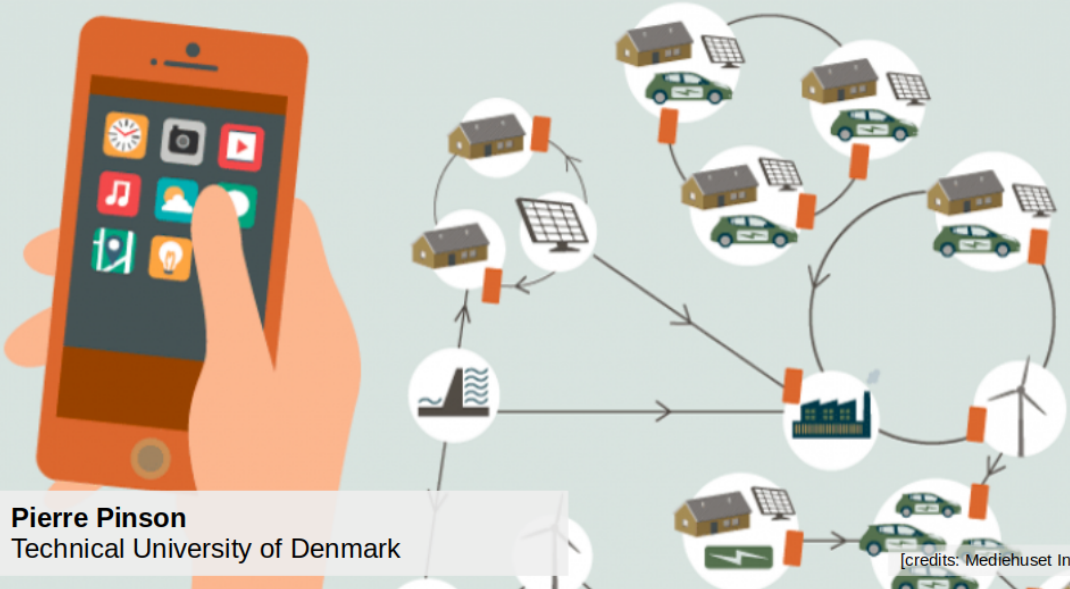
Module 5 – Impact of Renewables on Electricity Markets

5.4 The impact of renewables: from simulation to reality



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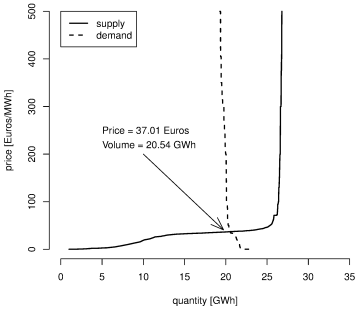
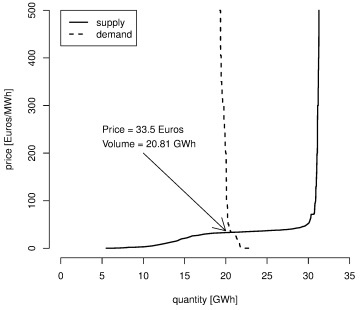
[credits: Mediehuset Ingeniøren]

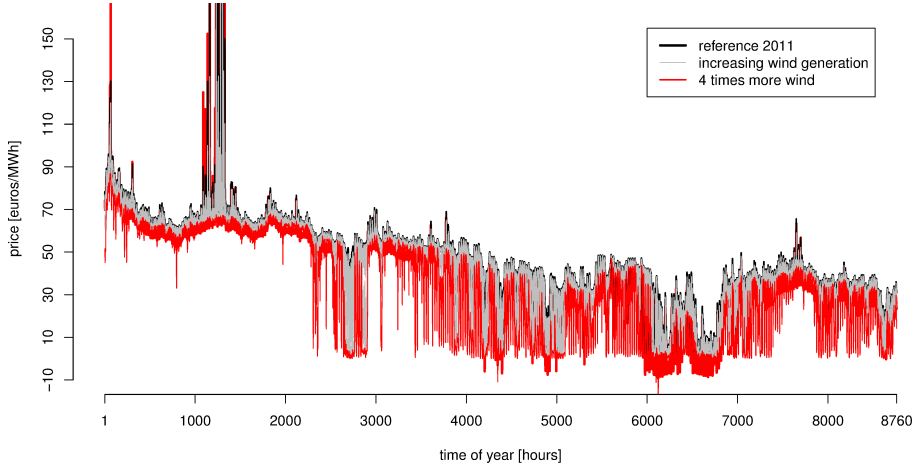
Simulating the impact of wind power on the Nord Pool

- **Reference year: 2011 (26% penetration, i.e., share of wind power to meet demand)**
- Simple model using the system supply curves for the Nord Pool day-ahead market
- Implying no transmission constraints (irrealistic, but well...)
- Supply curves are shifted around for different ratios of increased wind power penetration: 1.2, 1.4, ..., 4
- Resulting prices are collected for the whole year





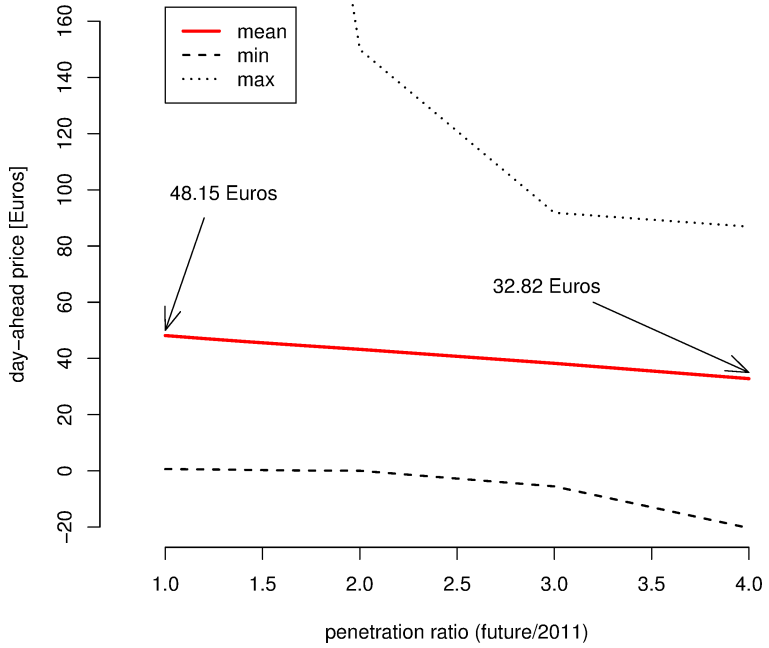
Series of prices



- Maybe not that visible because of the range... but, there are substantial differences from one curve to the next!

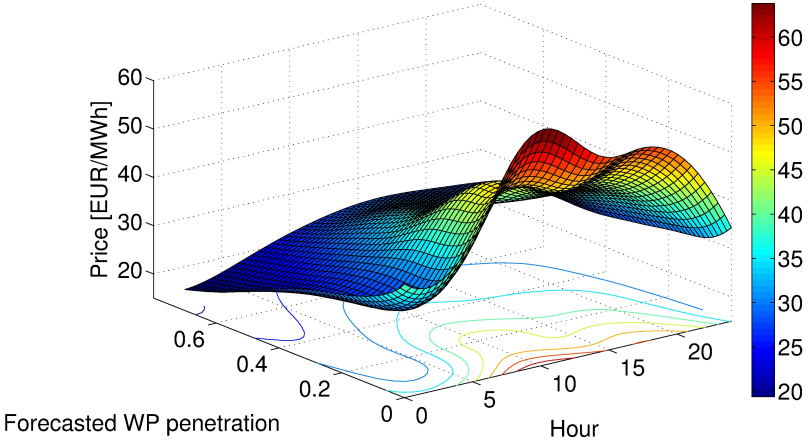
General statistics

- *Mean price:* steadily decreases
- *Most importantly:* min and max prices change significantly
- **Potential impact on investment in new capacities**



From simulation to reality!

The observed mean impact on day-ahead prices

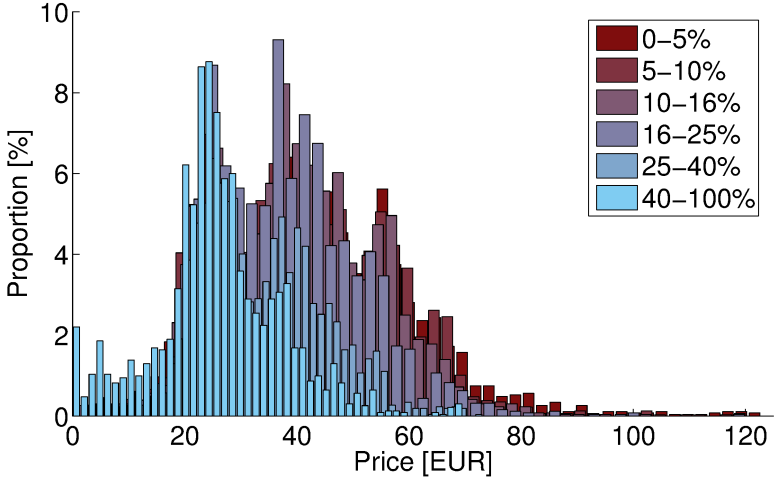


- The mean day-ahead price as a function of wind power penetration forecasts and hour of the day (Nord Pool, Western Denmark, 2007)

[source: Jónsson T, Pinson P, Madsen H (2010). On the market impact of wind energy forecasts. *Energy Economics* **32**: 313–320 (link)]

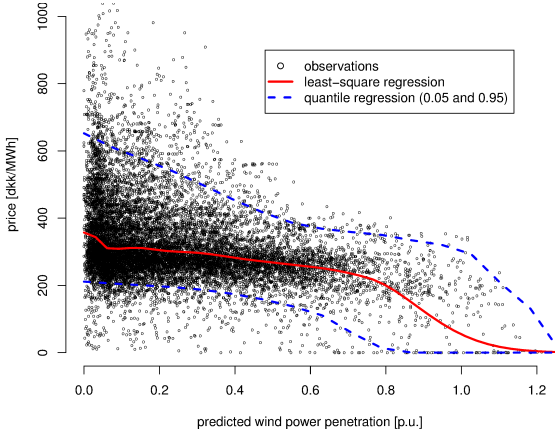
Overall qualitative impact on day-ahead prices

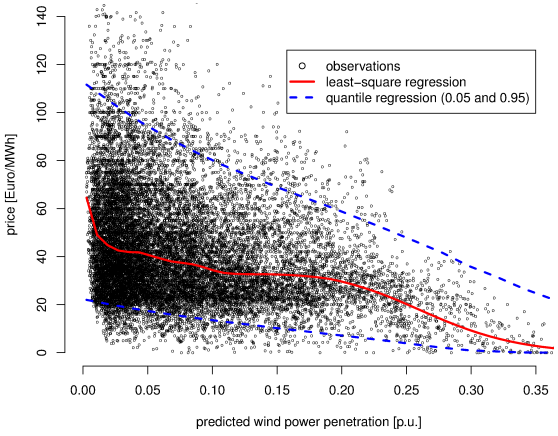
- With increasing (forecast) wind power penetration:
  - the average price decreases
  - distributions concentrate on lower values
  - extreme (high) prices disappear, but... zero prices appear!!



Impact of wind penetration on day-ahead prices prices

- The impact of *wind power penetration forecasts* on *day-ahead market prices* for Denmark (Nord Pool DK-1) and Germany (EEX)

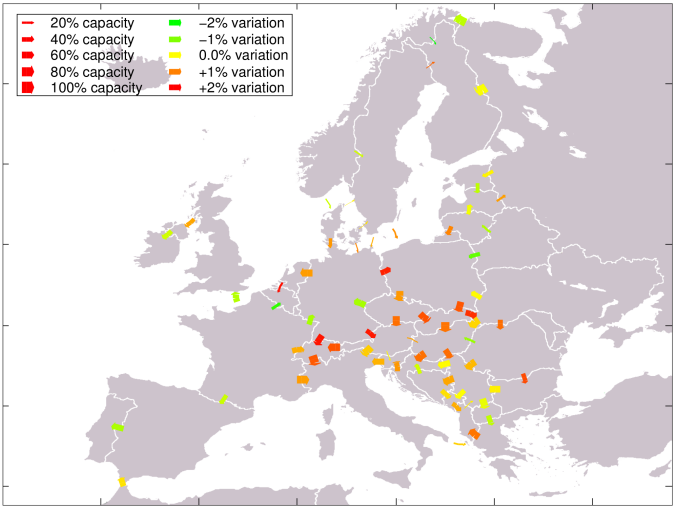




- Similar analysis were performed to qualitatively and quantitavely assess the impact on *regulation market prices*, *sign* and *volumes*

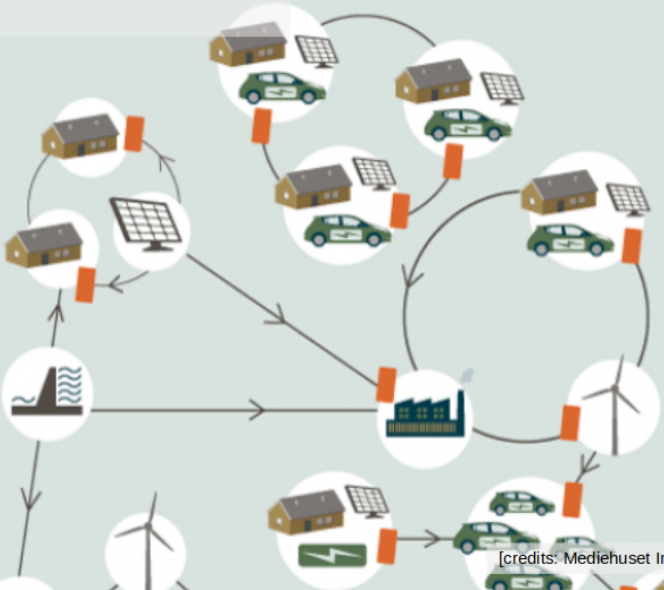
The impact of wind on EU cross-border power flows

Map of the **nonlinear impact** and **sensitivity of EU power flows** to *predicted wind power penetration in Germany...* here if within 10-15% of installed capacity



[source: Zugno M, Pinson P, Madsen H (2013). The impact of wind power on European cross-border power flows. *IEEE Transactions on Power Systems* **28**(4): 3566–3575]

Use the self-assessment quizz to check your understanding!



[credits: Mediehuset Ingeniøren]