PÖYRY

Modelling the future for EU power markets

WEC Paris, 7 December 2011

Andrew Nind

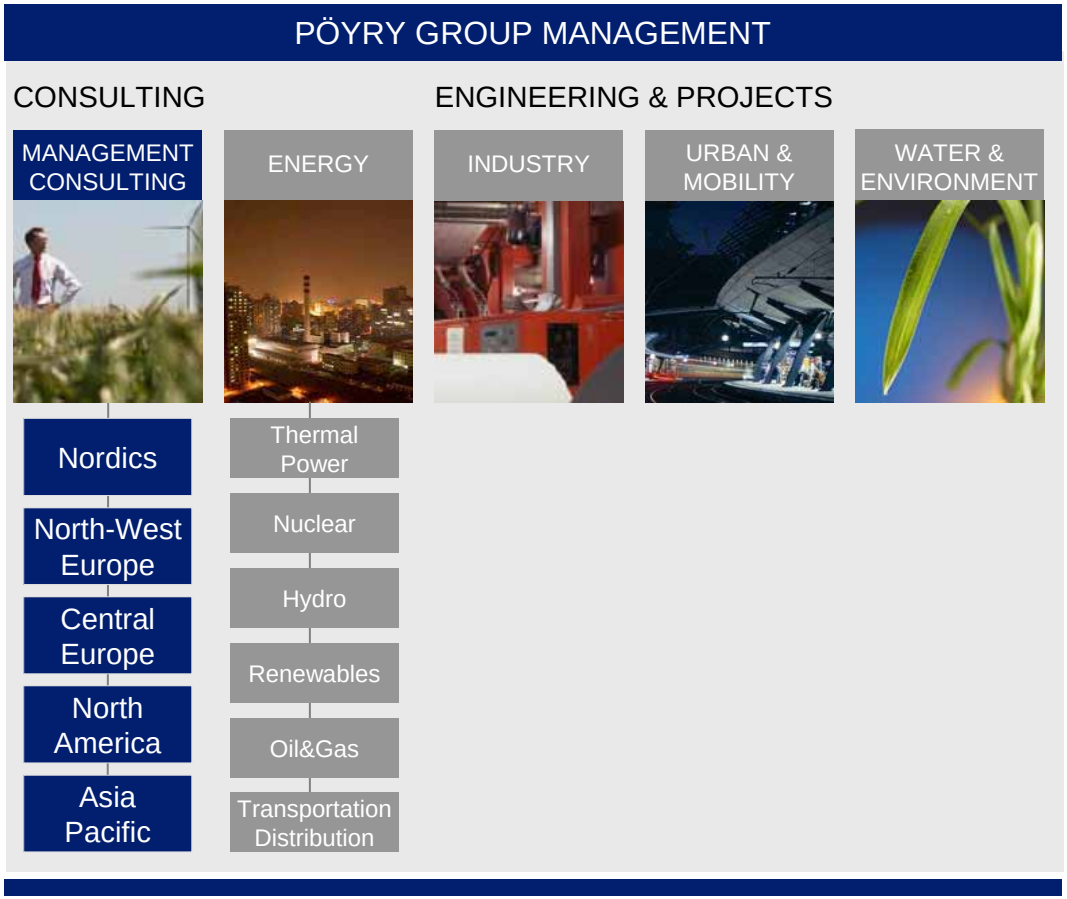
Pöyry is Europe's leading energy consultancy

○ Pöyry offices

● Pöyry Management Consulting energy offices

- Europe's leading management consultancy in the energy sector
- Offering expert advice on energy markets, regulation, business operations, financing and valuation and sustainability
- Providing in-depth analysis across Europe
- Over 200 energy market specialists in 14 offices across Europe:
  - Oxford
  - London
  - Moscow
  - Paris
  - Vienna
  - Düsseldorf
  - Madrid
  - Oslo
  - Stockholm
  - Villach
  - Helsinki
  - Milan
  - Zurich
  - Stavanger

Pöyry Management Consulting is part of Pöyry Group, a leading consulting and technology company



- Global consulting and engineering group
- Founded in 1958 in Finland
- Listed on the Helsinki Stock Exchange
- 71 offices in 49 countries worldwide
- 7.000 employees within the group
- Around 450 employees within Management Consulting with focus on the
  - Energy Industry
  - Forest Industry

Developing scenarios for an unknowable future

“He who forecasts the future lies, even if he tells the truth” (Chinese proverb)

Our modelling methodology

- Based on market fundamentals
- Not beholden to forward curves
- Market behaviour is assumed
- Energy flows between countries respond to relative energy prices
- SRMC determines despatch levels but prices cover fixed costs

The scenario approach

- Our approach is to develop detailed and internally consistent scenarios for the future behaviour of energy markets
- Each scenario tells a story about what could happen in the market
- Scenarios are not forecasts … but can act as shock therapy!
- We analyse typical market conditions in the long term
- We do not attempt to predict random events, or the weather
- Our scenarios have been used by developers and lenders throughout Europe

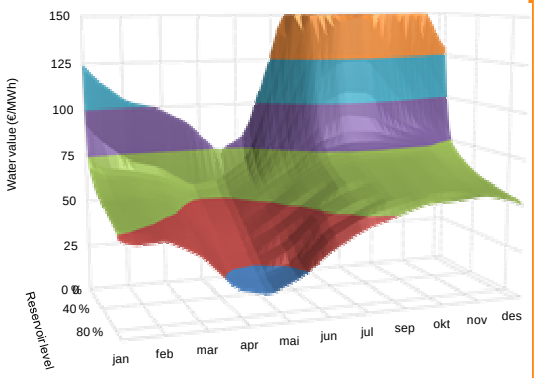
Overview of electricity models

Our power models are highly specialised, focusing on the important drivers for the system we are analysing

EurECa

- Plant-by-plant for all Europe
- 24 sample days/year
- Used for quarterly update process

BID



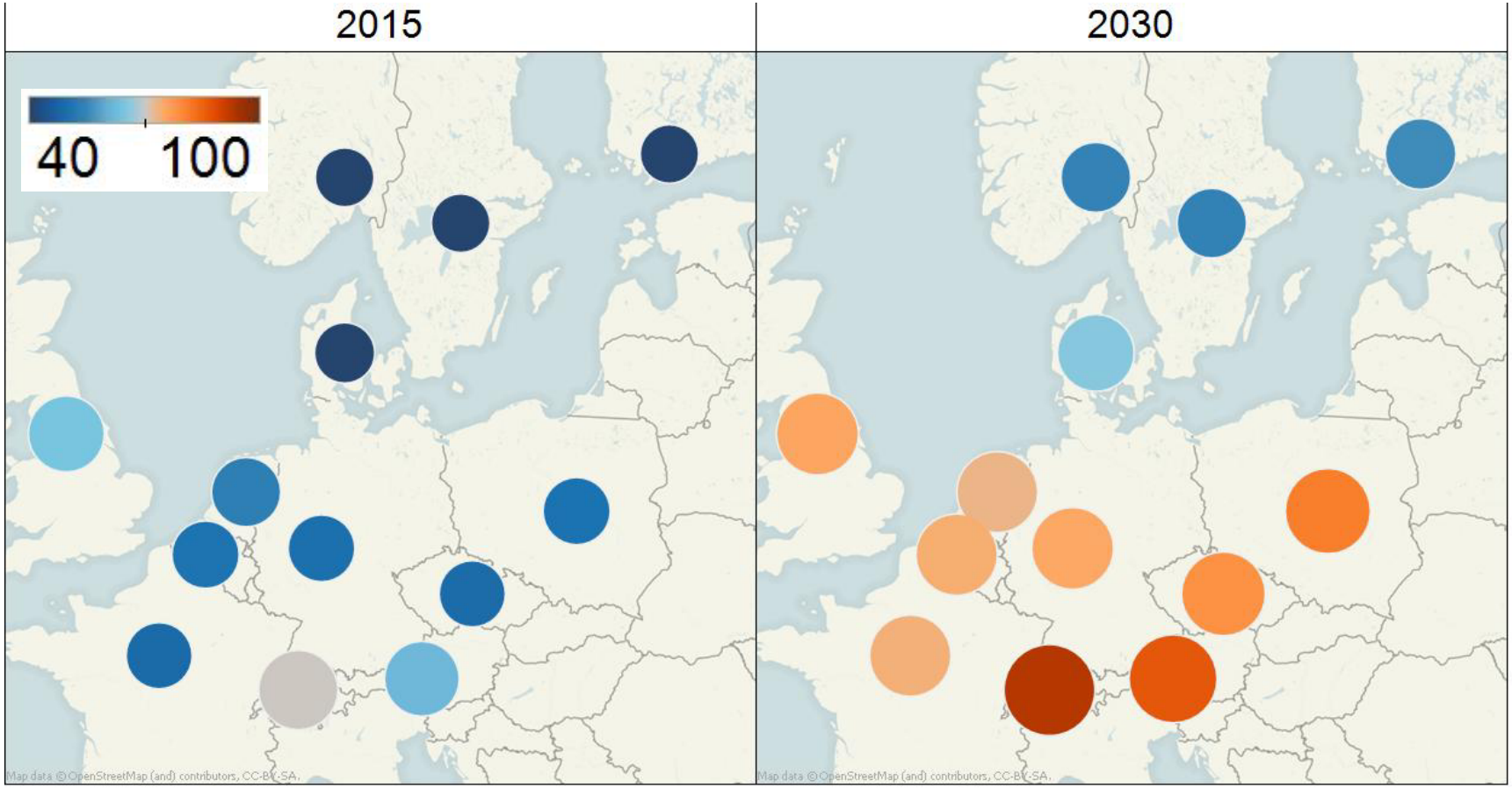
- Detailed water valuation
- 365 days/year x 50 hydro years
- Used extensively in Nordic countries

Zephyr

- Detailed wind and solar simulation
- 365 days/year x 8 weather years
- Used for NEWSIS and intermittency studies

Wholesale and retail prices are likely to rise, but diverge between countries

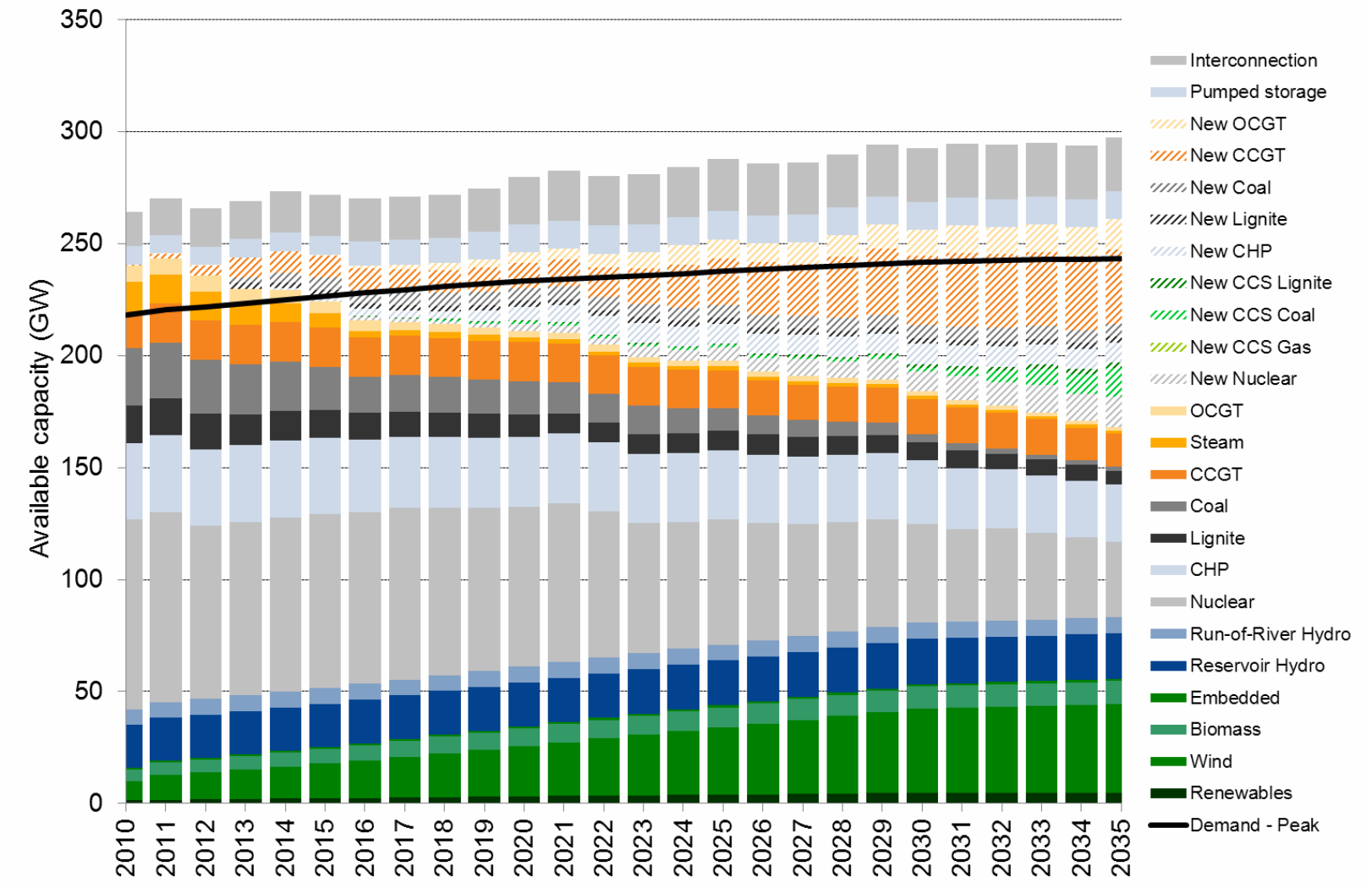
Overall market prices will rise significantly (especially if Europe is serious about CO2 reduction) but to different levels and in a different manner in each country. They are also likely to diverge between countries unless substantial interconnector reinforcement takes place



Annual average wholesale prices (€/MWh) – one scenario of the future!

Despite the rhetoric, how much renewable capacity is likely?

In North West Europe, thermal capacity is likely to be dominant for a couple of decades



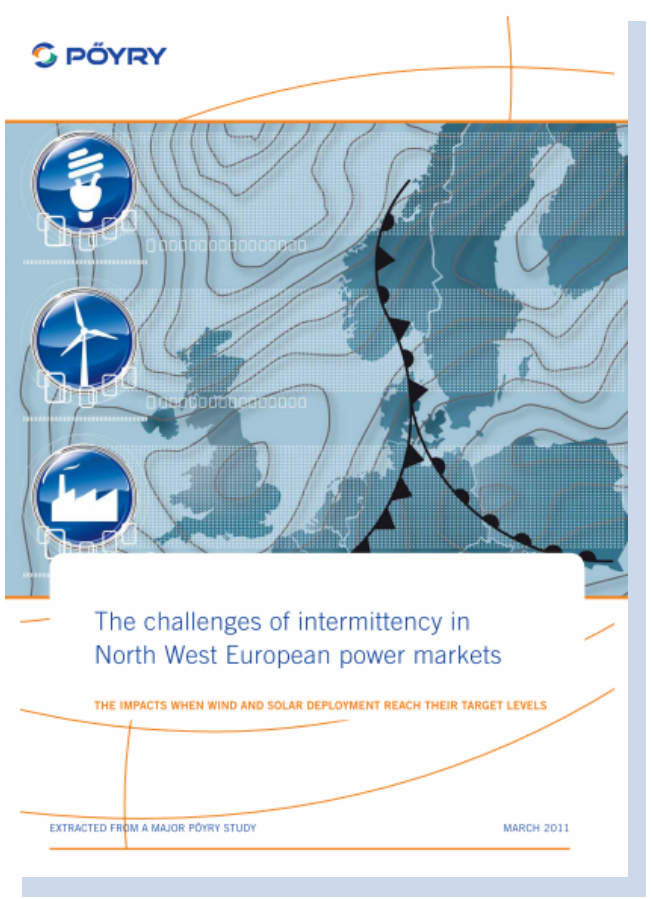
Our modal view of capacity development – just one scenario of the future!

If reality does indeed match rhetoric in the de-carbonisation of power generation, what can we expect?

- Pöyry has been actively engaged in intermittency projects, including our North Europe Wind and Solar Intermittency Study (NEWSIS) earlier this year

- Study members:
  - DONG, RWE, ENBW, Statkraft, GDFSuez, EdF, DECC, SSE, Kemijoki

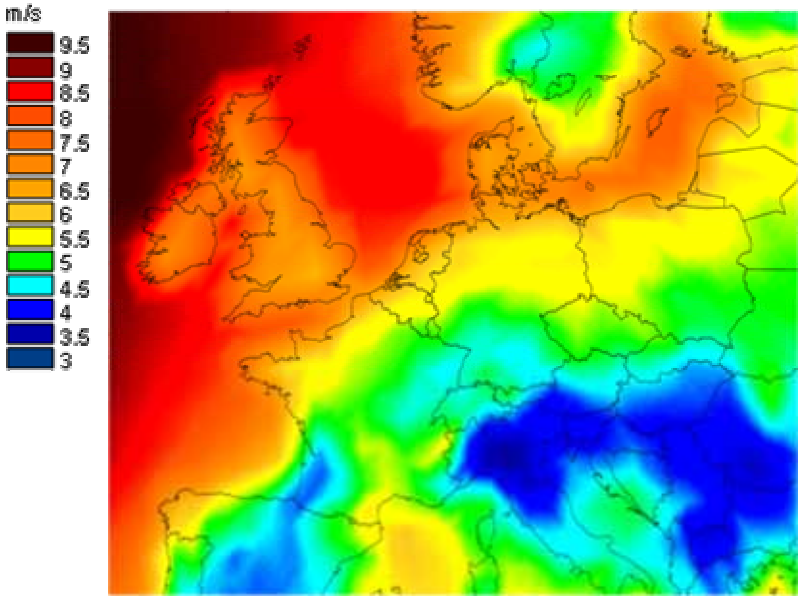
- Public summary available of the main report



Will historical wind and solar patterns apply in the future?

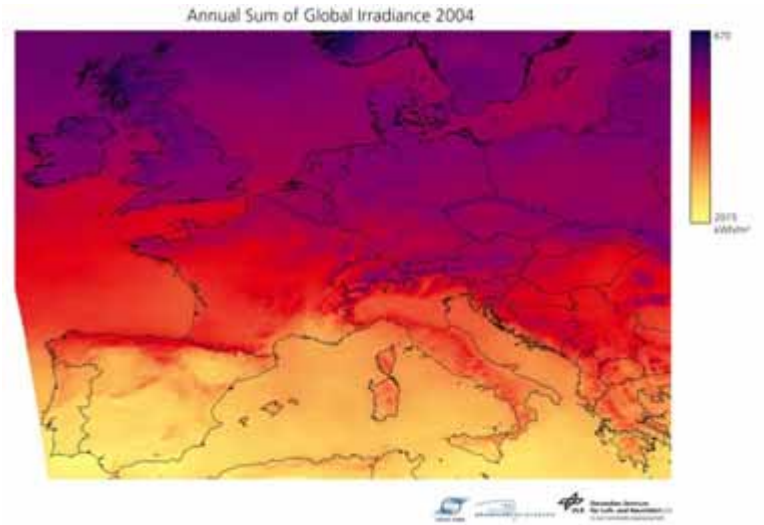
We have used detailed historical wind and solar data to create intermittent profiles

Anemos wind atlas



- 3 hourly data 1970-2009
  - Used 2003-2009
- 90km intervals across Europe
- Data converted to hourly intervals
- 20 million data points

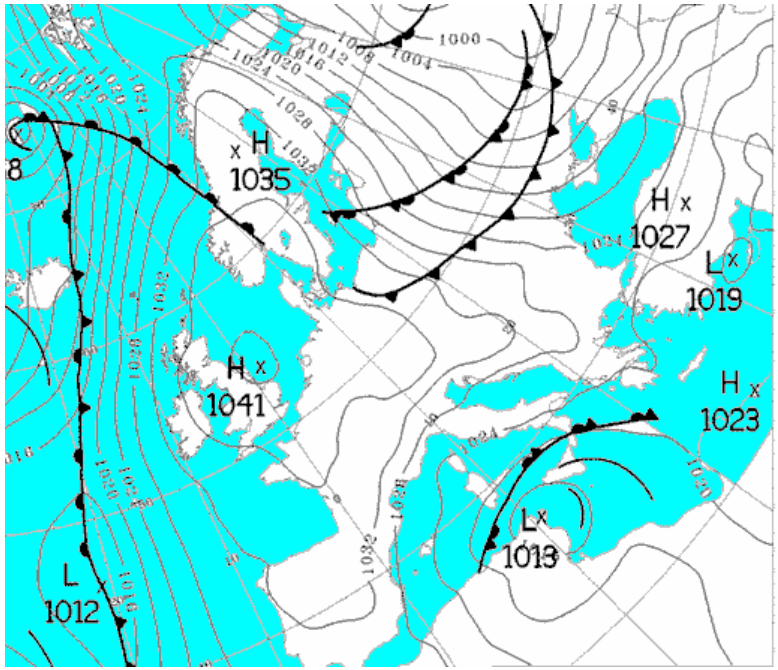
Transvalor solar data



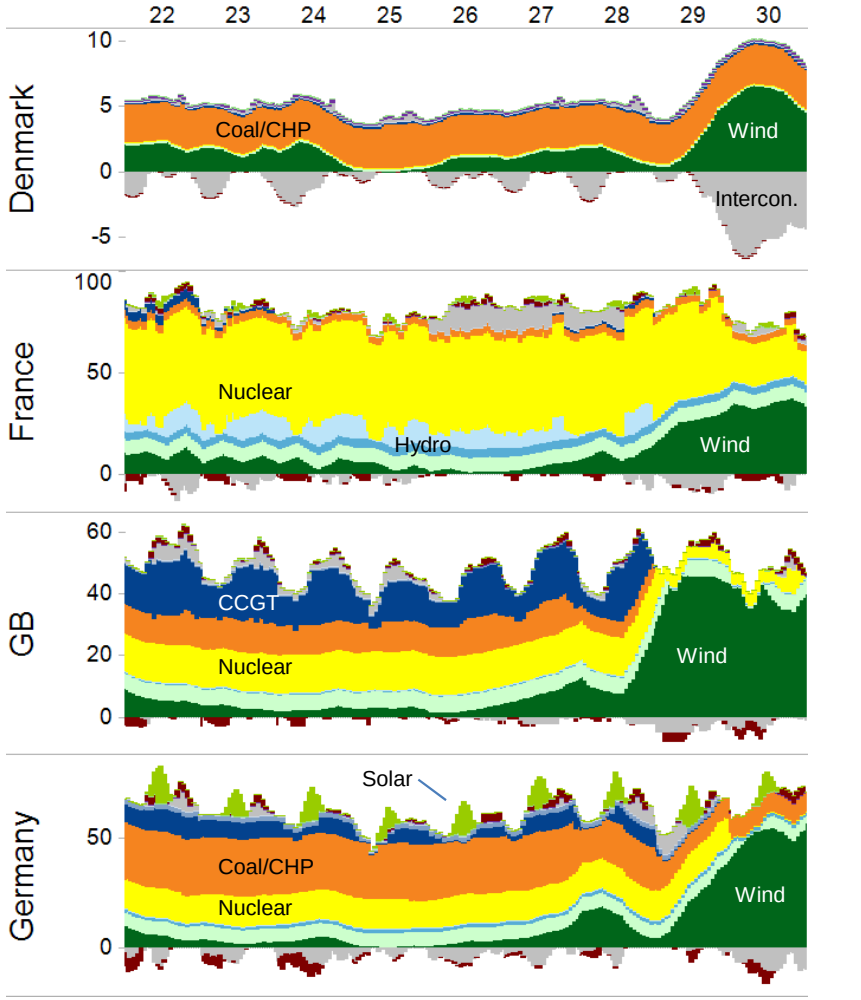
- Hourly data 2003-2009
- 2 km intervals across Europe (sampled at 45km)
- 60 million data points

If so, wind output will be well correlated across Europe

Weather patterns for 25 December 2006



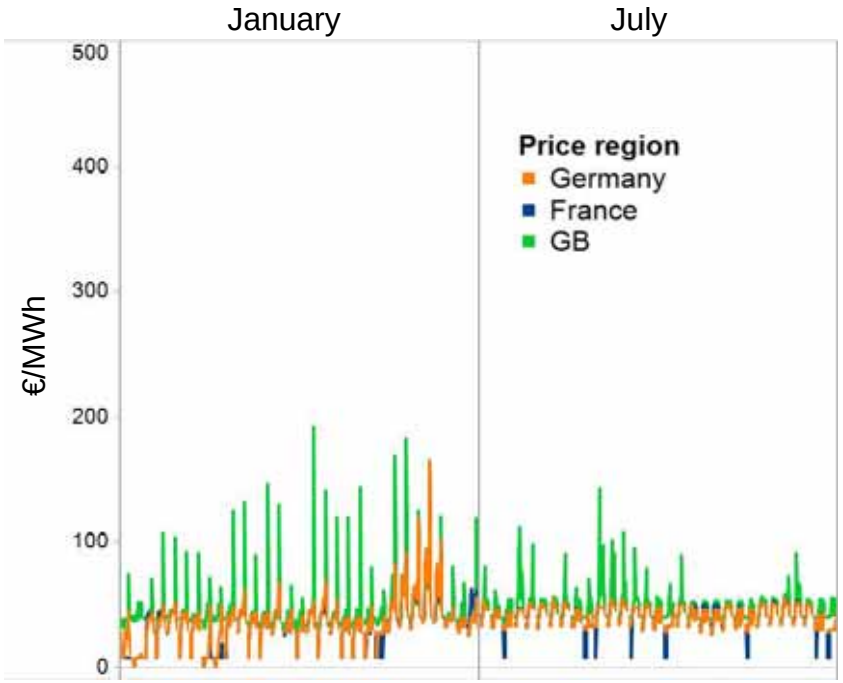
Generation 22-30 Dec 2030



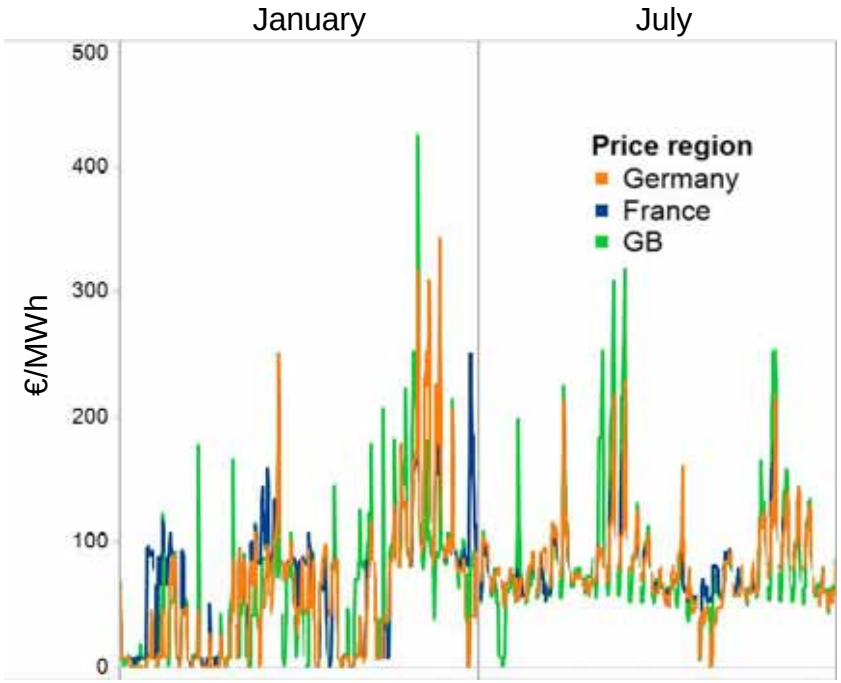
A low carbon future is a volatile price future

In our ‘Targets Met’ scenario, prices become more volatile and unpredictable, with increased numbers of low-priced periods.

2010

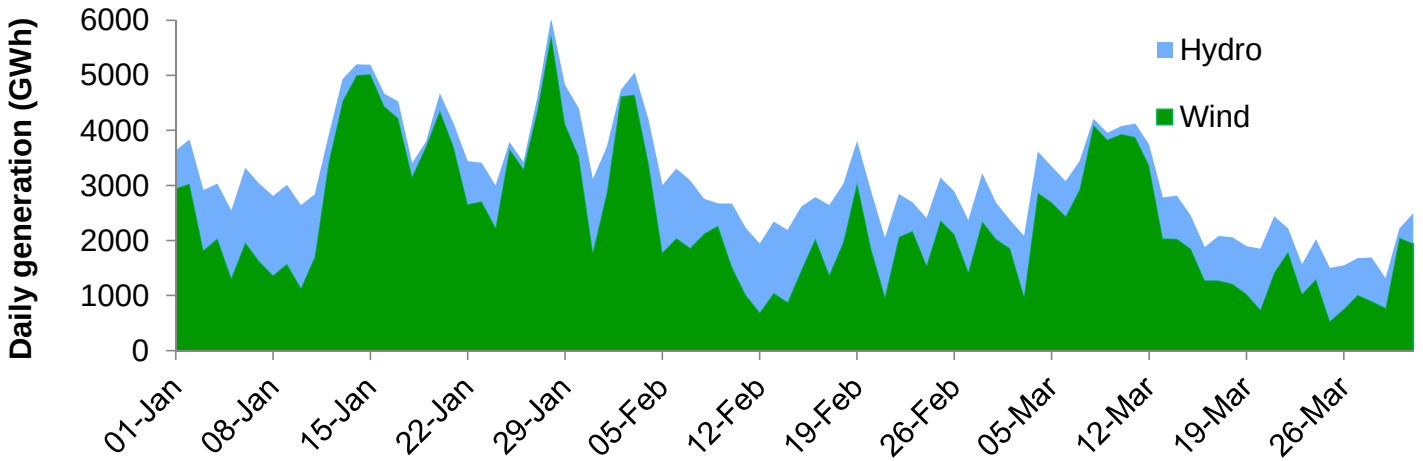


2030



Hydro helps to balance intermittency provided there is significant interconnection

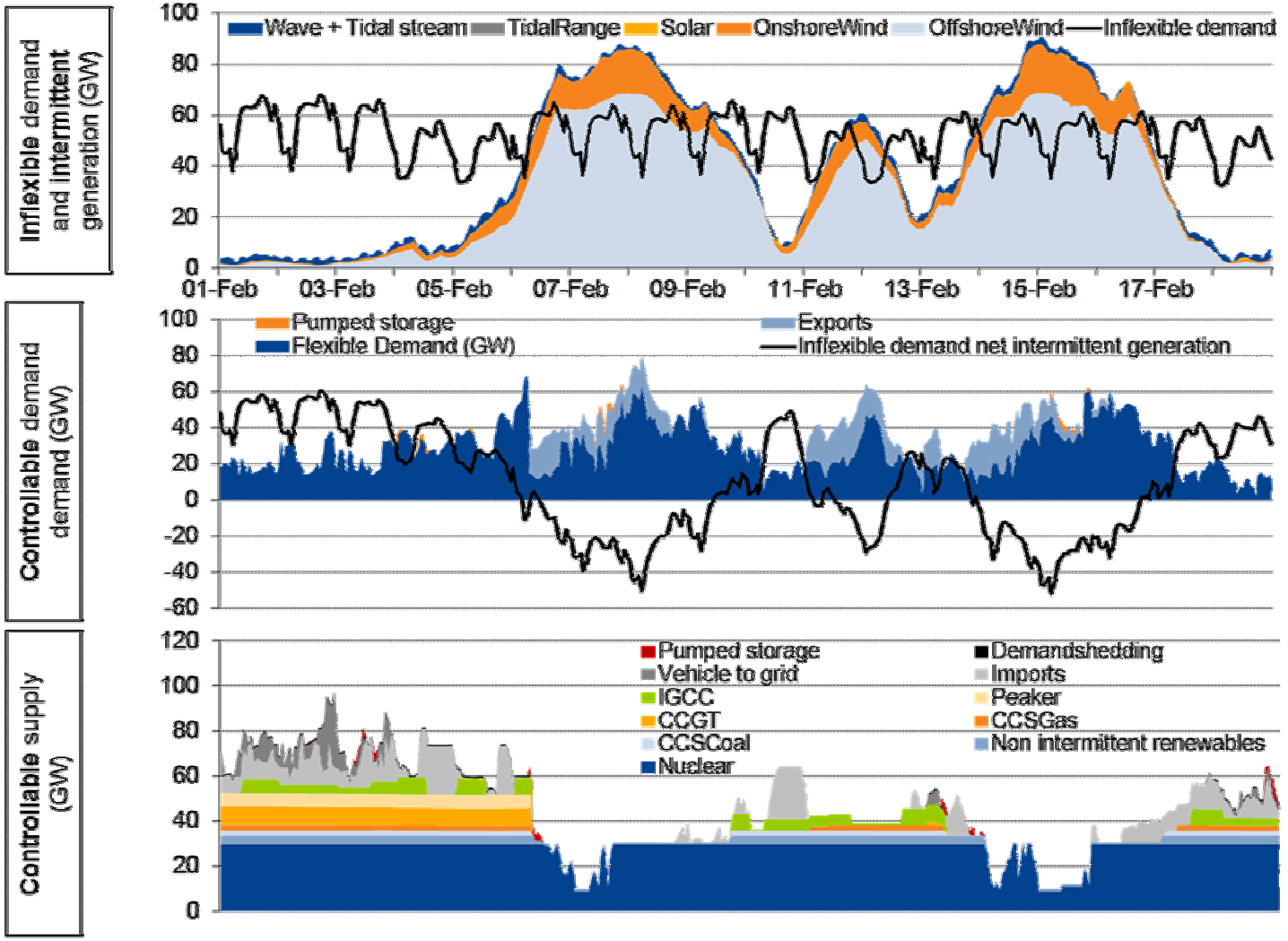
Hydro and wind generation across Europe



- Interconnectors to Nord Pool become increasingly valuable in high wind scenarios as there is a rise in demand for hydro to balance wind generation:
  - high interconnector growth between Nord Pool and other countries results in higher and more volatile Nord Pool prices but greater value for hydro capacity
  - low interconnector growth between Nord Pool and other countries results in lower and more stable Nord Pool prices but lower value for hydro capacity

Without hydro, intermittency needs flexible thermal generation

February 2050 in Great Britain with 80% annual output from renewables



*Net exports are shown on middle chart when positive and are shown on bottom chart when negative

PÖYRY

Can a system cope with high wind reliance?

Various key issues need to be understood better

- How flexible are thermal power stations? Will German lignite, French nuclear, British CCGTs ramp up and down in response to wind fluctuations?
- How are frequency response and fast reserve requirements (seconds or minutes) related to market penetration of wind and solar? What proportion of these requirements can be met by the demand side?
- Can peaking plant be designed to switch on faster? In under 10 minutes?
- How much transmission and distribution network reinforcement is required?
- Can short-term forecasts of demand and intermittent generation be improved?
- How much hydrogen storage is realistic?
- What are realistic demand assumptions for electric heating and transport?

Contact:

Name: Andrew Nind
Mail: andrew.nind@poyry.com
Phone: +44 1865 812264