

Towards Regional Integrated Power Systems

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Belgian Energy Day – Riyadh – 16 March 2014

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Possible evolutions

- Our social model is based on growth with the following drivers:

- natural resources available
- population
- technological & scientific innovation
- investment capacity & policy
- human knowledge
- ...

- Evolution observed the last 50 years worldwide:

- population: from 3 billion → 7 billion human beings
- GDP: from 10.000 billion € → 70.000 billion €
- average growth $\approx 4,5\%$ → 140.000 billion € in 2030
→ 280.000 billion € in 2050

→ Same pace in the future?

Increasing importance of grids in energy allocation

The U.S. proposes a stronger, smarter grid that connects the east coast and west coast

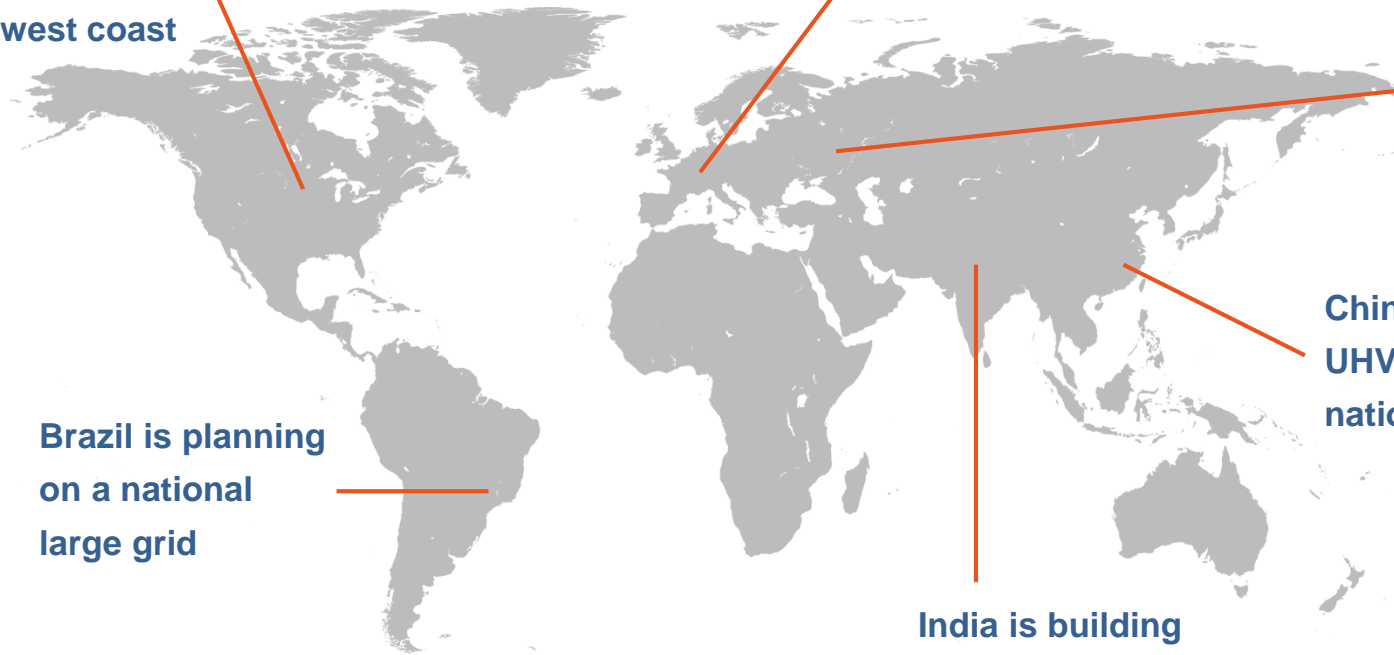
Europe proposed Super Grid that runs across the European continents and connects many countries

Russia is planning grid upgrading

China is building UHV networks nationwide

Brazil is planning on a national large grid

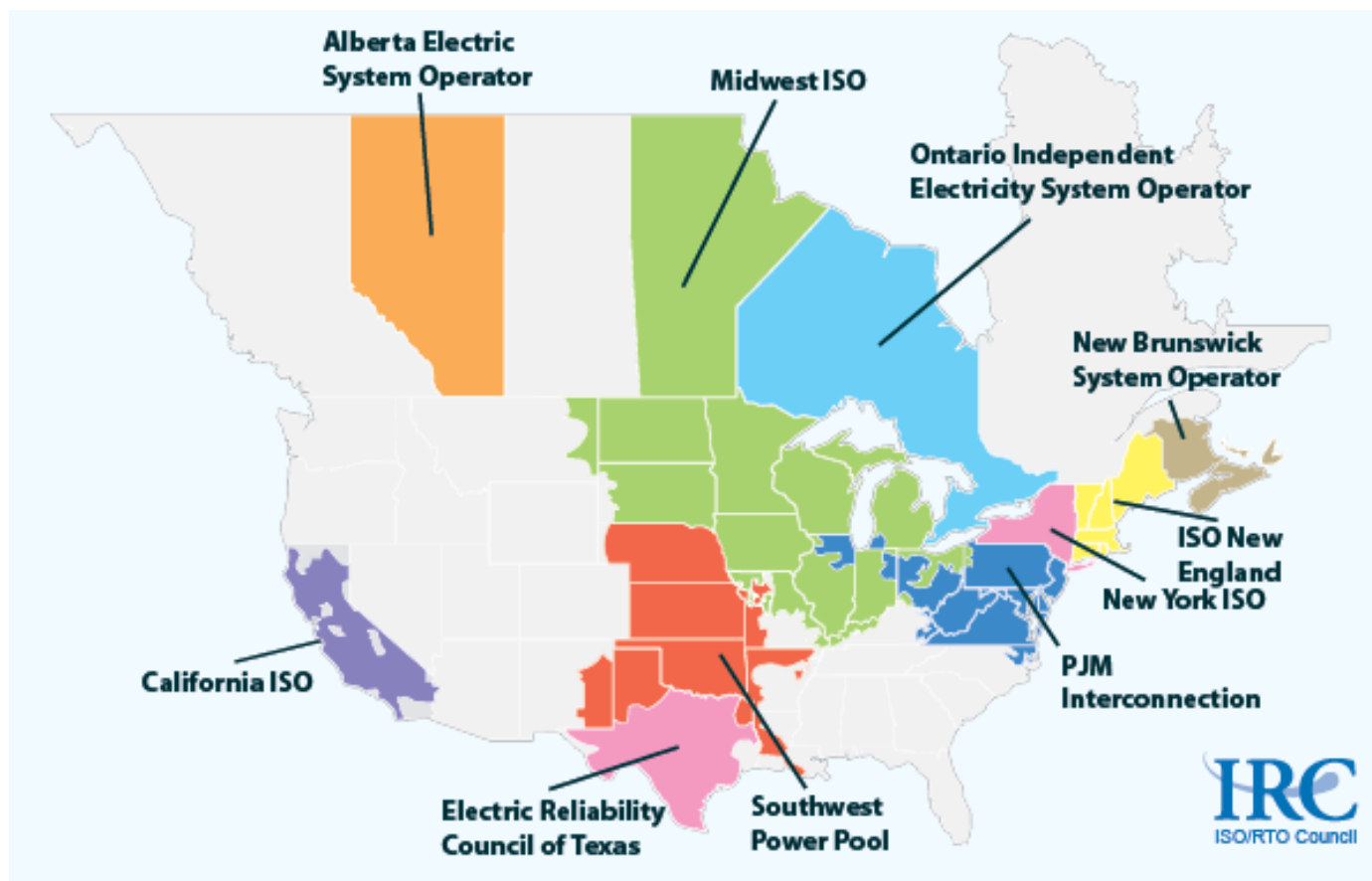
India is building its first UHV lines



Different market models, legislation, regulation, energy-mix ...

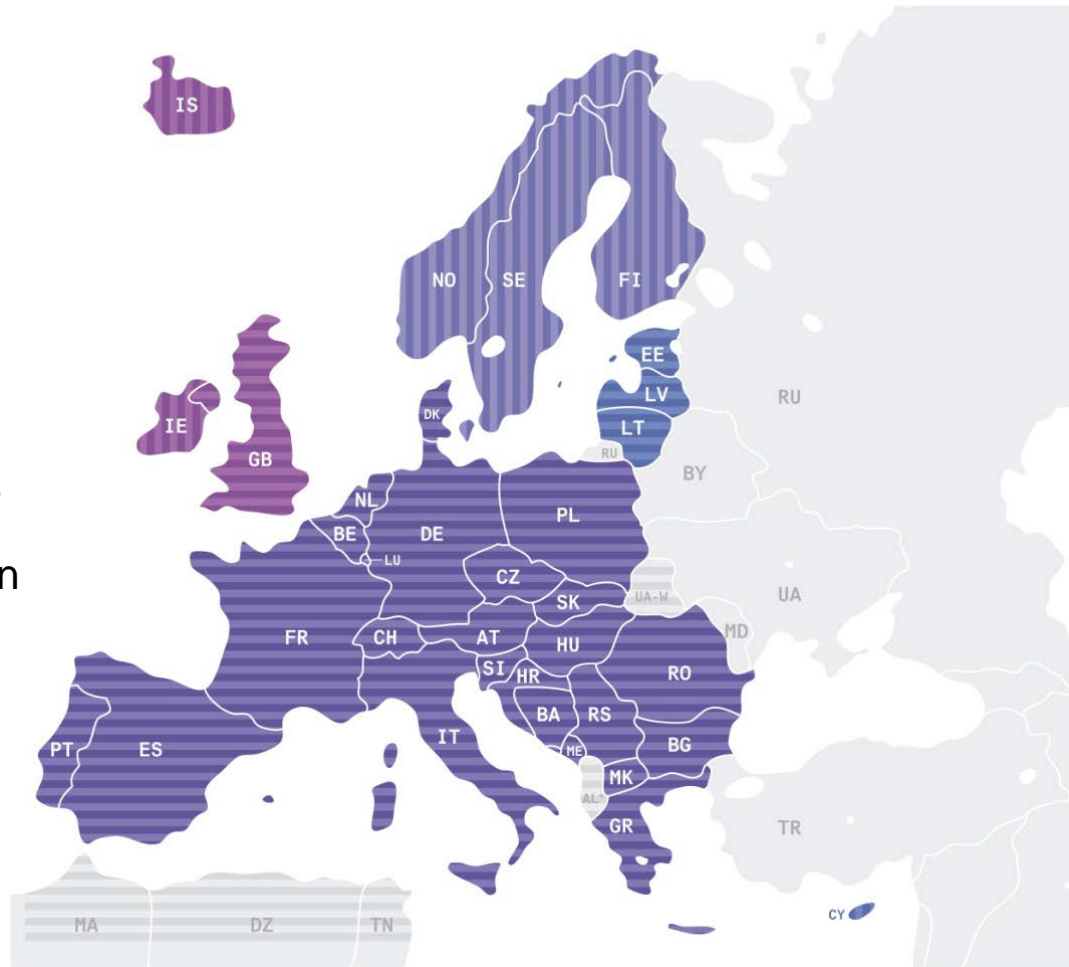
... **with very similar challenges!**

US electricity ISO mapping



About the EU network of TSO for Electricity: entsoe.eu

- **41 TSOs** from **34 countries**
- A trans-European network
 - **534** million citizens served
 - **910** GW generation
 - **305,000** Km of transmission lines
 - **€104 bil** ten year investment plan
 - **3,400** TWh/year demand
 - **400** TWh/year exchanges
- **A legal mandate**



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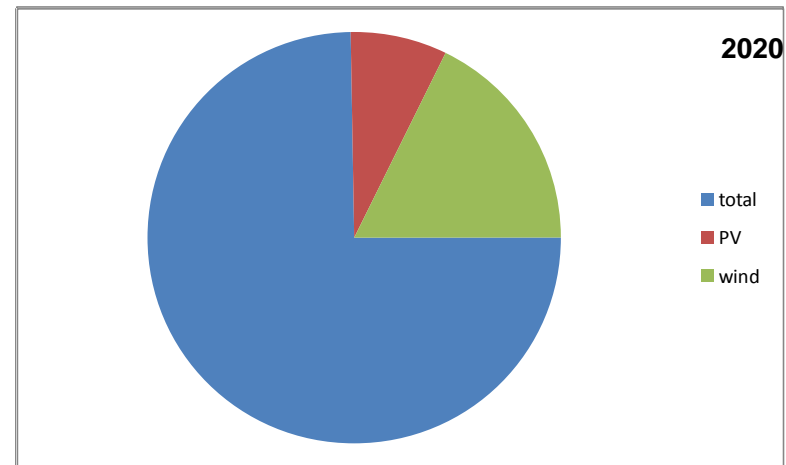
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EU Power System and the RES revolution

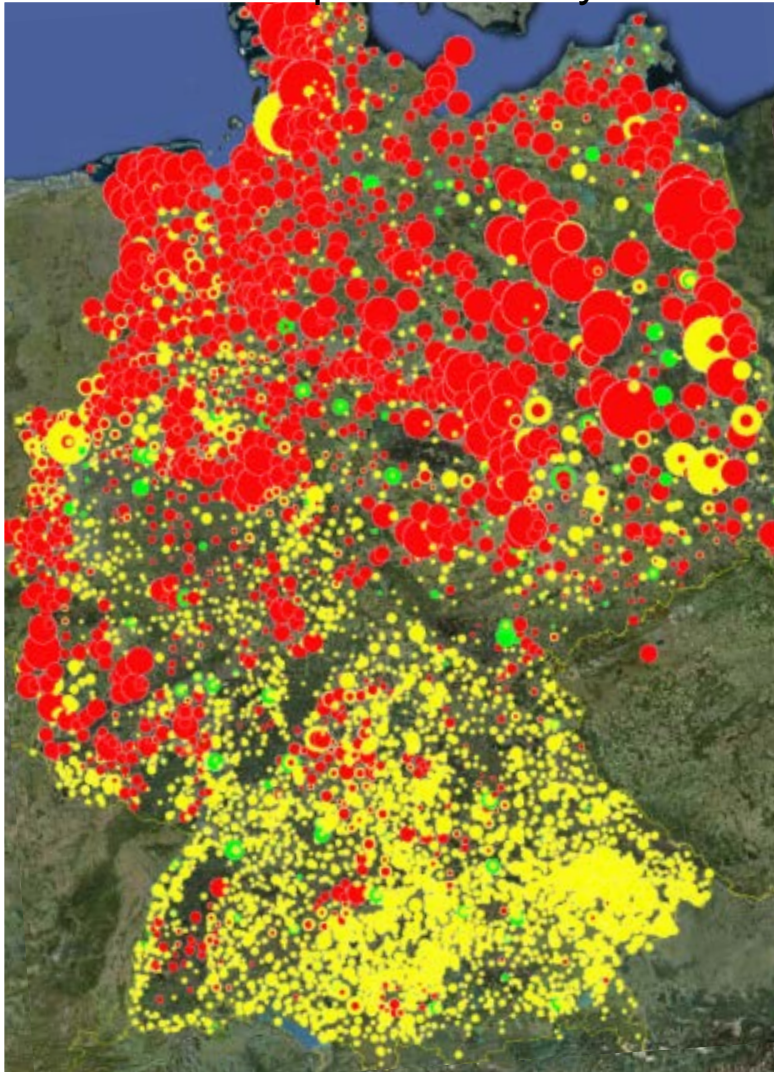
Large **flows** all over Europe



Development of energy generated from Renewables

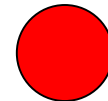
Installed capacity of Renewables (1)

Example: Germany

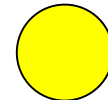


Total capacity of renewables
(End 2012)

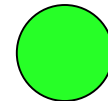
~ 1.300.000 installations



Wind energy



PV

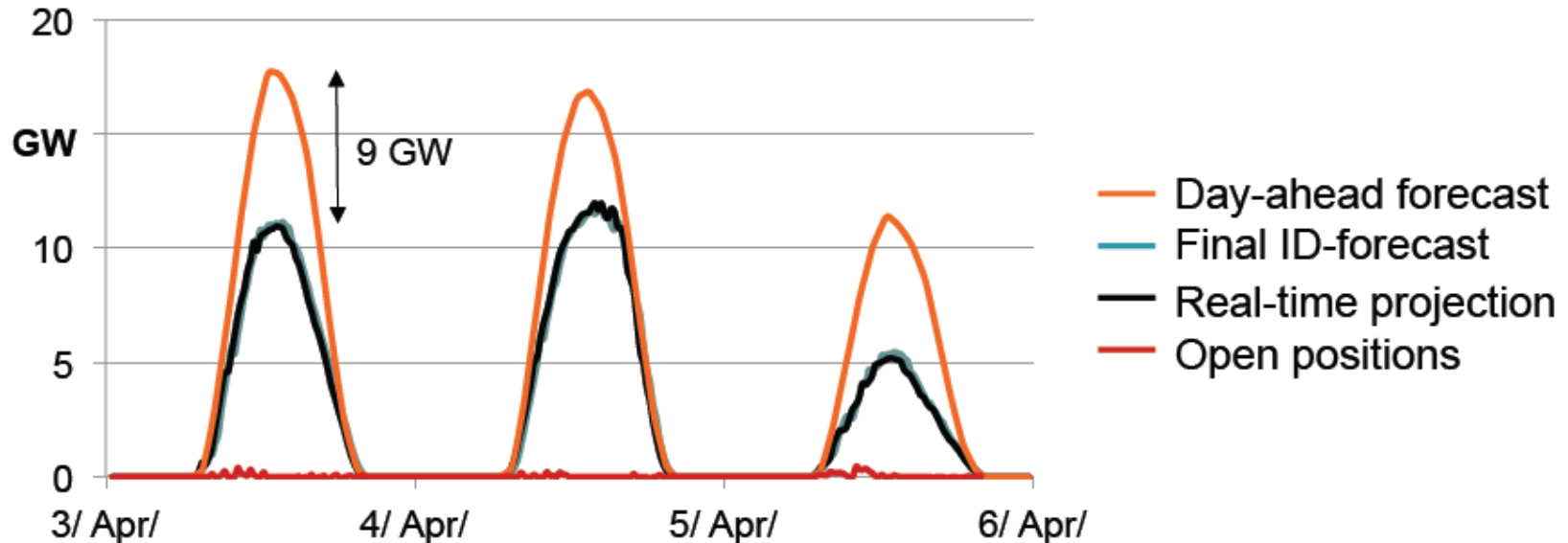


Biomass

*The circle diameter is proportional
to the electrical capacity*

Example: a foggy morning

- Unforeseen early morning fog induced a lack of 8,000 MW from solar generation
- Due to limited intraday liquidity, some positions remained open (max. 445 MW)



→ without storage and increasing RES, acting on demand up and down is urgent!

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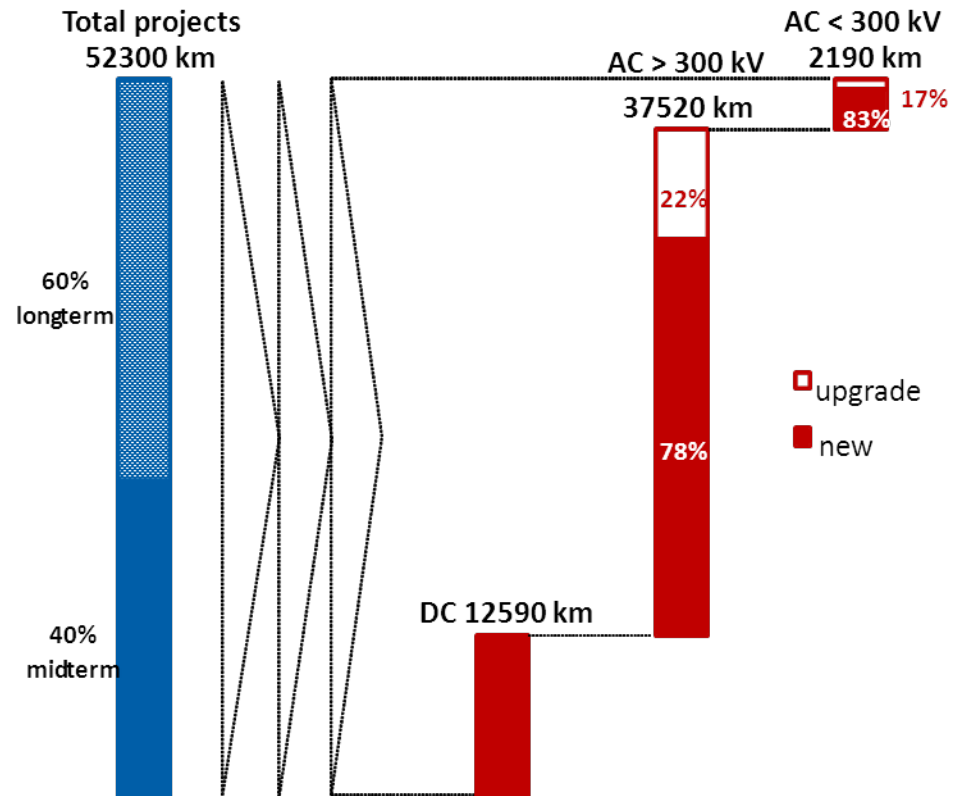
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Three pillars of EU Energy policy

Transmission investment projects that answer the three pillars of EU energy policy

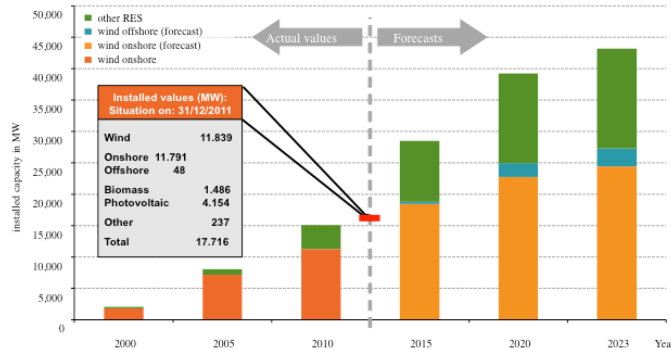
- Security of Supply
- Integration of RES
- The completion of the IEM



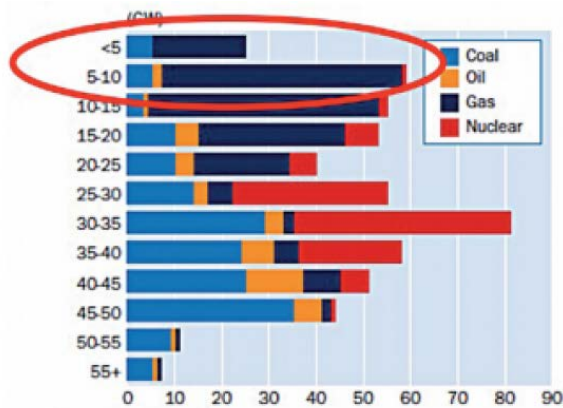
More grid capacity: +17% till 2020

RES growth

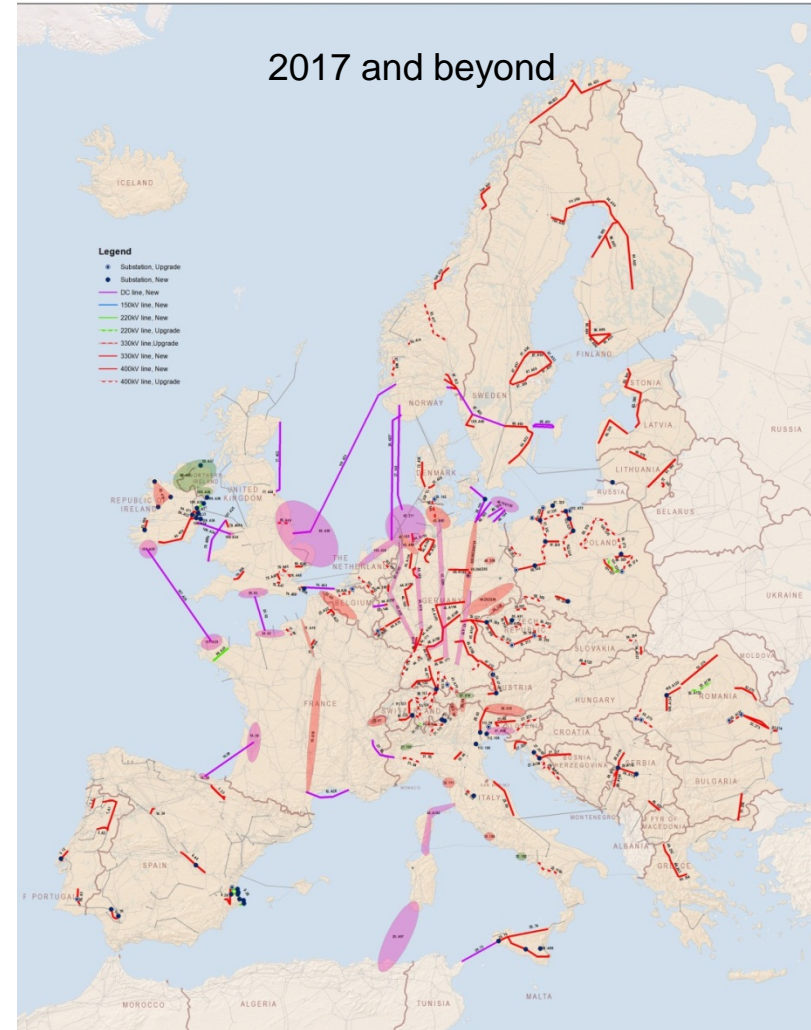
Example from one German area



Age of EU thermal plants by fuel



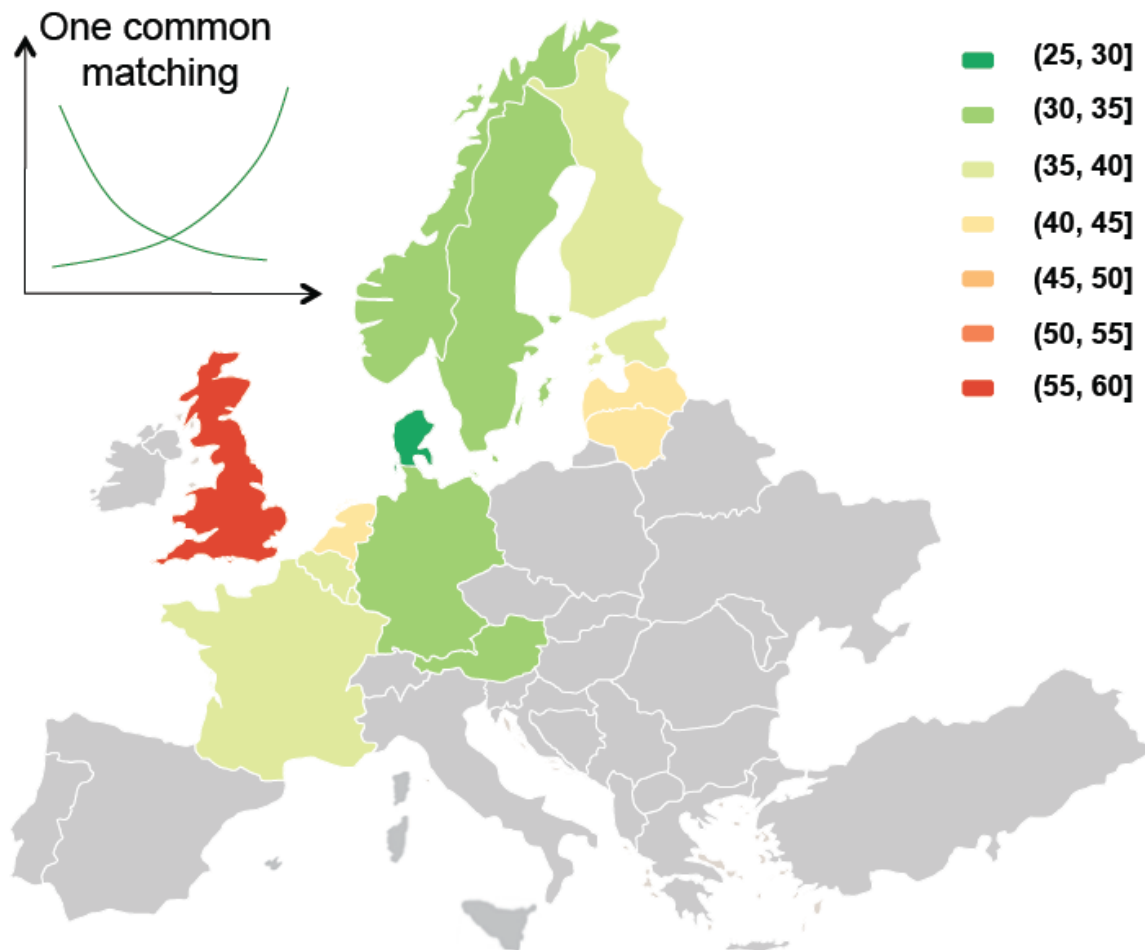
SOURCE: PLATTS POWERVISION, DECEMBER 2013



→ On the average, it takes 12 years to build a new transmission line ... **PCI impact ?**

IEM: price results 8 days NEW-market coupling 05-12/02

Area	MCP
Denmark	€ 29.47
Norway	€ 30.58
Sweden	€ 30.64
Germany	€ 32.57
Finland	€ 35.53
Estonia	€ 35.95
Belgium	€ 39.16
France	€ 39.16
Latvia	€ 41.53
Lithuania	€ 41.56
Netherlands	€ 43.51
Great Britain	€ 55.48



Note: arithmetic mean of MCPs for first 8 days of NWE MC; for Denmark, Norway and Sweden (with firstly an aggregation on country level of the arithmetic mean of the concerned area prices). Source: own computation based on data from APX, Belpex, EPEX Spot, N2EX and NordPoolSpot

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Physical interconnections: a must!

Europe connecting with MENA



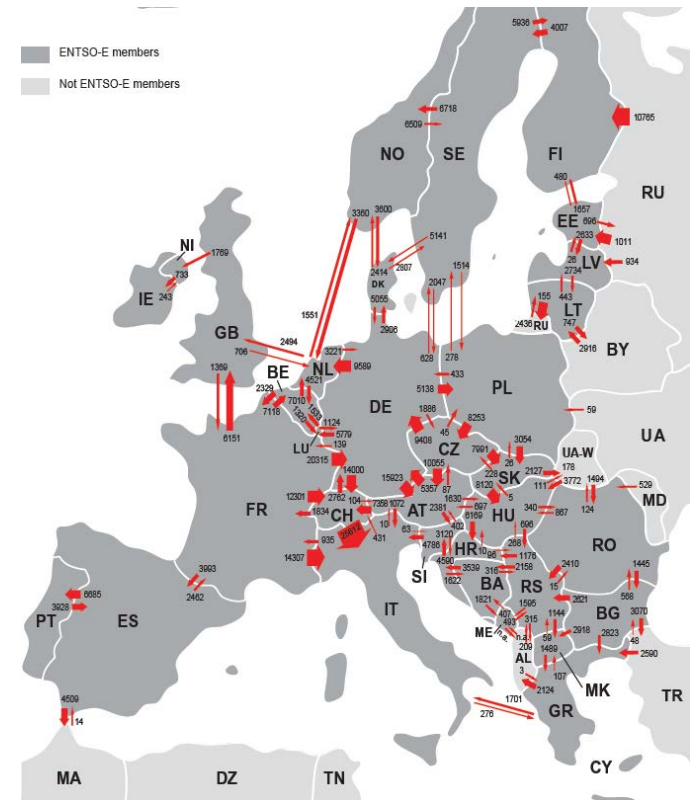
Source: MEDGRID, Arab Union of Electricity, SCIP

Inter-regional security of supply

Physical interconnections: a must!

Market coupling = transmission capacity

The Gulf interconnector successfully achieved in 2011

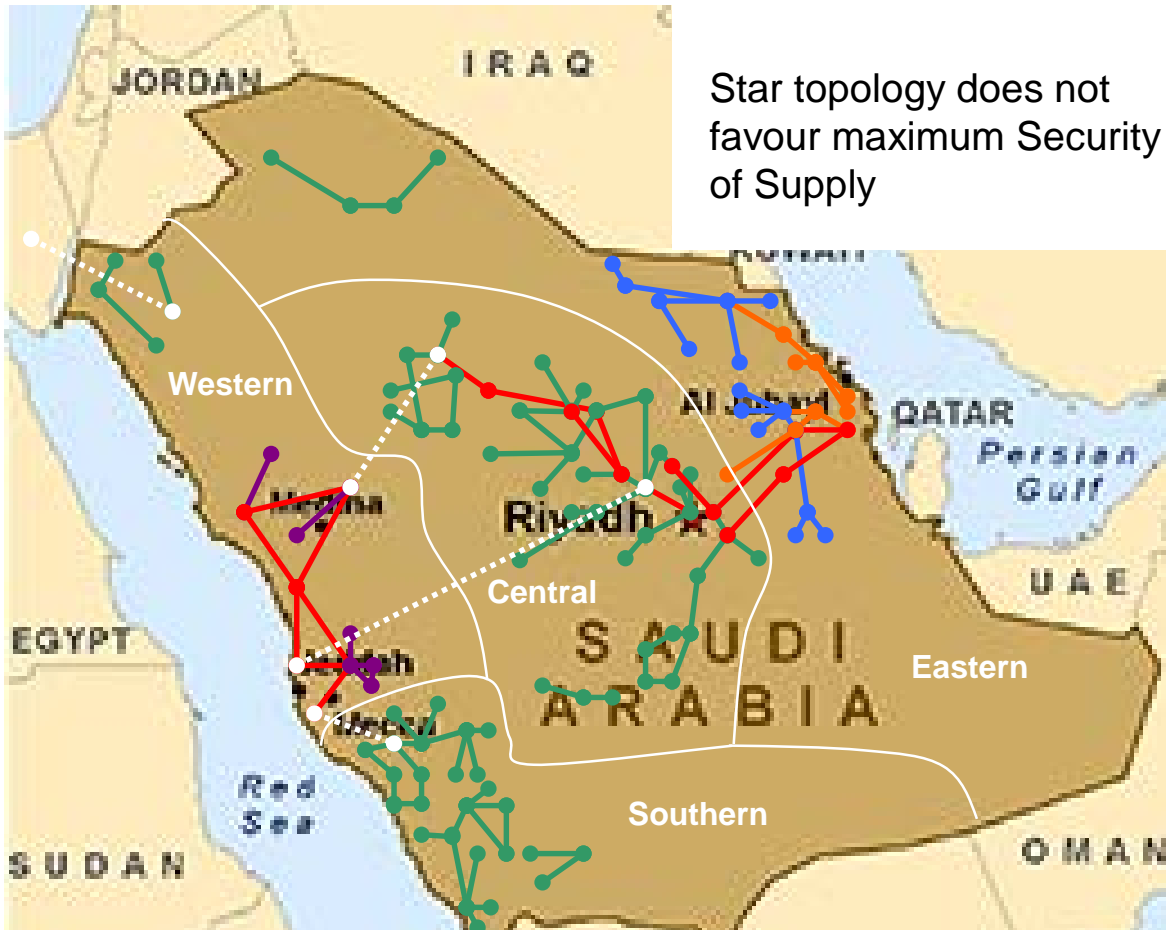


Source: ENTSO-E 2011 statistical report

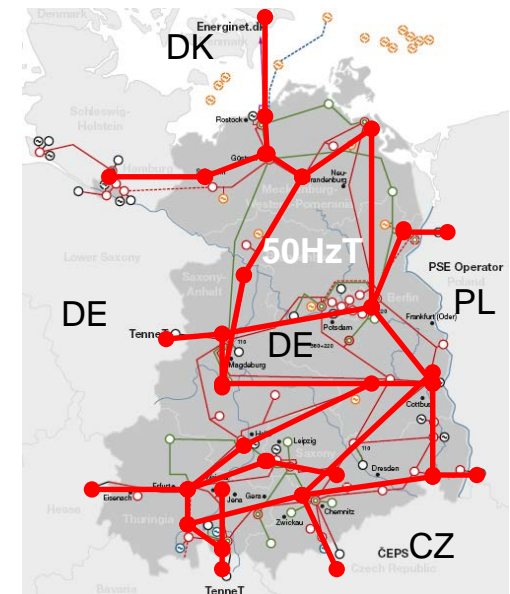
Energy flows in Europe jumped from 63 to 412 TWh since 1975

Physical interconnections: a must!

Reliability = transmission capacity



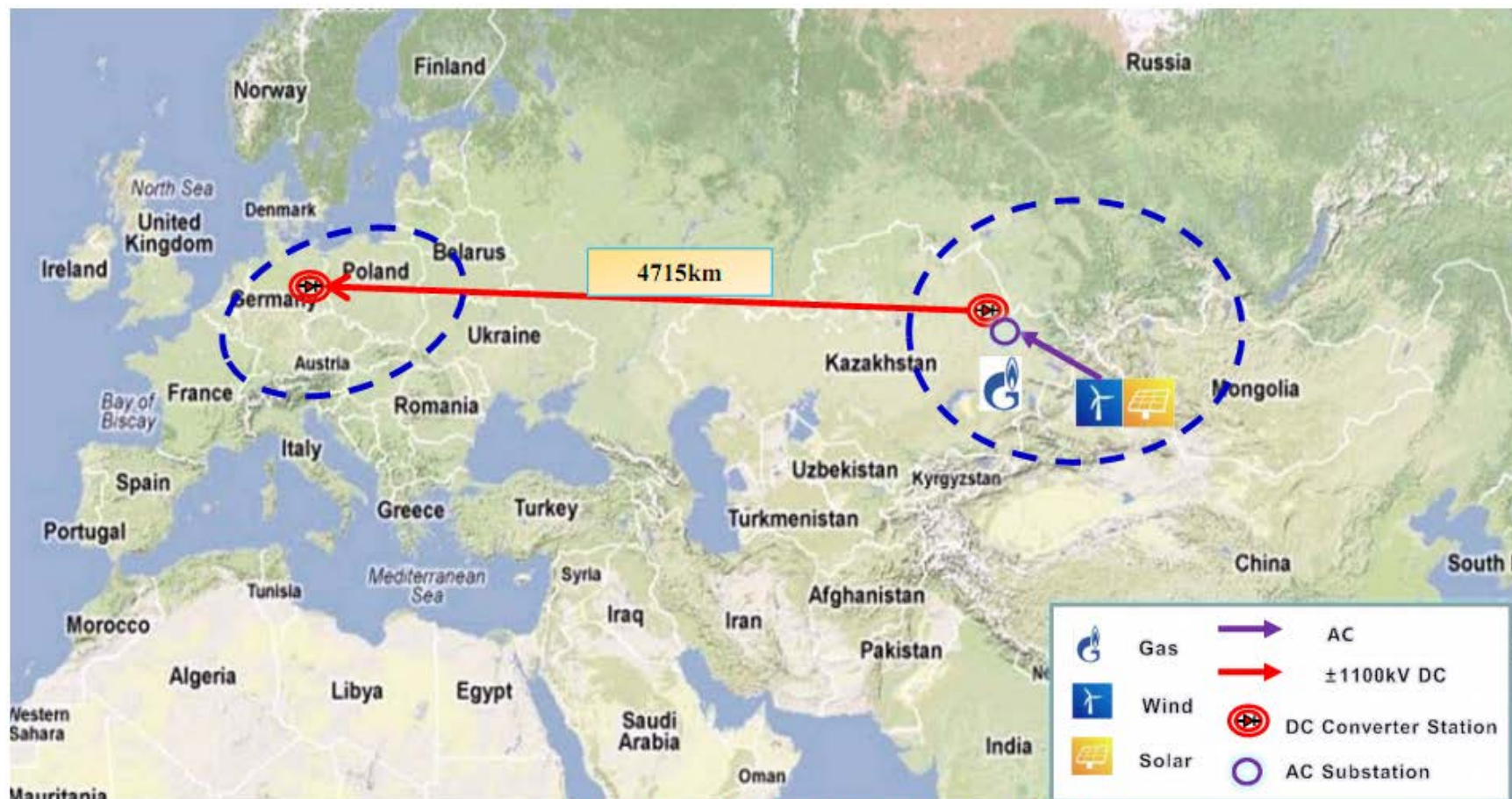
- AC 380kV
- AC 230kV
- AC 132kV
- AC 115kV
- AC 110kV
- DC 400kV



KSA is meshing its grid via inter-regional connections

Physical interconnections: a must!

Intercontinental transmission



Ekibastuz (Kazakhstan) ~ Berlin

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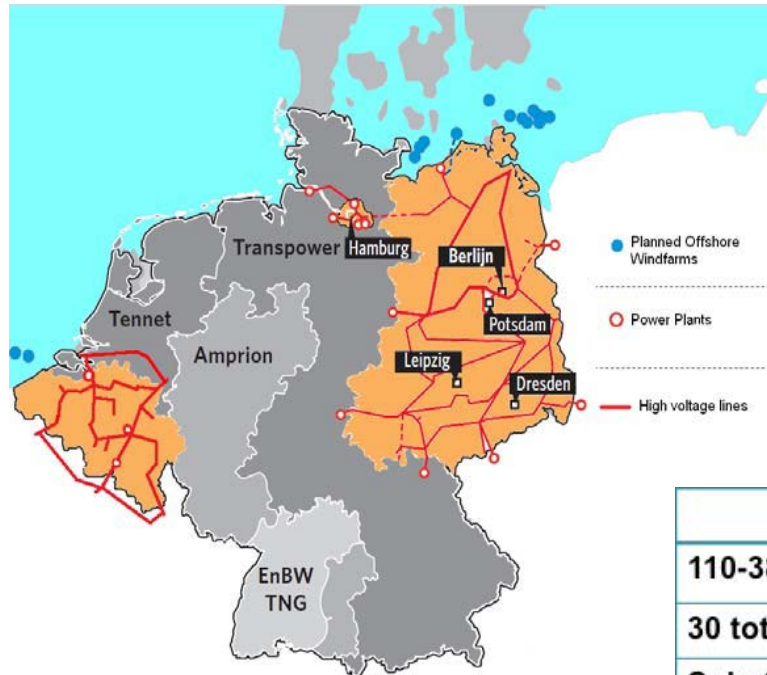
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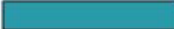








Elia-TSO (today)

- 2000 MW PV power
- 1100 MW wind power
- (2020: times 2 to 3)

50Hertz (today)

- Conventional power: ~16,200 MW
- Renewable power: ~15,000 MW
- 40% of German wind generation for 20% of German consumption

			Elia Group
110-380 kV lines and cables			13,421 km
30 tot 70 kV lines and cables			4,800 km
Substations			872
Served territory (km2)			~ 143,000
Direct consumers			~ 130
Inhabitants			~ 30 mio
Staff (FTE)			~ 1,950
Regulated Asset Base			€ 5,1 bil