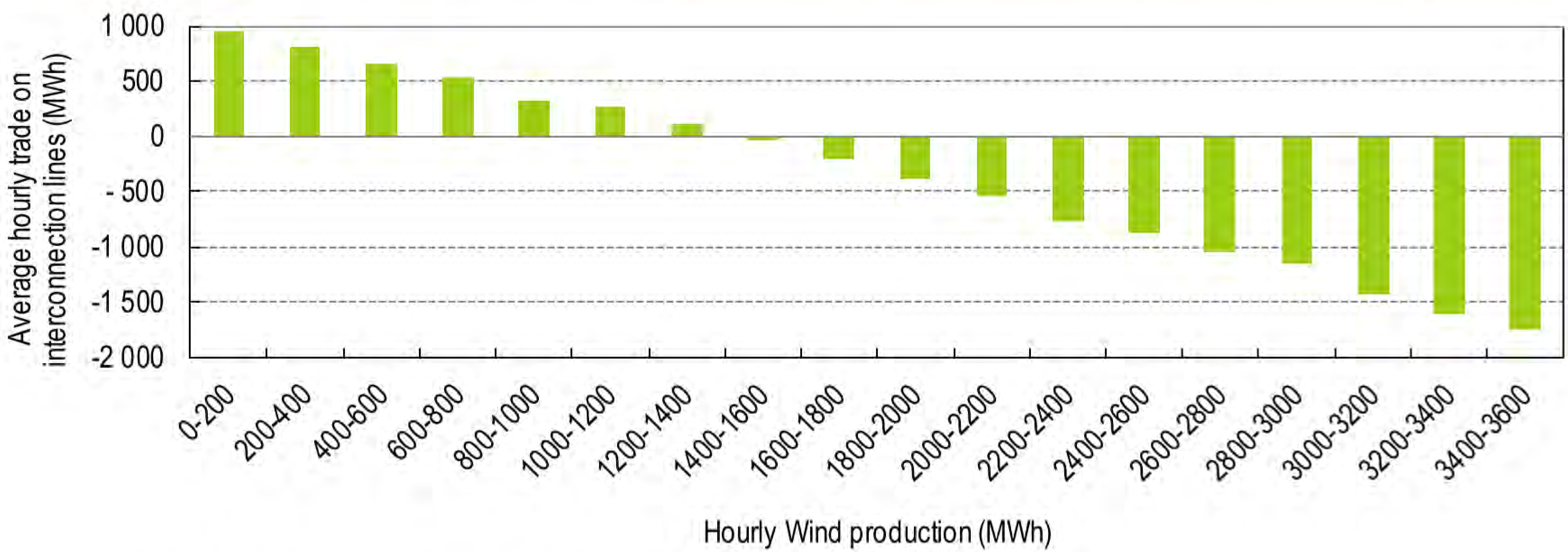


Source: DG Internal Policies 2015

Interconnections key to power balance

Example wind power in Denmark

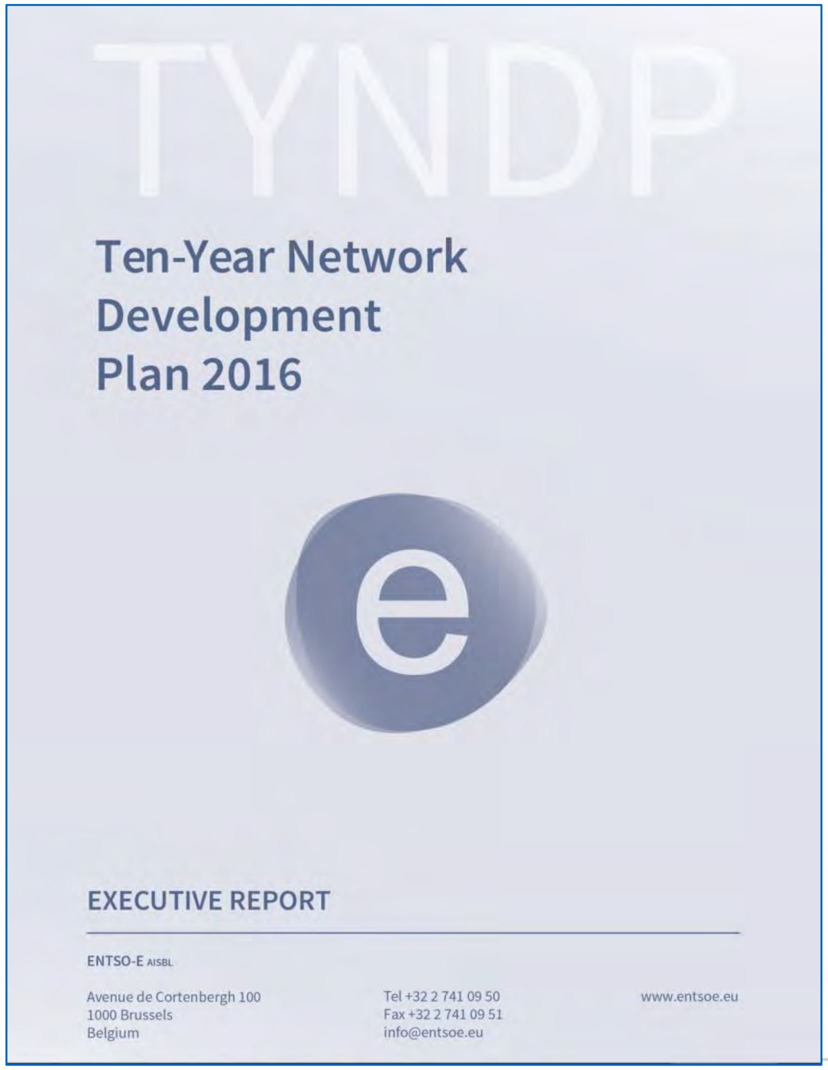
Figure 6 • Average trade on interconnection lines by wind generation levels, western Denmark, 2015



Source: Adapted from Energinet.dk (2016), Market data

ENTSO-E

Ten Year Network Development Plan 2016


TYNDP

Ten-Year Network Development Plan 2016

EXECUTIVE REPORT

ENTSO-E AISBL

Avenue de Cortenbergh 100
1000 Brussels
Belgium

Tel +32 2 741 09 50
Fax +32 2 741 09 51
info@entsoe.eu

www.entsoe.eu

€150bn
investments, of which 70-80 by 2030

1 to 2 €/MWh
impact on bills due to transmission investment

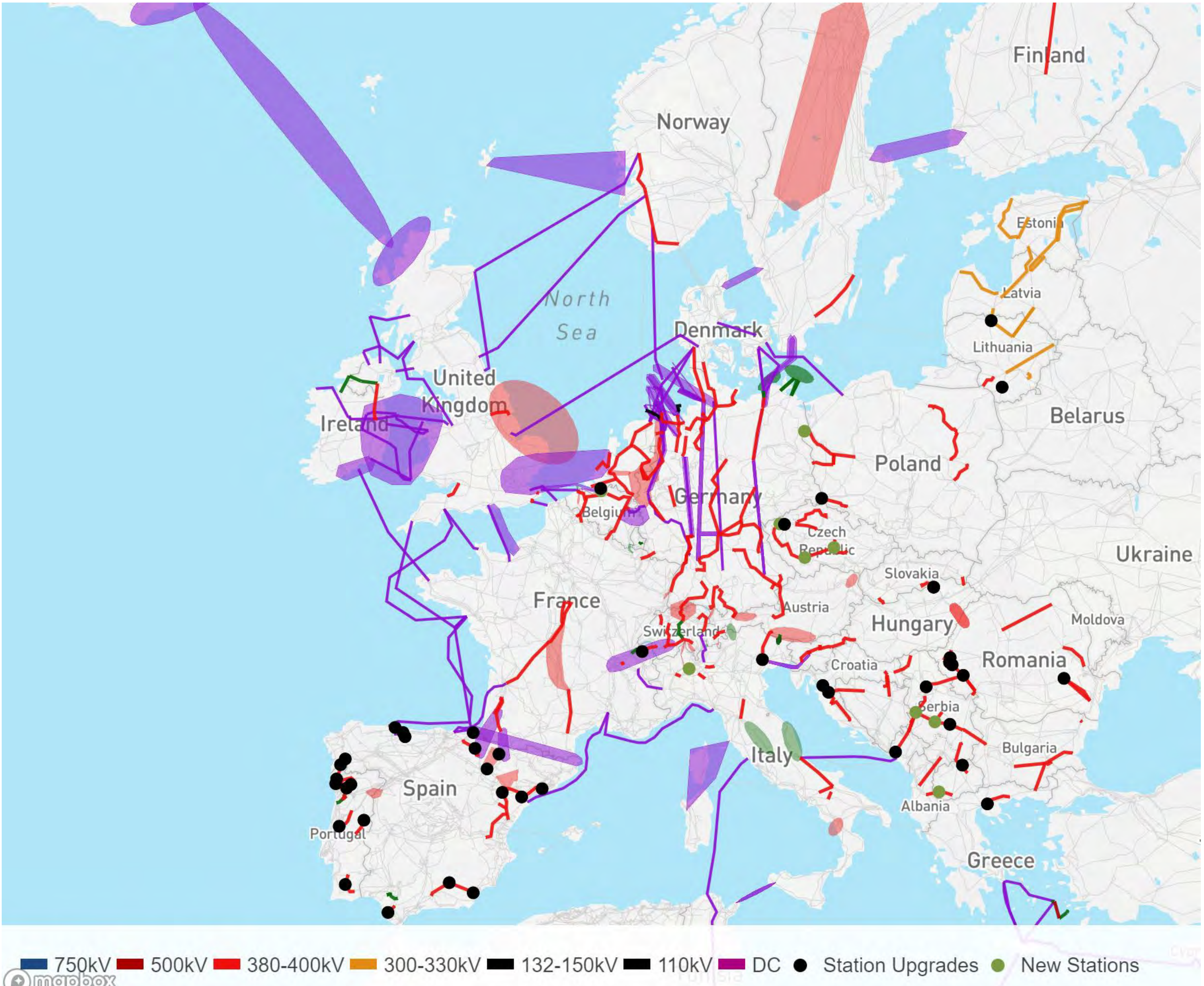
45 to 60%
RES across 4 Visions for 2030

50% to 80%
emissions cut depending on the vision

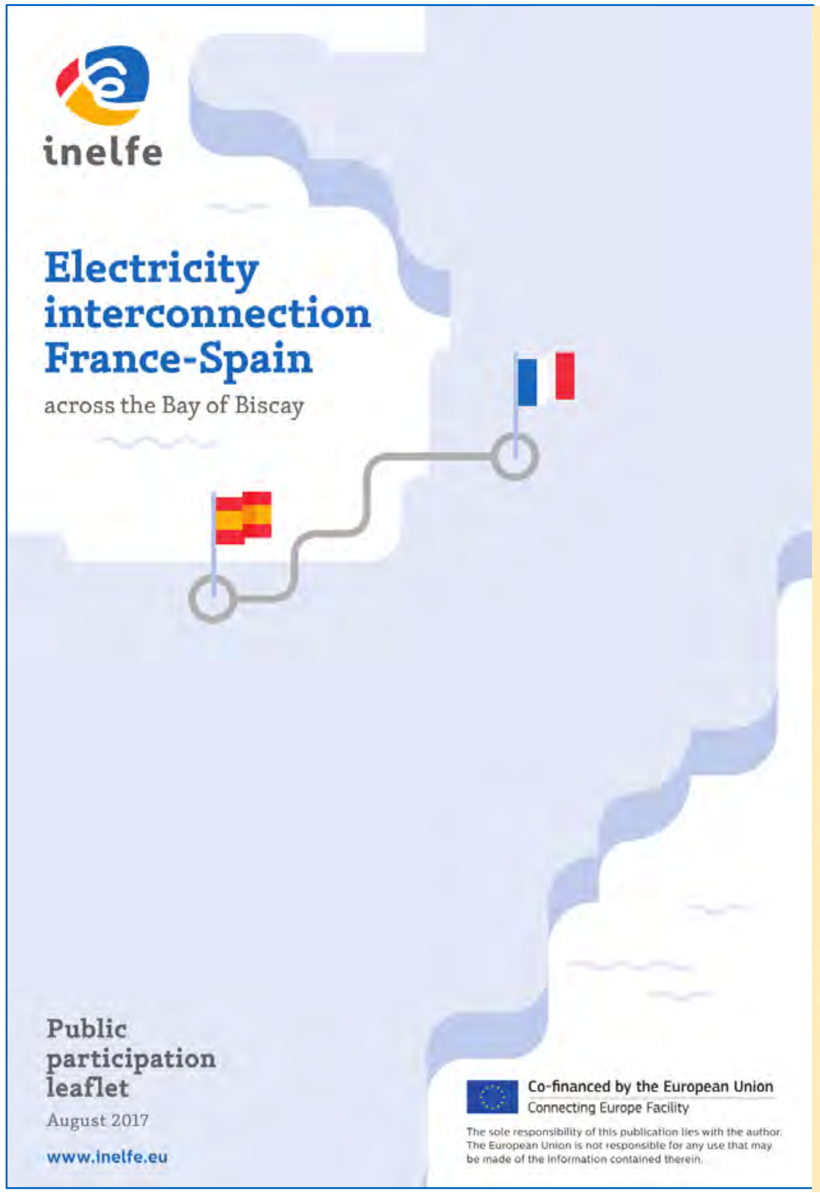
1.5 to 5 €/MWh
potential reduction in wholesale prices

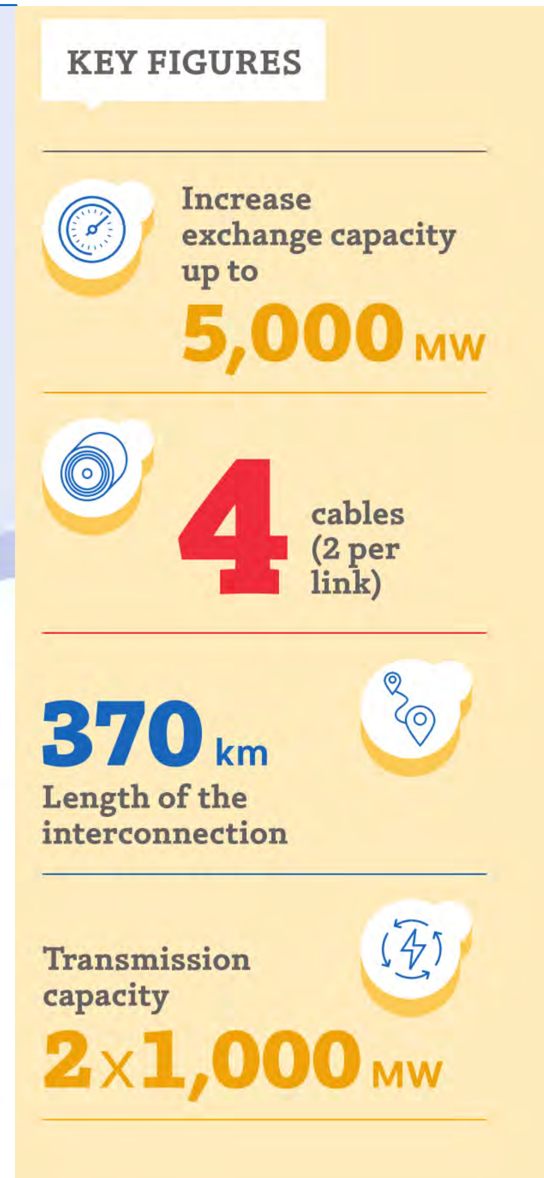
40%
reduction in congestion hours

ENTSO-E, Ten Year Plan, all projects

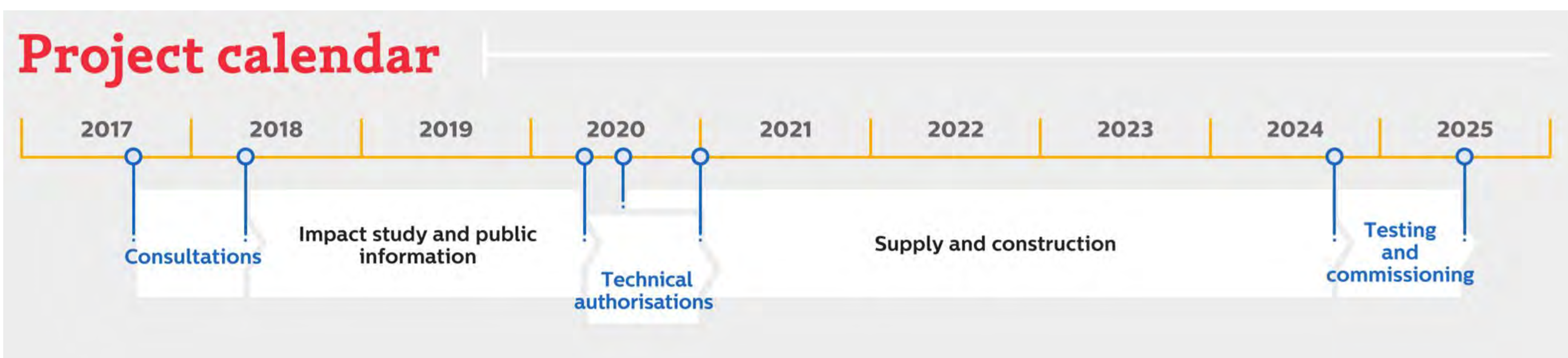


Case: INELFE Interconnection France - Spain





- Security of supply
- Increased efficiency
- Economy
- Integration of RES
- Total cost €1.75bn of which EU support €0.70bn



Case: INELFE Interconnection France - Spain

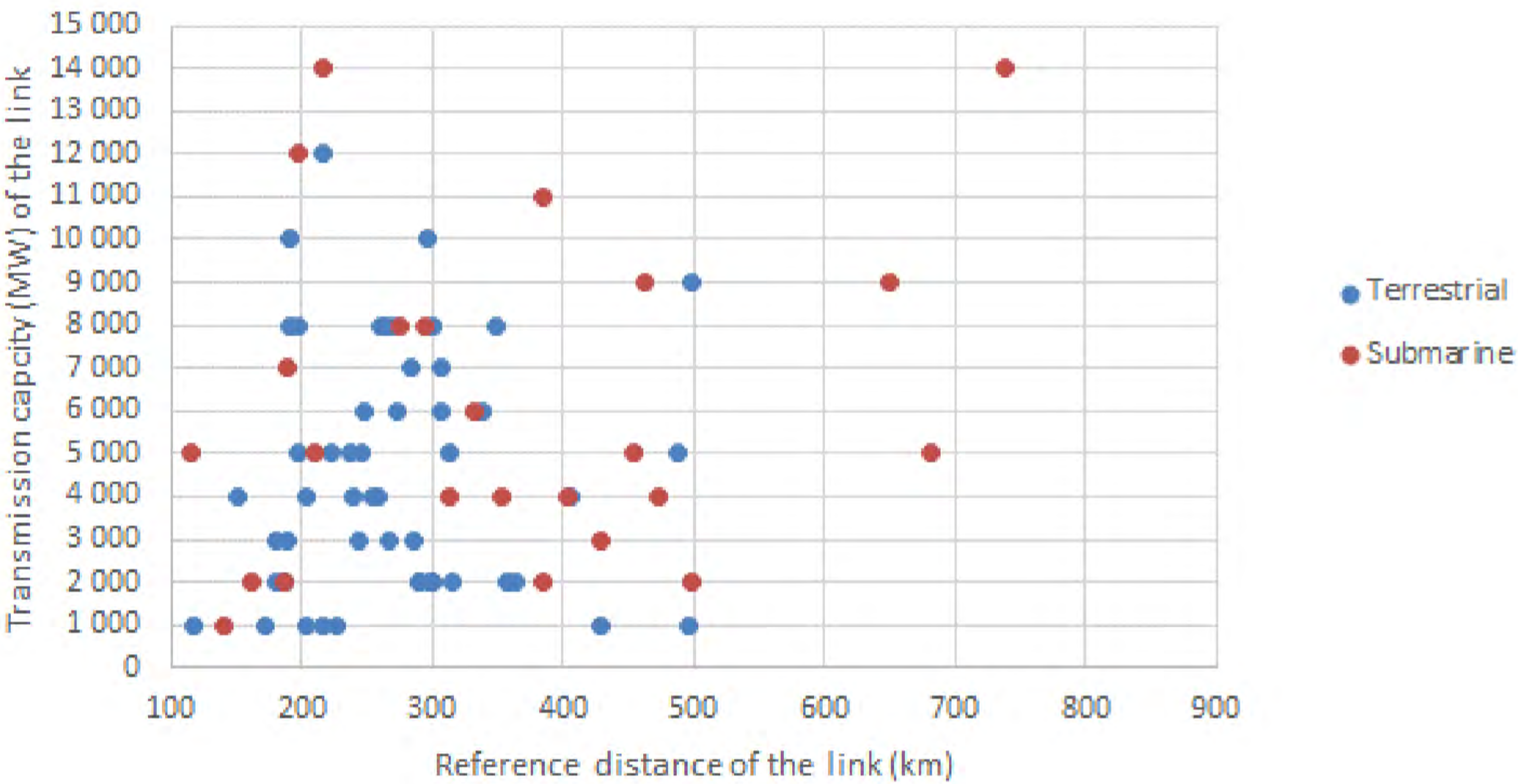
•	SEW	Savings in generation fuel and operation cost	Meuros/yr
•	RES	Additional hosting capacity renewable	GWh/yr
•	Losses	Reduction in losses	GWh/yr
•	CO_2	Change in CO_2 emissions	kT/yr

Scenario specific CBA indicators	EP2020	Vision 1	Vision 2	Vision 3	Vision 4
B1 SoS (MWh/yr)	N/A	N/A	N/A	N/A	N/A
B2 SEW (MEuros/yr)	200 ±30	120 ±20	150 ±20	120 ±30	240 ±30
B3 RES integration (GWh/yr)	40 ±40	460 ±200	960 ±190	700 ±250	1000 ±140
B4 Losses (GWh/yr)	700 ±100	800 ±100	1200 ±400	750 ±100	1200 ±200
B4 Losses (Meuros/yr)	30 ±5	40 ±10	55 ±20	35 ±10	55±20
B5 CO_2 Emissions (kT/year)	2400 ±500	800 ±400	±100	-1000 ±200	-2300 ±200

75 planned links, 25 Submarine

100% RES electricity (X7): 100% renewable electricity with both large scale and small-scale generation units, as well as links with North Africa. Both large-scale and small-scale storage technologies are needed to balance the variability in renewable generation.

Distribution of the 50 terrestrial and 25 submarine links in transmission capacity (MW) X distance (km) for the scenario: '100% RES (X7)'



Will transmission investments pay off ?

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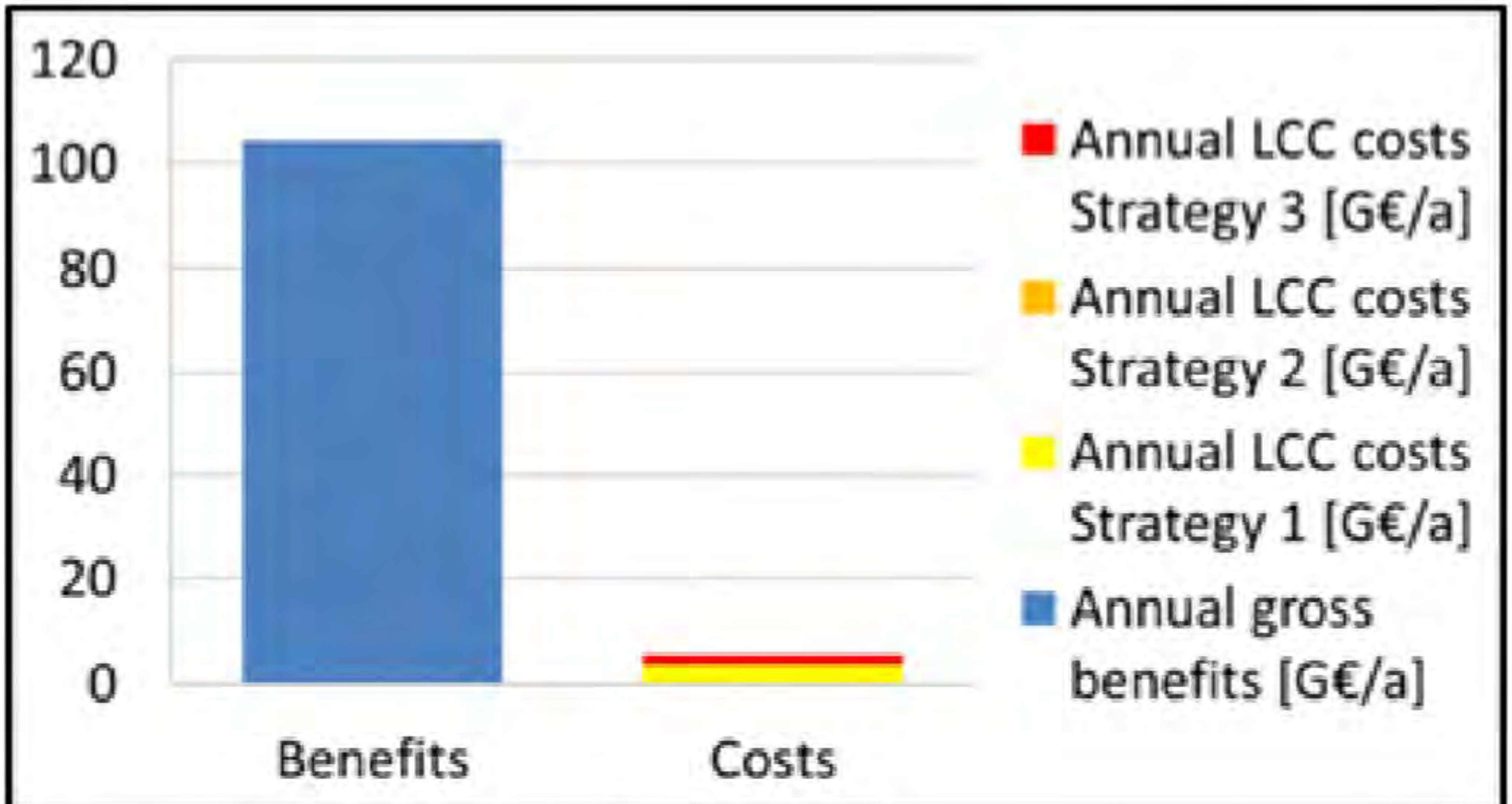
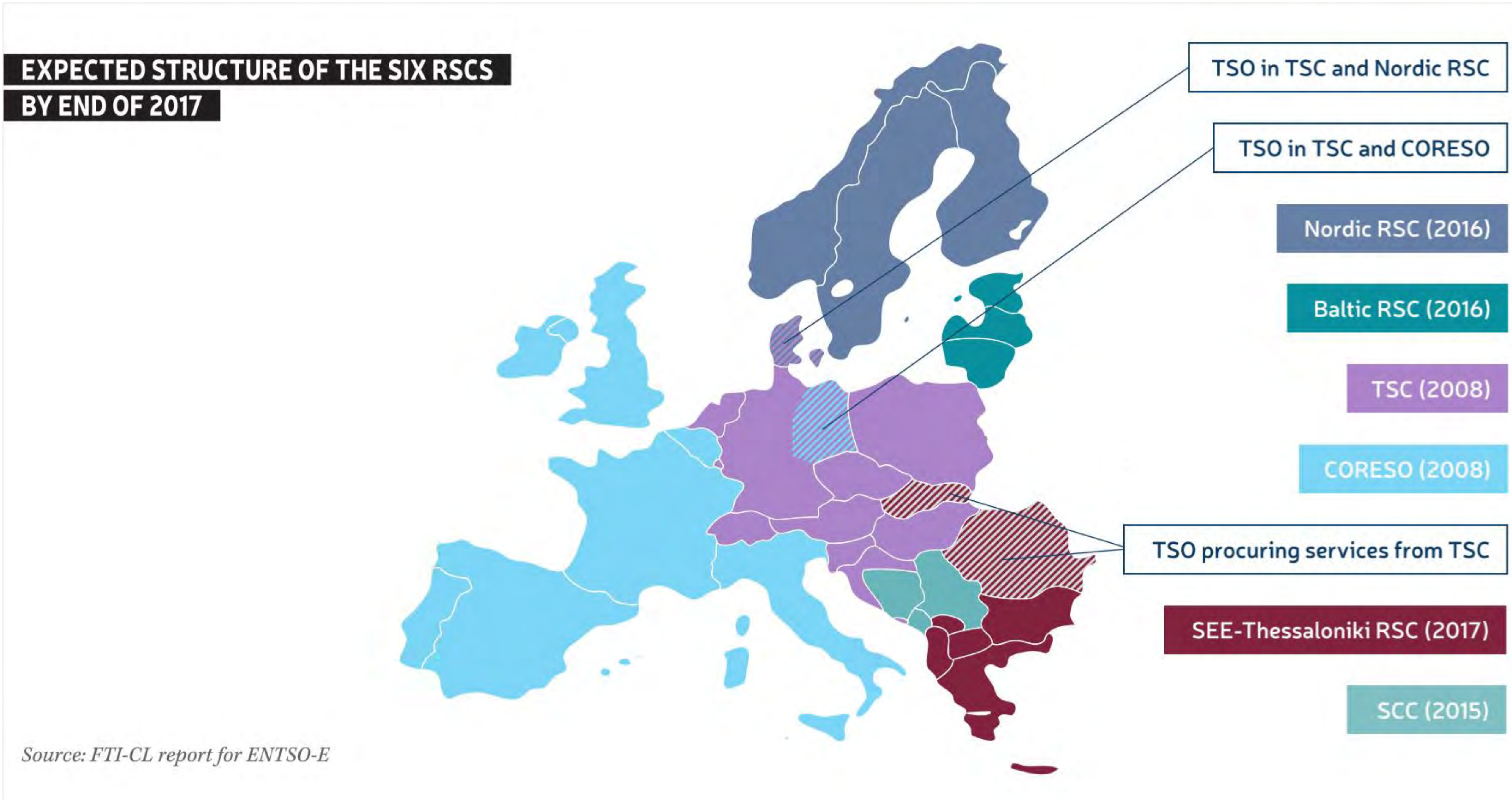


X-7 - 2040

ENTSO-E, Ten Year Plan Observations

- Involves the entire continent
- High number of off-shore cables
- Both onshore and offshore HVDC transmission systems
- All HVDC Systems based on VSC Technology

Market / Price challenge
Market integration, starting with regions



Lessons learned

- **Grid investments is generally a very cost efficient way to improve the electricity system.**

- **Multiple benefits from interconnectors**

- **A common system for economical evaluation of projects is essential.**

- **Value of interconnections is higher the more renewable production is introduced.**

- **Be aware of technological development, new solutions gives more options.**

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RENEWABLE ENERGY INSTITUTE

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