Integrating wind power EU-wide: TradeWind

Frans Van Hulle
Technical advisor to
European Wind Energy Association

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Backdrop

- Large amounts of new spatially uncorrelated variable output generation bring new challenges at a European scale:
  - Transmission network infrastructure is relatively weakly interconnected
  - Power market design is not optimally suited for integration; inefficiency of cross border allocations and lack of flexibility in time
  - Desirable improvements go hand in hand with creation of single European electricity market
- The network and market aspects of large-scale wind power integration had not been studied before at a European level.
- TradeWind (and the parallel EWIS study) pioneering in this respect.

The TradeWind project

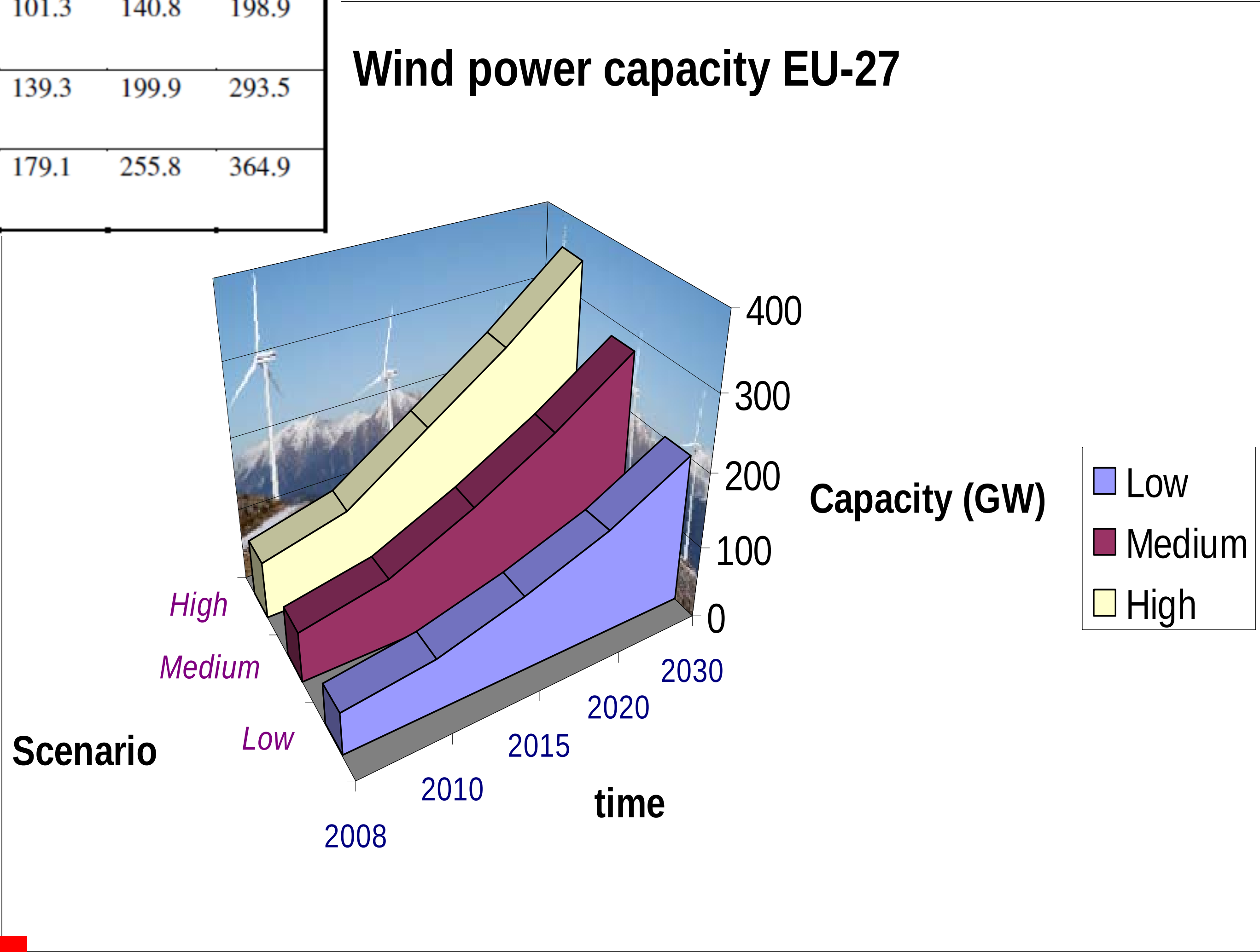
- Set up in 2006 before the Renewables Directive and the 3rd Liberalisation Package – delivering results relevant for the implementation of these
- Starting from big vision: 300 GW in 2030, wind energy penetration 25% of gross European electricity
- EU-27+ wide (UCTE+Nordel+GB+Ireland)
- 2 main parts: transmission (interconnection) and market design
- Exchange of scenarios and network information with the European TSO study EWIS via common working group

Main steps in the modeling approach

- Wind power scenarios:
  - medium the most probable scenario
  - Low and High: to capture the ‘extremes’
- Wind model: captures the wind speed correlation on continental scale, **but** limited resolution
- Demand and other generation scenarios from official EU and Eurelectric publications
- Network representations: focus on interconnectors, no internal constraints within most countries
- Electrical model: DC power flow
- Market model: Single grid – perfect market
- Economic approach to congestions

TradeWind wind power capacity scenarios

scenario	2005	2008	2010	2015	2020	2030
low	42.0	56.2	69.0	101.3	140.8	198.9
medium	42.0	64.9	85.4	139.3	199.9	293.5
high	42.0	76.0	105.0	179.1	255.8	364.9



Compare: 94 GW end 2011

Equivalent network models focused at cross border lines

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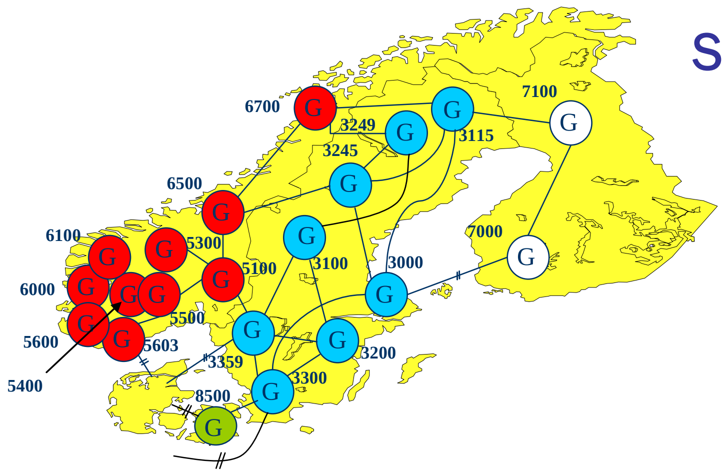
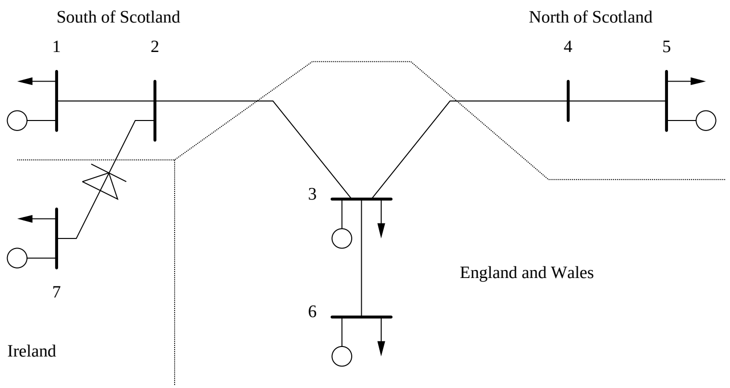
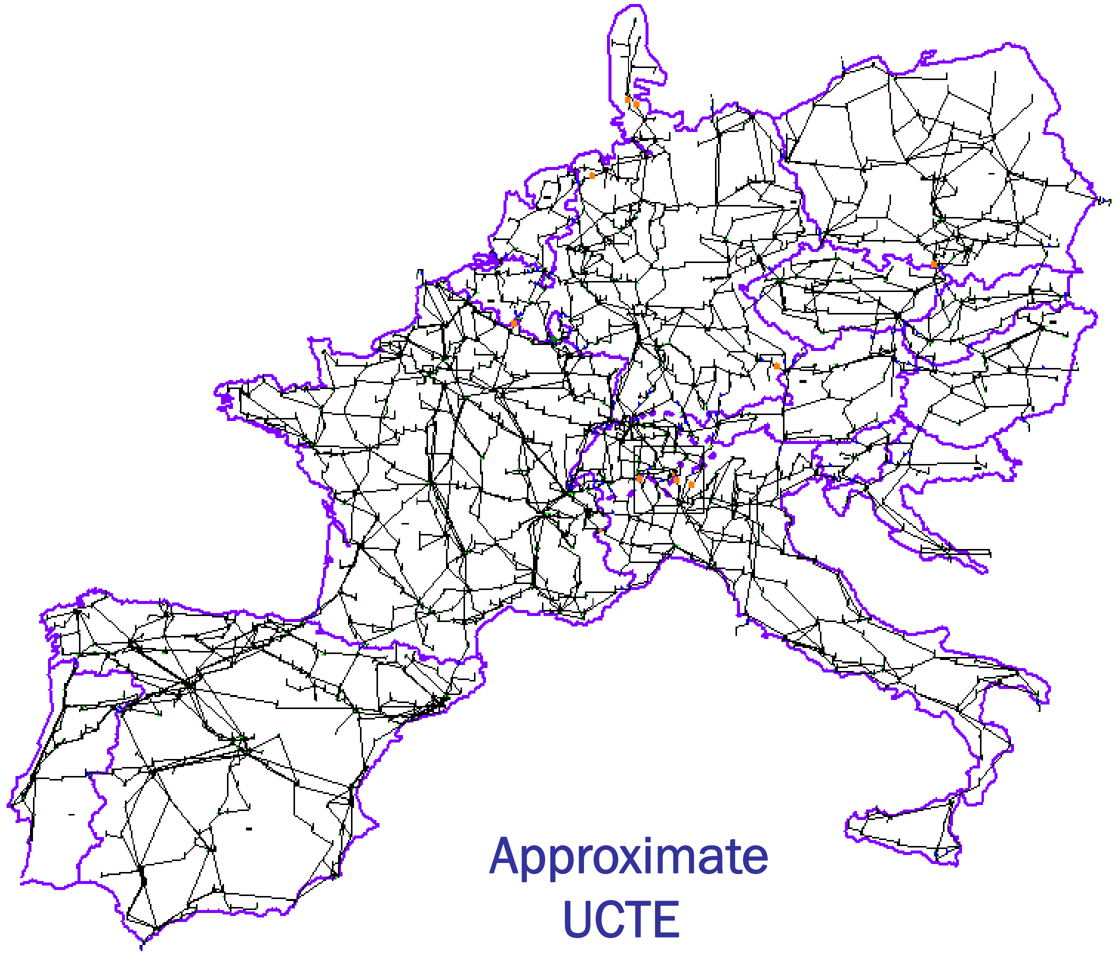


Simplified Nordel



Simplified Great Britain

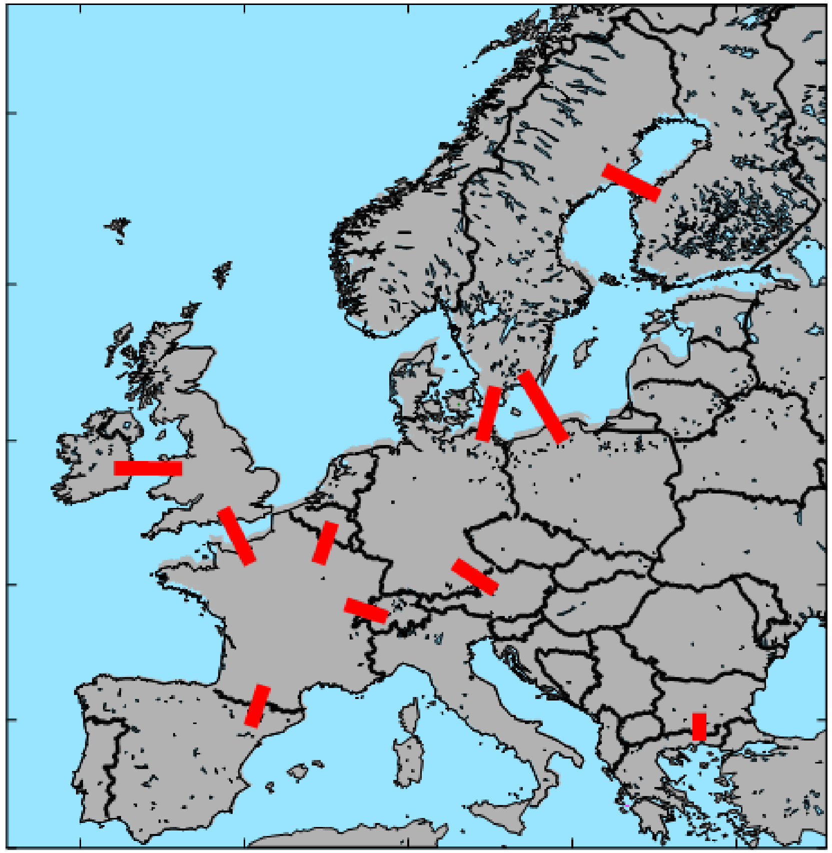
+ island of Ireland



Approximate UCTE

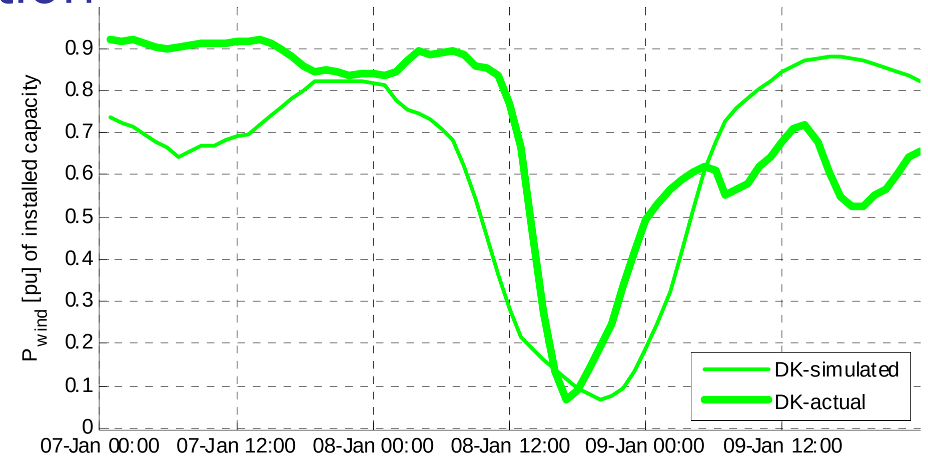
Impact on cross border bottlenecks

- Many bottlenecks no matter the wind scenario – strong influence of demand development
- Impacts of wind on bottlenecks both positive and negative
- For most interconnectors: impact low for the scenario years 2015, 2020
- Significant impacts for the 2020 and 2030 scenarios (see map)
- Prediction errors results affect actual cross-border flow during a substantial part of the time → can aggravate the congestions.



Results – storm events

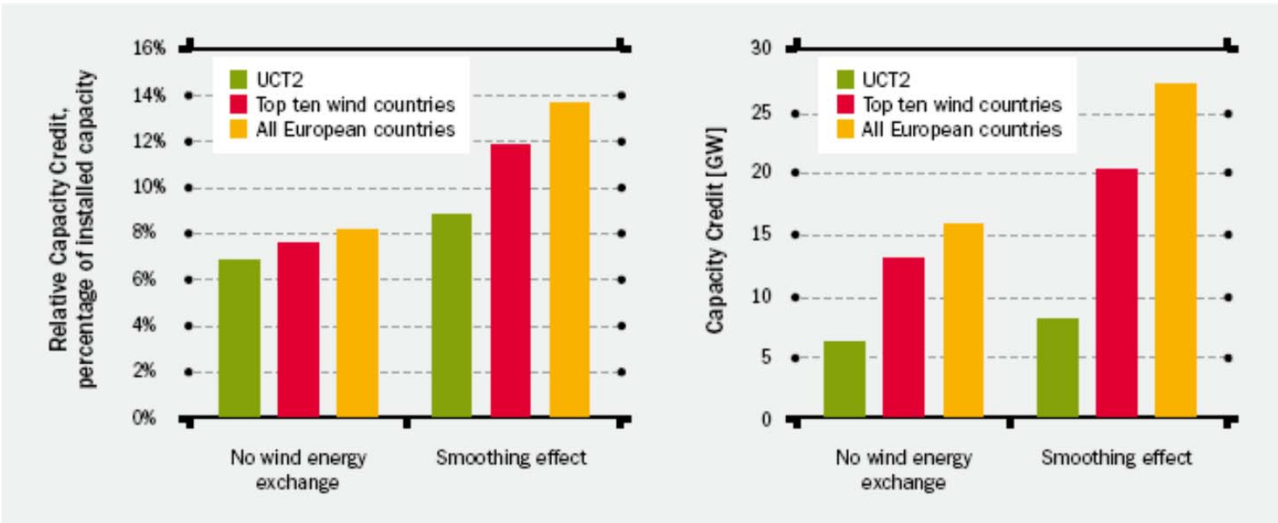
- Cross-border transmission is not significantly affected by storm events up to year 2015.
  - Low pressures move in the same time scale as diurnal load variation, even if a dramatic drop of production occurs in one country, not so much seen at a European scale
  - If a storm impacts at all, it is on the severity of the congestion



Results capacity value

- Aggregating wind energy production strongly increases wind power's contribution to firm power capacity in the system
- First order analysis shows that year 2020, 200 GW of wind power, relative capacity credit increases 70% compared with calculating the capacity credit to a single country.
- Harmonised method for calculating capacity credit of wind power for system adequacy forecasts should be established

FIGURE [28]: **Increase in the capacity credit in Europe due to wind energy exchange between the countries in the 2020 M Scenario (200 MW, 12% penetration)**



Planned and new connections analysed

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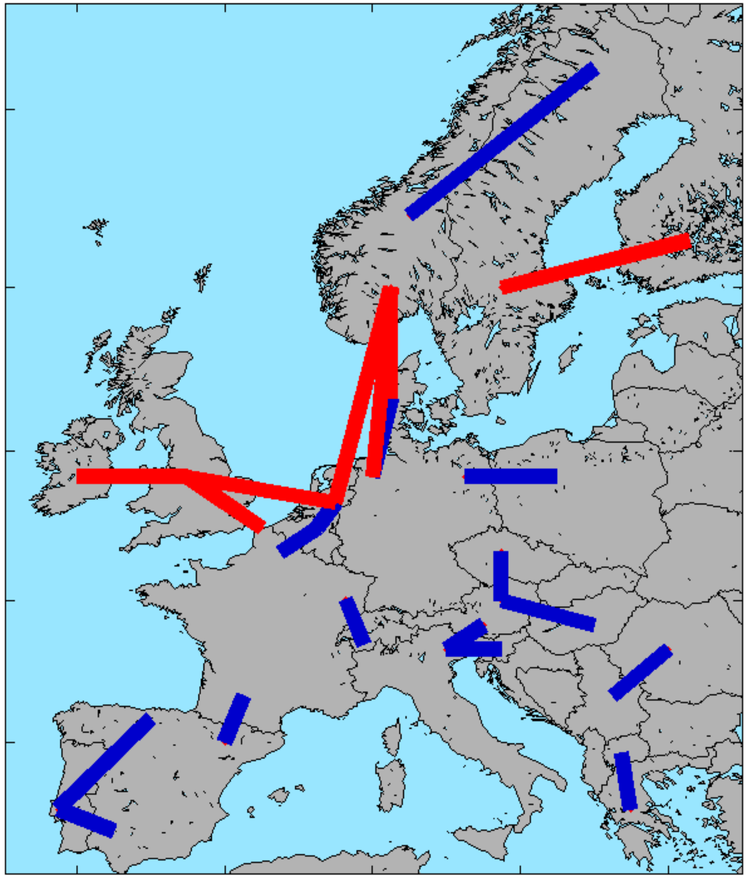
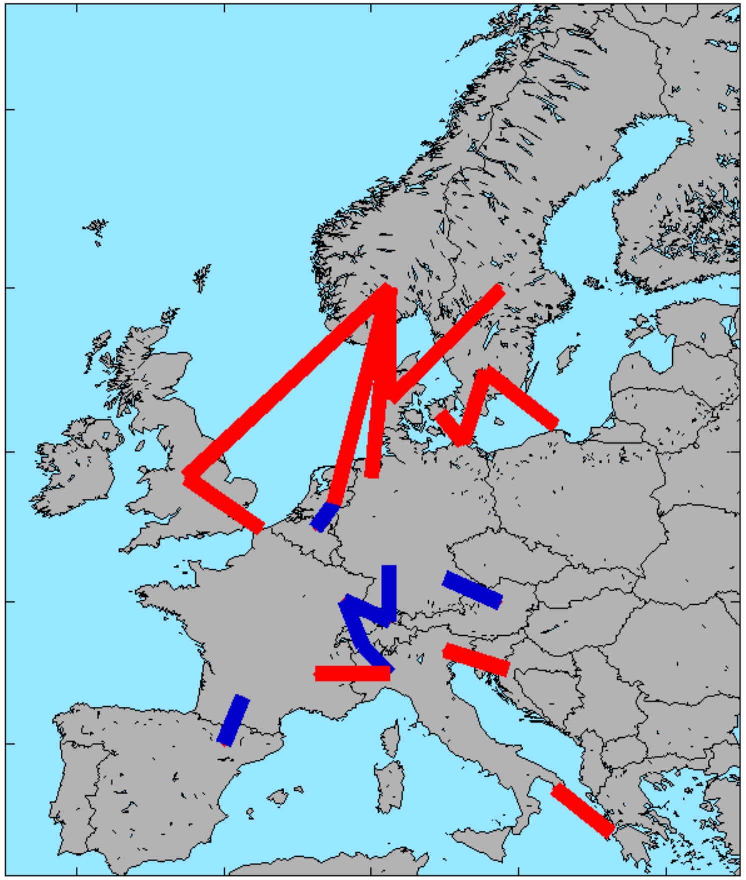
Stage 1 grid upgrades:

- planned scenarios known from TSOs, TEN-E priorities + upgrades to avoid curtailment



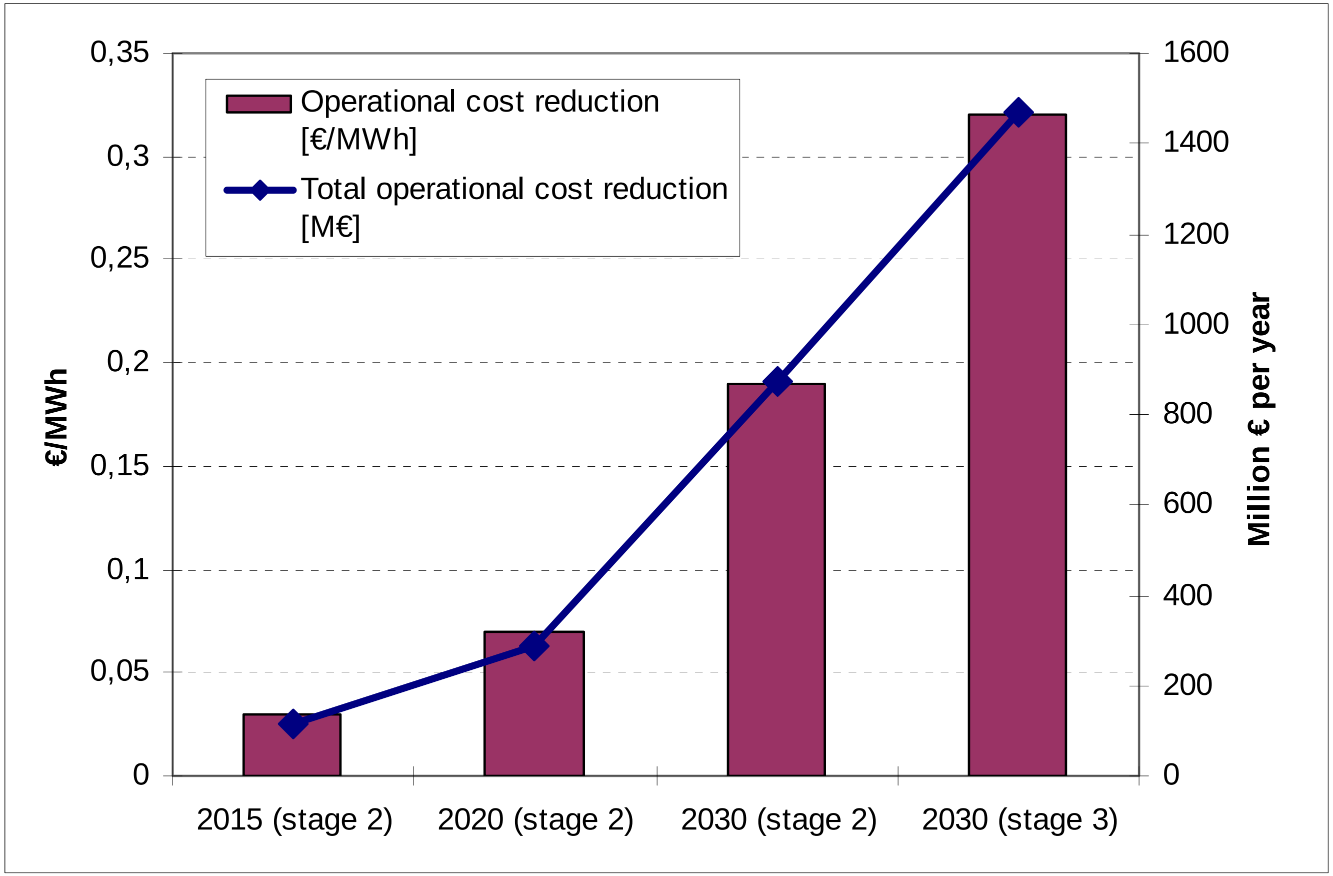
Stage 2+3 grid upgrades:

- Upgrading the 10 branches with the highest sensitivities >> ONE STEP further than existing studies



Operational cost reduction caused by proposed grid upgrades

- **The upgrades result in significant reduction in operational cost of power generation**
- **For the 2030 scenario the cost reduction allows for an average investment of minimum 475 Million € for each of the 42 identified cross border projects**



Effect of market rules: rescheduling & cross-border exchange

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TIME DIMENSION

Reduced wind power forecast error from moving to intraday rescheduling of operational reserves:

- system costs savings: 200 M€/yr (0.2%)

TIME AND SPACE DIMENSION

Intra-day rescheduling of cross-border exchange

- system costs savings: 1-2 bn €/yr (1%)

Cross-border exchange of reserves:

- minor effect: 40 M€/yr (0.04%)
- differences in reserve capacity requirements per country

Key findings

- Increasing wind increases causes significant effects of wind power on cross-border flows; mostly visible after 2015
- Reinforcing the 42 identified transmission corridors will significantly reduce operational costs of power generation
- Wind power brings firm capacity, these benefits can be enhanced by better interconnection
- A dedicated meshed offshore grid has significant economic value for Europe because it enables offshore wind and enhances trade
- TradeWind was one of the first studies at European level, first order approach was successful, and identifies areas to be pursued in follow up:
  - more detailed network representations to study reinforcements within the countries, also to interface with the offshore grid
  - other aspects should be entered in the equation, such as the role of other renewables, demand side management, and the interactions between transmission and more active and smart distribution grids.

Some observations 3 years after the study

- TradeWind methods and models used and refined in several EU studies afterwards
- Common finding EWIS/TradeWind: economical benefits of wind integration – need for network capacity and proper market mechanisms are cornerstones of EU policy in developing the IEM
- Major progress since 2006
  - vision development and strategy on wind integration by TSOs thanks to ENTSO-E
  - Common mind set wind industry and TSOs
  - Joint formulation of RD objectives and tasks in the frame of the SET Plan (EWI – EEGI)

Final report

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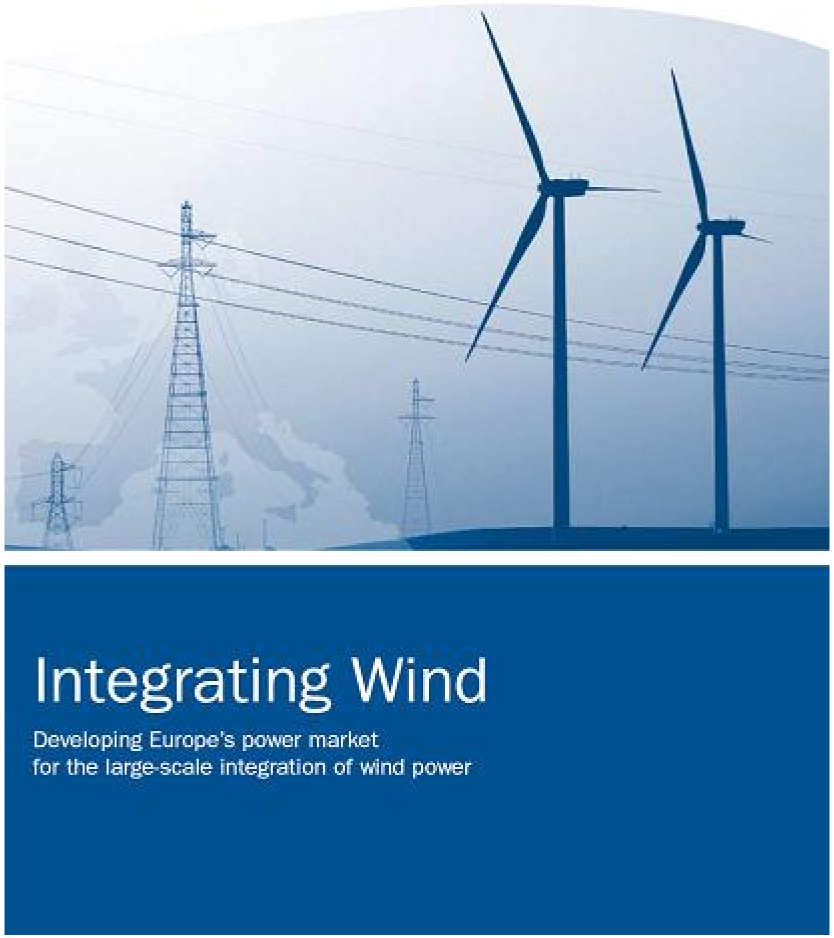

Soft copy and detailed deliverables:

www.trade-wind.eu

Still a useful read

Questions?

frans.vanhulle@ewea.org
www.ewea.org

Wind Power House
80 RUE D'ARLON
B-1040 BRUSSELS
BELGIUM