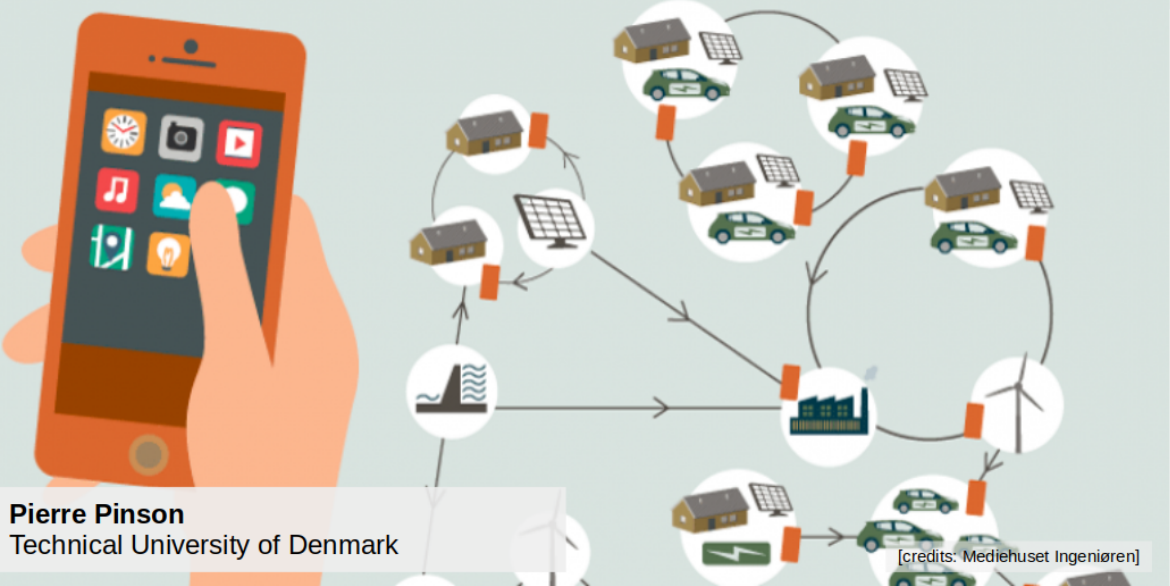
Module 7 – Introduction to Renewable Energy Analytics

7.1 Forecasts, why and in what form?



[credits: Mediehuset Ingeniøren]

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Why forecasting?

- Forecasting is a *natural first step* to decision-making
- Believing we know what will happen
  - helps making decisions
  - but mainly, makes us more confident about it!
- Key application areas include:
  - weather and climate
  - economics and finance
  - logistics
  - insurance, etc.

"But to be fair, there's a fifty percent chance of just about anything."

What to forecast?

- Different actors may have different needs...
  - market participant, **supply side** (e.g., conventional generator, wind farm operator)
  - market participant, **demand side** (e.g., retailer)
  - participants in neighboring markets
  - **market operator**
  - **system operator**

  - but also, *you and I*

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  - but also, *you and I*
- One may want forecasts of:
  - the *electric load*
  - *day-ahead prices*
  - potential *imbalance sign*
  - *regulation prices/penalties*
  - potential *congestion on interconnectors*
  - etc.
  - *Generation from renewable energy sources!!!*
- **Nearly all these quantities are driven by weather and climate!**

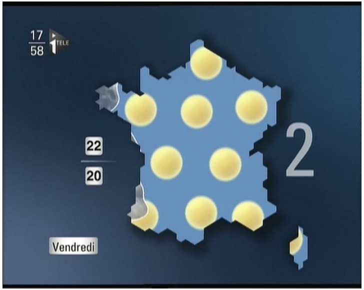
Renewable energy forecasts in decision-making

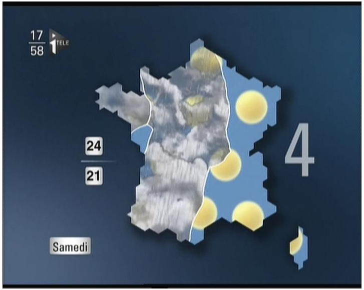
- Forecast information is widely used as input to several decision-making problems:
  - definition of **reserve** requirements (i.e., backup capacity for the system operator)
  - **unit commitment** and **economic dispatch** (i.e., least costs usage of all available units)
  - coordination of renewables with **storage**
  - design of optimal **trading** strategies
  - electricity **market-clearing**
  - optimal **maintenance planning** (especially for offshore wind farms)
- Inputs to these methods are:
  - deterministic forecasts
  - probabilistic forecasts as **quantiles, intervals, and predictive distributions**
  - probabilistic forecasts in the form of **trajectories** (/scenarios)
  - **risk indices** (broad audience applications)
- For nearly all of these problems, optimal decisions can only be obtained if fully considering forecast uncertainty...

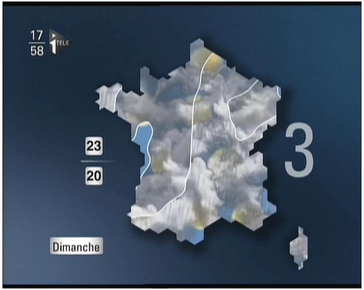
The problem with forecast uncertainty estimation

- The French National meteorological office (Meteo-France) has been communicating *"confidence indices"* (indices de confiance) along with their forecasts for quite a while...

- Example set of forecasts: (from "1 = low confidence" to "5 = high confidence")







- *Do you get something out of it?*

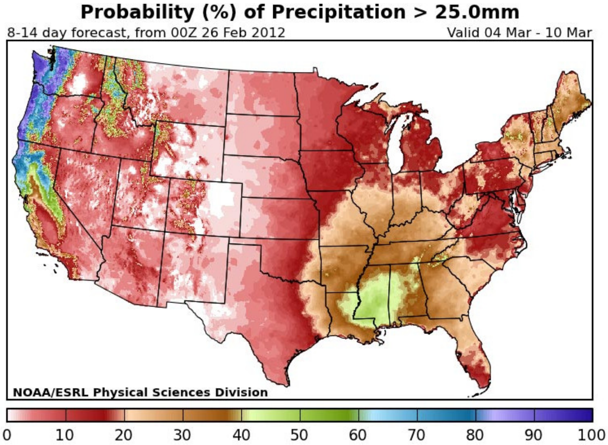
Now... the “big mouth” paradox

- It might always be difficult to trust someone providing you with forecasts
- Even more so if these are probabilistic...

- Let us consider a simple american setup (focus on **New Orleans**), with two rival forecasters:

- The two competing forecasters tell you that:
    - **Forecaster A:**
      It will rain next Monday, and the precipitation amount will be of 22mm
    - **Forecaster B:**
      There is a probability of 38% that precipitation is more than 25mm next week

- Who would you hire?



[Extra reading: S Joslyn, L Nadav-Greenberg, RM Nichols (2009) Probability of precipitation: Assessment and enhancement of end-user understanding. *Bulletin of the American Meteorological Society* **90**: 185–193 (pdf)
UR Karmarkar, ZL Tormala (2010). Believe me - I have no idea what I'm talking about: The effects of source certainty on consumer involvement and persuasion. *Journal of Consumer Research* **36**(6): 1033–1049 (pdf)]

Example use of forecasts: market participation

- **Dutch electricity market** over the year 2002:
  - day-ahead market APX
  - regulation mechanism managed by TenneT, the TSO for the Netherlands

- Participation of a **15 MW wind farm**, without any storage device and without any control on the power production

- **Point** and **probabilistic** predictions (full predictive distributions) generated with state-of-the-art statistical methods

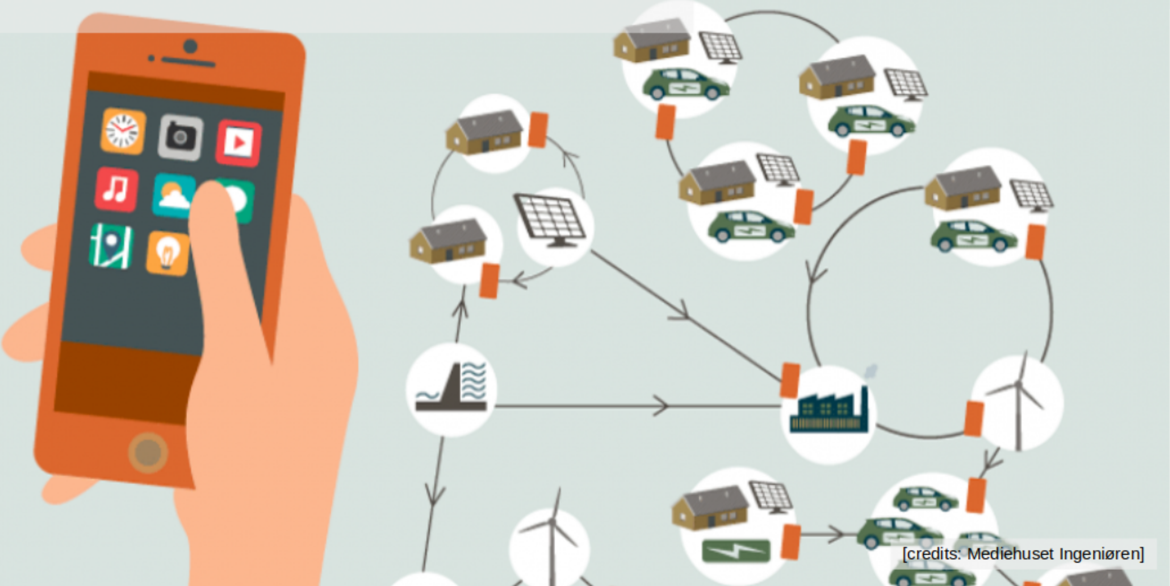
- **Revenue-maximization** strategies
  - based on point predictions only (persistence or advanced method)
  - derived from probabilistic predictions and a model of the participant's sensitivity to regulation costs

Trading results

	Pers.	**Adv. point pred.**	**Prob. pred.**	**Perfect pred.**
Contracted energy (GWh)	44.37	45.49	62.37	46.41
Surplus (GWh)	18.12	9.87	4.89	0
Shortage (GWh)	16.08	8.95	20.85	0
Down-regulation costs (10^3 €)	195.72	119.99	42.61	0
Up-regulation costs (10^3 €)	79.59	52.01	61.46	0
Total revenue (10^3 €)	1041.38	1145.69	1212.61	1317.69
Av. down-reg. unit cost (€/MWh)	10.80	12.15	8.71	0
Av. up-reg. unit cost (€/MWh)	4.95	5.81	2.95	0
Av. reg. unit cost (€/MWh)	8.05	9.13	4.04	0
Av. energy price (€/MWh)	**22.44**	**24.68**	**26.13**	**28.37**
Part of imbalance (% prod. energy)	**73.69**	**40.55**	**55.46**	**0**
Performance ratio (%)	**79.1**	**86.99**	**92.1**	**100**

[Source: P Pinson, C Chevallier, G Kariniotakis. Trading wind generation from short-term probabilistic forecasts of wind power. *IEEE Trans. on Power Systems* **22**(3): 1148-1156 (pdf)]

Use the self-assessment quizz to check your understanding!



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