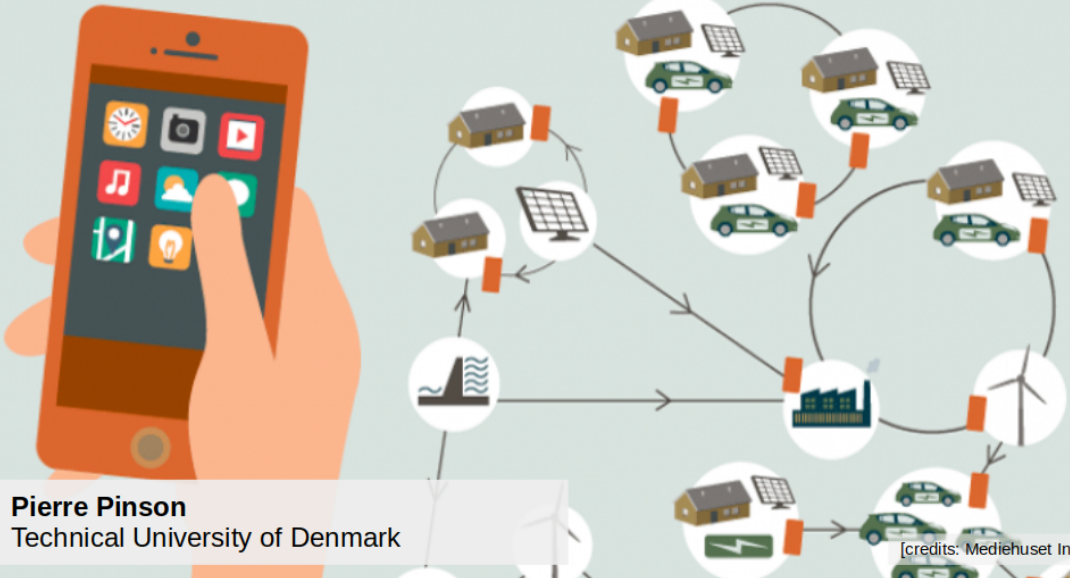
Module 7 – Introduction to Renewable Energy Analytics

7.2 Uncertainty origins and characterization



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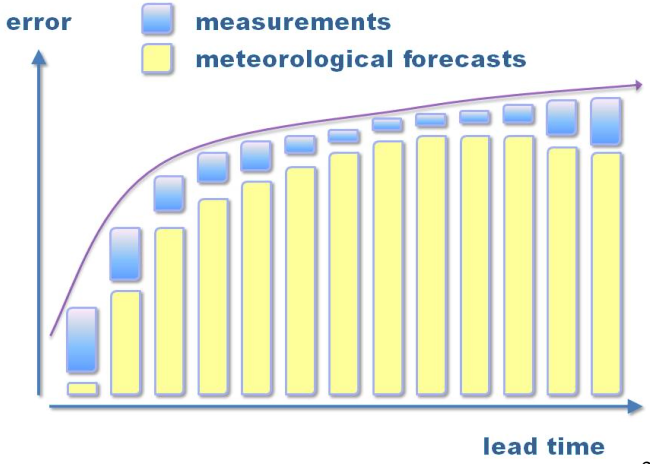
[credits: Mediehuset Ingeniøren]

Contribution to forecast uncertainty/error

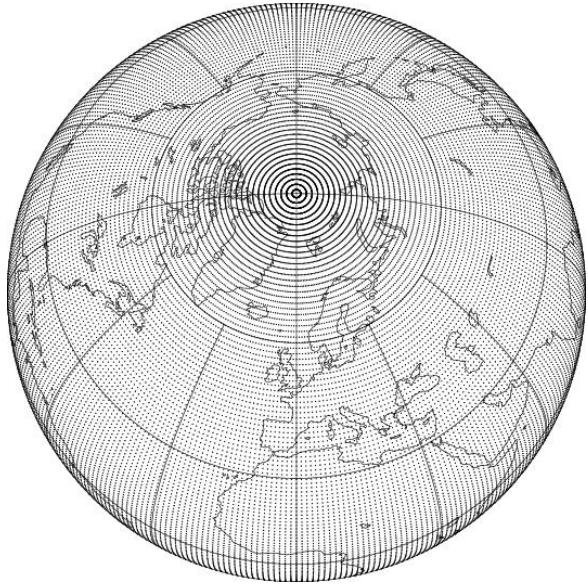
- To generate renewable energy forecasts in electricity markets, necessary inputs include:
  - recent power generation measurements
  - weather forecasts for the coming period
  - possibly extra info (off-site measurements, radar images, etc.)

- Their importance varies as a function of the lead time of interest...
  - *short-term* (0-6 hours): you definitely need measurements
  - *early medium-range* (6-96 hours): weather forecasts are a must have!



Numerical Weather Prediction

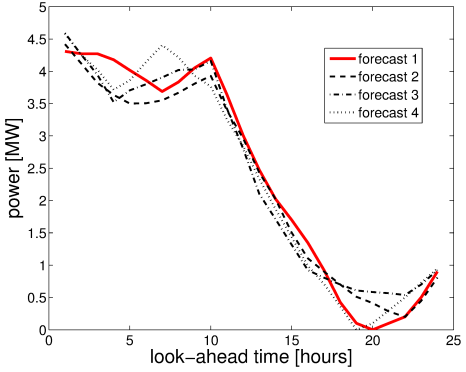
- Future values of meteorological variables (wind, temperature, etc.) on a grid
- Temporal/spatial resolution, domain, forecast update and forecast length vary depending upon the NWP system
- Large number of alernative system today (global, mesoscale, etc.) providing free or commercially available output.

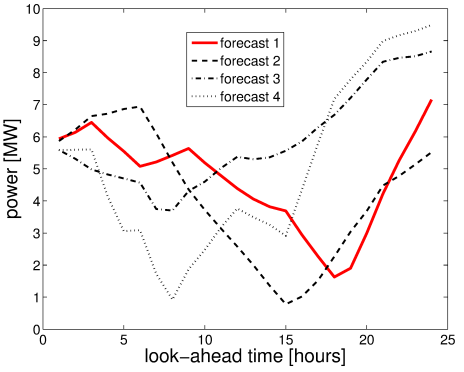


- **Origins of uncertainty in NWPs**: initial state, model/physics, numerical aspects (filtering)

Predictability of meteorological variables

- A large part of the prediction error directly comes from prediction of weather variables
- This uncertainty in the meteorological forecast is then amplified or dampened by the power curve (model)

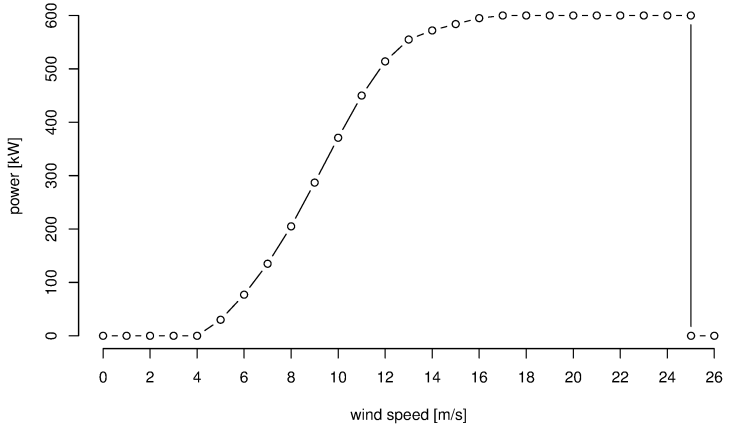




typical representation of what could be more and less easily predictable situations...

The manufacturer power curve

- Power curve of the Vestas V44 turbine (600 kW)

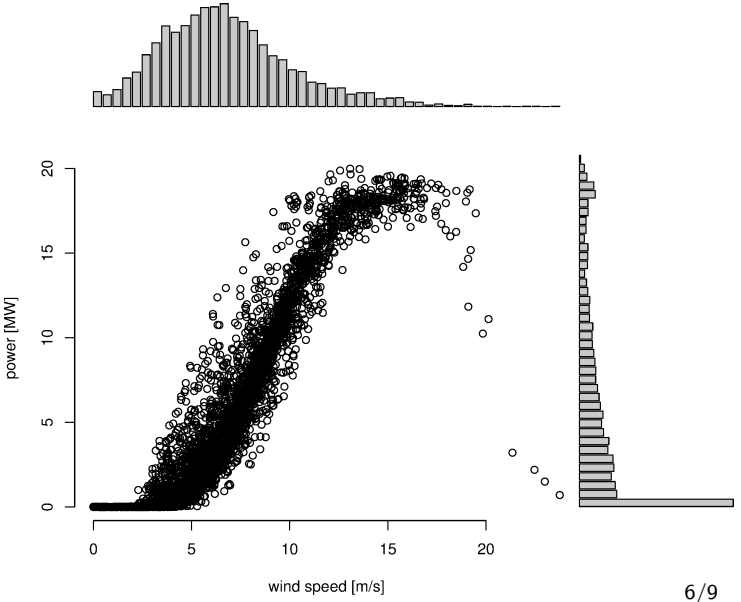


- **Klim wind farm** (North of Jutland, Denmark): 35 V44 turbines
- **Nominal capacity**: 21 MW
- Easy direct scaling of the power curve from 600kW to 21MW!

The *actual* power curve looks different!

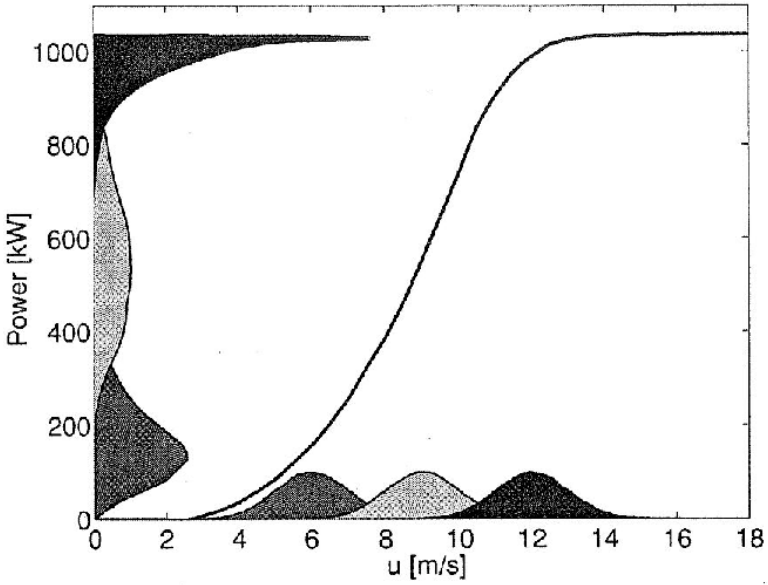
Origins of uncertainty in the conversion process:

- actual meteorological conditions seen by turbines,
- aggregation of individual curves,
- non-ideal power curves,
- etc.

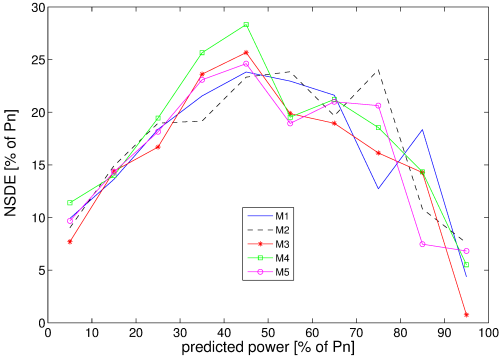


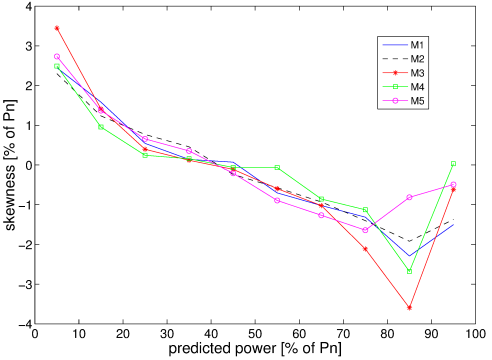
Shaping forecast uncertainty

courtesy of Matthias Lange



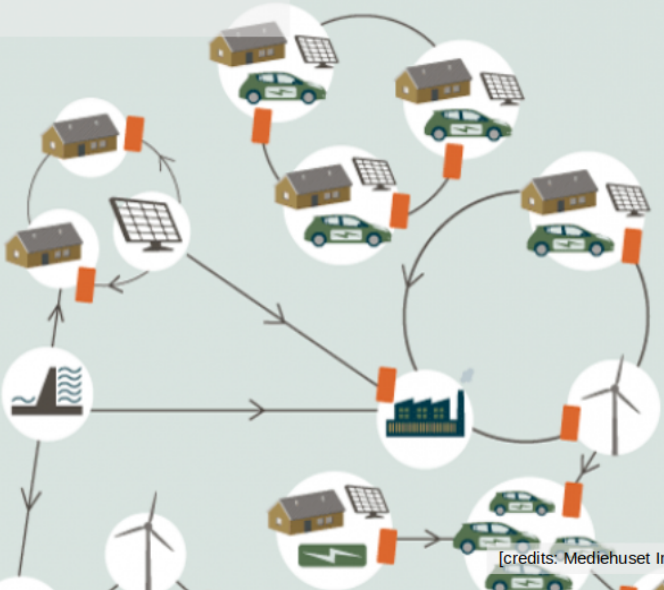
The power curve of a wind farm shapes the distributions of prediction errors





the above example involves 5 different approaches to point prediction, for the same site, over the same period and with the same inputs...

Use the self-assessment quizz to check your understanding!



[credits: Mediehuset Ingeniøren]