Using climate information for energy: ***why*** and ***how***

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ECEM project

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European Commission

Copernicus
Europe's eyes on Earth

Implemented by ECMWF

Using climate information to manage risk

- ECEM aim: support and promote the use of climate information in energy
- Construction of "demonstration of principle" case studies of ***why*** and ***how*** the service might be used
  - Intention: illustrations to stimulate engagement with climate risk, not necessarily to provide the definitive "answer"
- Two main types of climate information available from ECEM service:
  - Risk "climatologies" (historic and future)
  - Risk "forecasts" (especially season-ahead)
- Seeking input:
  - Suggestions for case studies – either events *or* decision-making processes
  - Preferences for formatting, presenting and evaluation

Risk climatologies

- ECEM provides, for each eHighway cluster and scenario, ~30+ years of daily-data:
  - Weather, electricity demand, electricity supply: wind, solar, hydro, …
- Offers opportunities for improved quantification of climate risk. Questions:
  - What climate risks are most important?
  - How should this information be communicated to demonstrate its relevance?
- Here: three ideas of how data, taken from the demonstrator, might be subsequently "used"

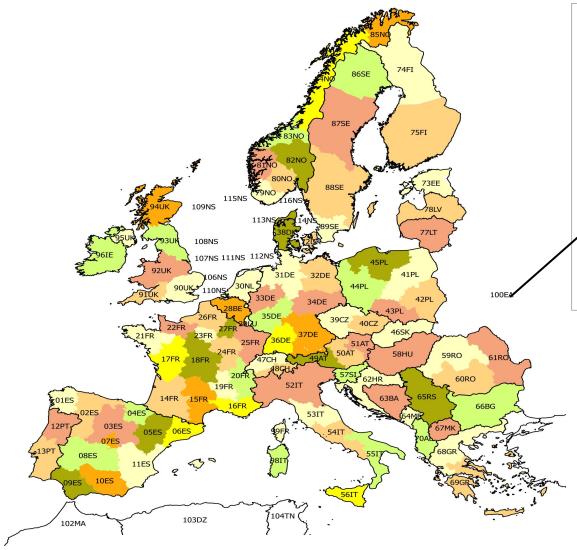
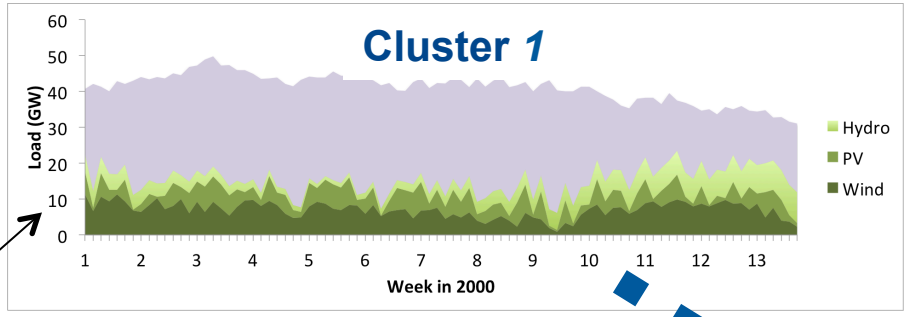
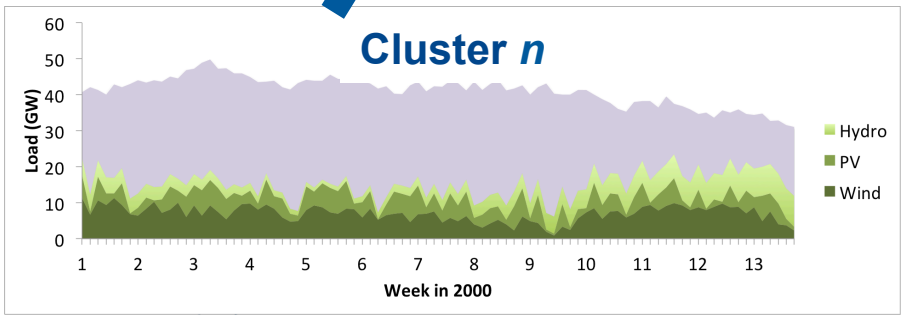


Fig: eHighway2050





Demand
Hydro
PV
Wind
… etc

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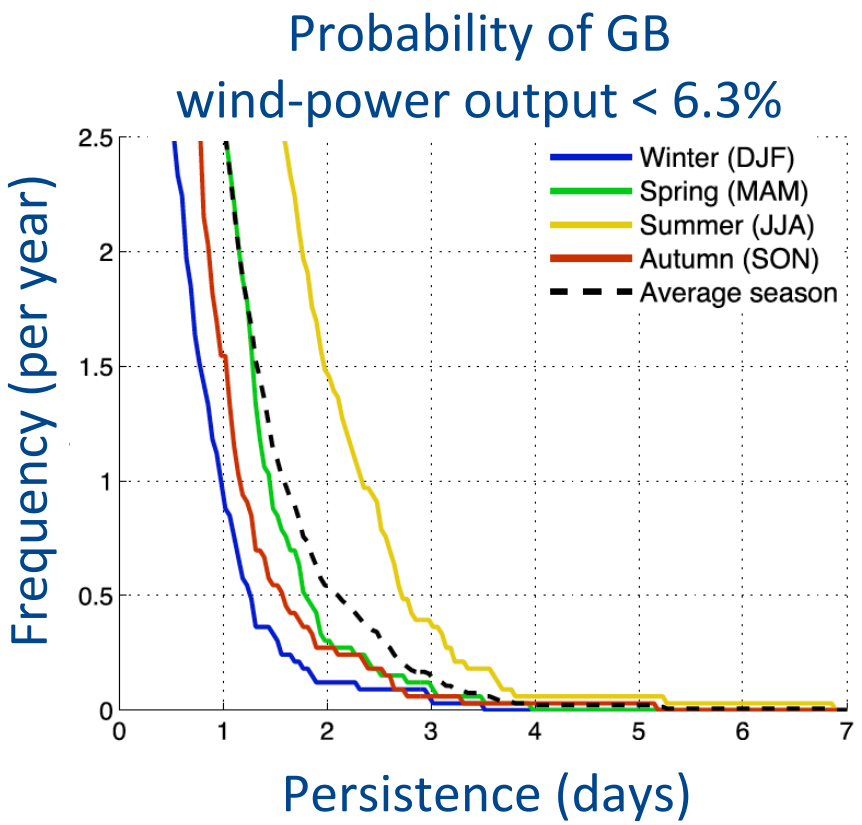
Risk climatologies - examples

★ Example 1 – system-wide persistent low wind power events



Potential ideas and issues:

- Critical thresholds? (what are they)?
- Availability of other RE resources?
- Correlation with demand?
- RE availability in near-by zones?
- Generation capacity margins?
- Transmission/interconnection adequacy?

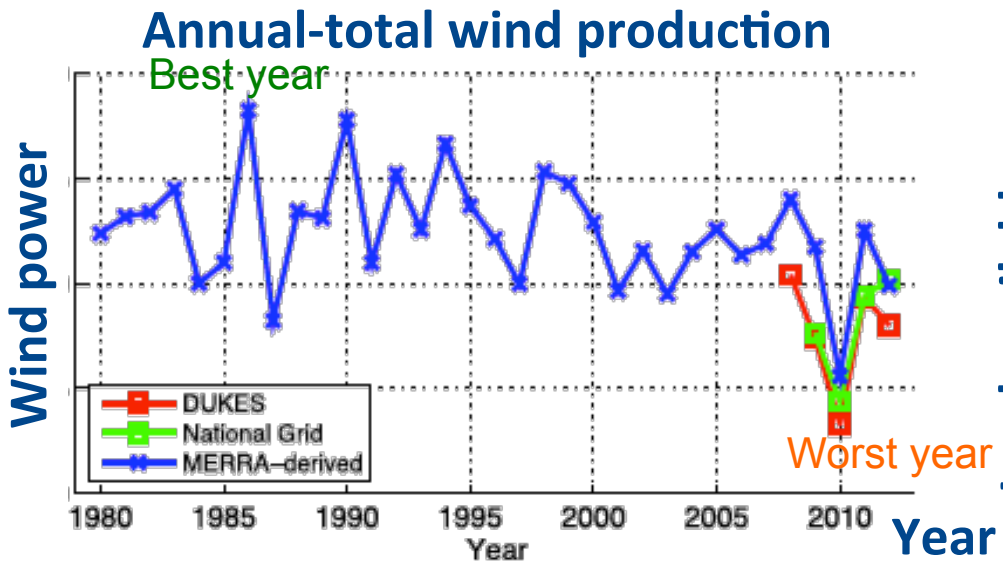
Similar examples:

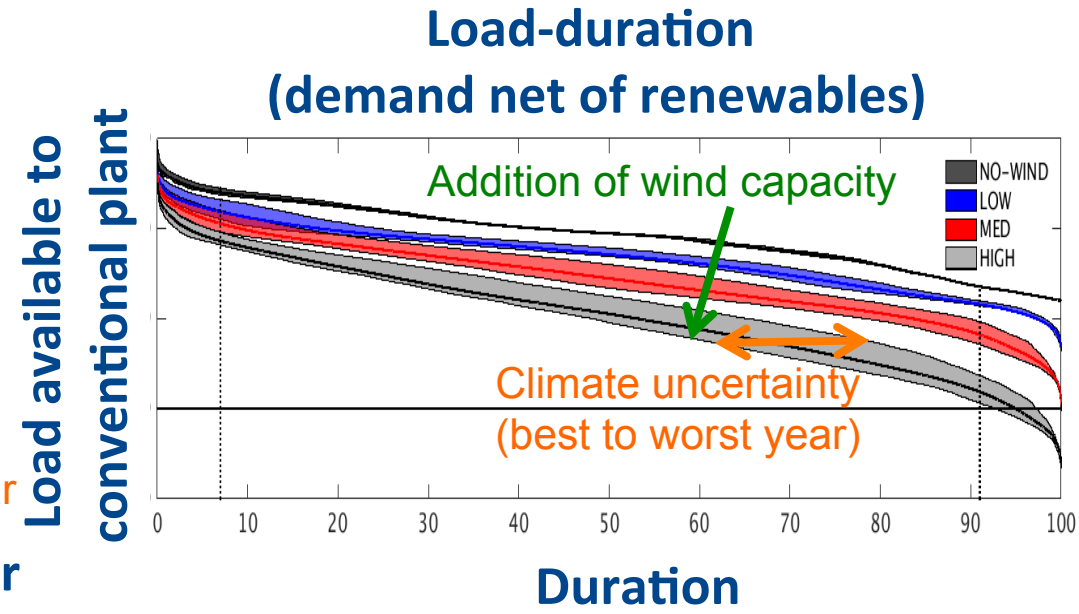
- Offshore maintenance planning

Figure: Cannon et al (2015, RE)

Risk climatologies - examples

★ Example 2 – Investor/owner/planner: Volumetric generation risk





★ Ideas:
- ★ p5-p95 of production volume for RE
- ★ p5-p95 of annual hours at a specified load level for conventional plant
- ★ "best" and "worst" case years
- ★ Curtailment
- ★ Spatial correlations maps for neighbouring zones

Figures:
Cannon et al (2015, RE)
Bloomfield et al (submit, Nat. Energy)

Risk climatologies - examples

- ★ Example 3 – Trading and system planning: extremes and correlated risk
  - ★ Winter 2009/2010 very low wind in the UK; "NAO negative"
- ★ Identifying other "stressful" events (e.g., France Feb 2012)?
- ★ Forecasting: European subseasonal-seasonal predictability
  - ★ NAO - Scaife et al 2014 GRL; Month-ahead wind - Lynch et al 2014 MWR

Wind anomaly (DJF 2009/10)

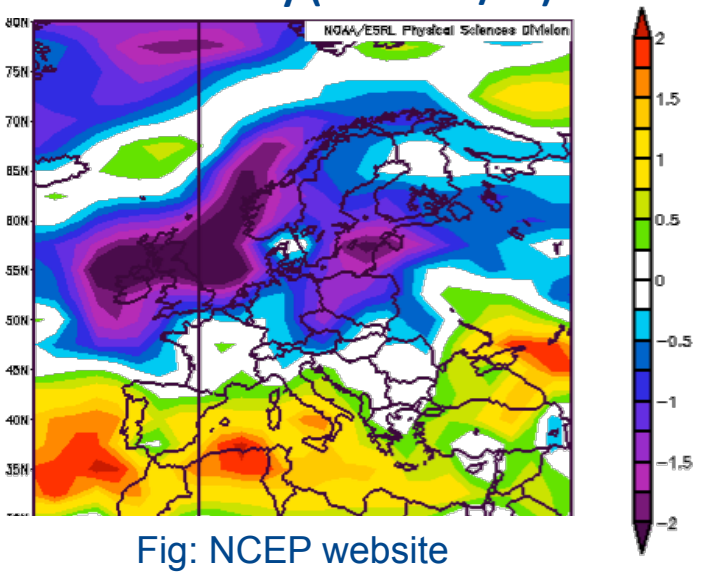
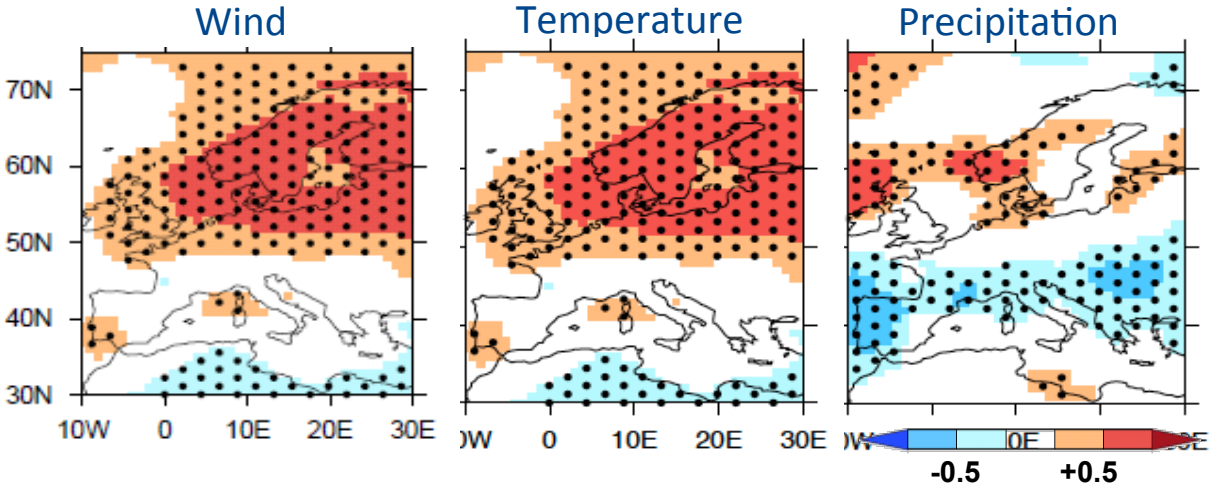


Fig: NCEP website

NAO correlations to surface climate (Ely et al 2013, Energy Policy)



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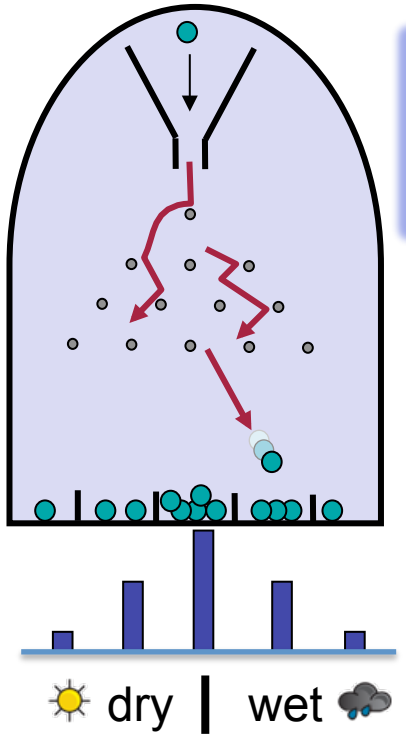
Climate (seasonal) forecasts

- ★ We can't predict the **weather** more than ~10 days ahead (chaotic system)
- ★ But some parts of the climate system change **slower** than the atmosphere
  - ★ Oceans, sea ice, soil moisture, ...
- ★ So using a full **climate** model, there is predictability several months ahead.

'chaos'
→ 'weather'



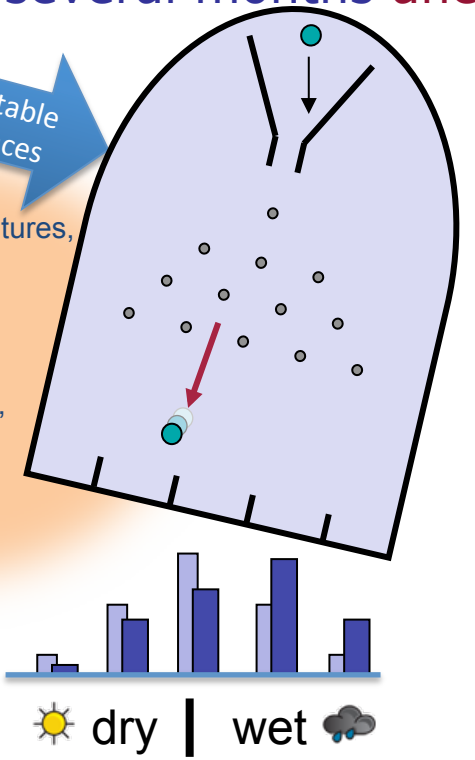
Distribution → 'climate'

But we are predicting
the **climate**,
NOT the weather!

Cannot predict 1 ball...
Can predict the distribution!

Predictable influences

Ocean temperatures,
Tropical rain,
Sea ice,
Soil moisture,
Volcanoes,
Solar variability,
Aerosols,
Snow cover, ...



Forecasting a *different* distribution

Can we produce *useful* seasonal forecasts?

- ★ Performing a skill and reliability assessment of seasonal forecast systems, looking at probabilistic and deterministic measures across 3 models
- ★ Using the climate variables described earlier (temperature, wind, ...), and the corresponding energy variables (demand, wind power, ...)
- ★ Skill in one variable/model/season/region does not mean skill in others but…
  - ★ Positive indications that some skill for some energy-relevant properties over Europe

What is a useful level of skill?

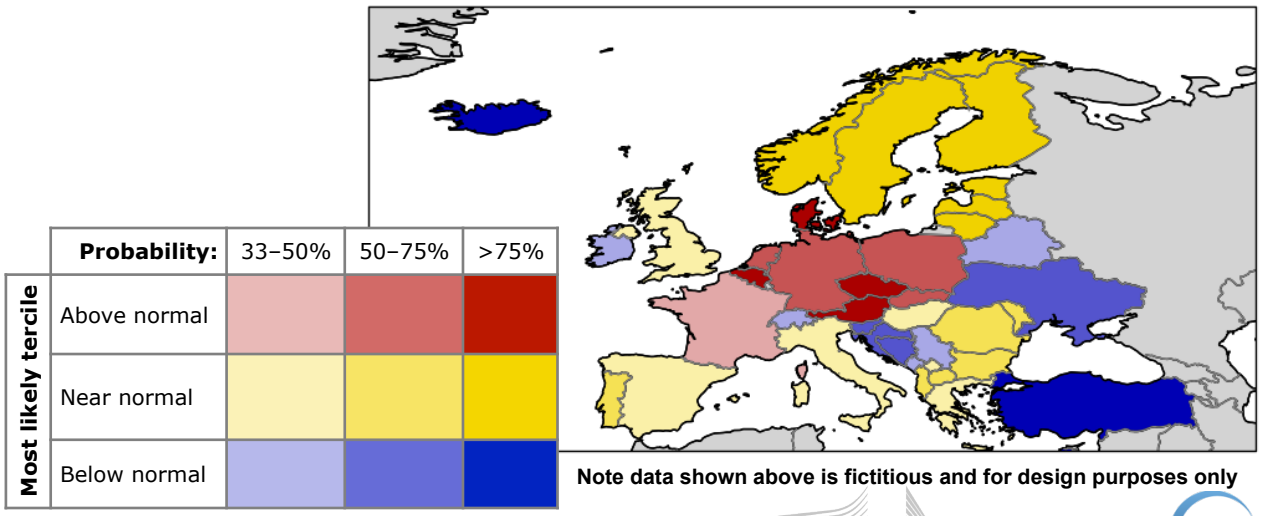
How can it be exploited?

Depends upon the "decision" being made!

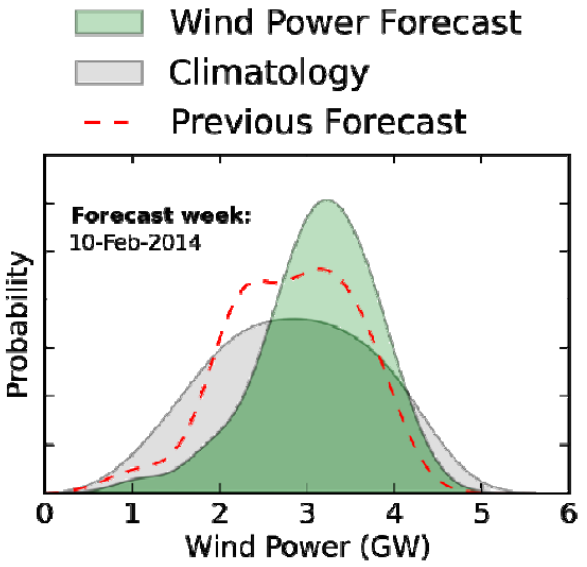
What might a seasonal forecast look like?

There are many different ways of presenting seasonal forecast information:

- ★ Mean and uncertainty (how much - 3σ? 95%? 99%?)
- ★ Probability of categories (above/below average; terciles; outer quintiles)
- ★ Anomalies (compared to what climate?)
- ★ Distribution (CDF/PDF? how many categories?)
- ★ …



Note data shown above is fictitious and for design purposes only



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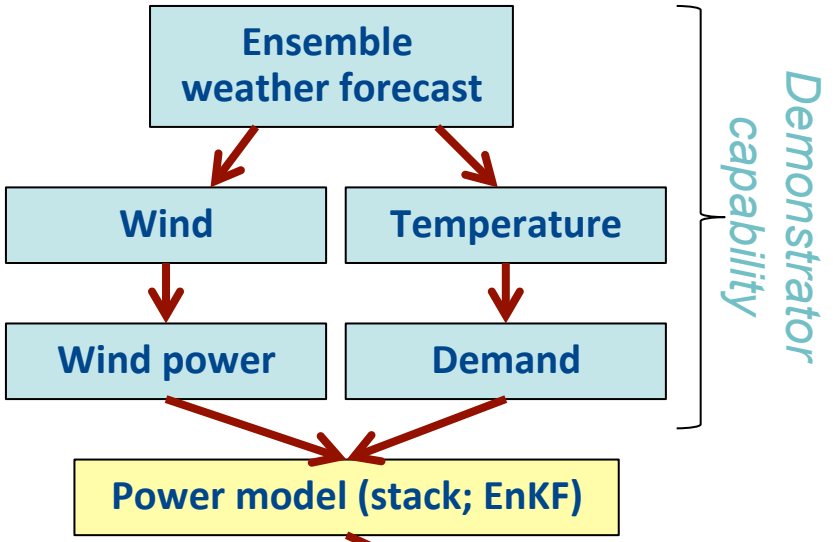
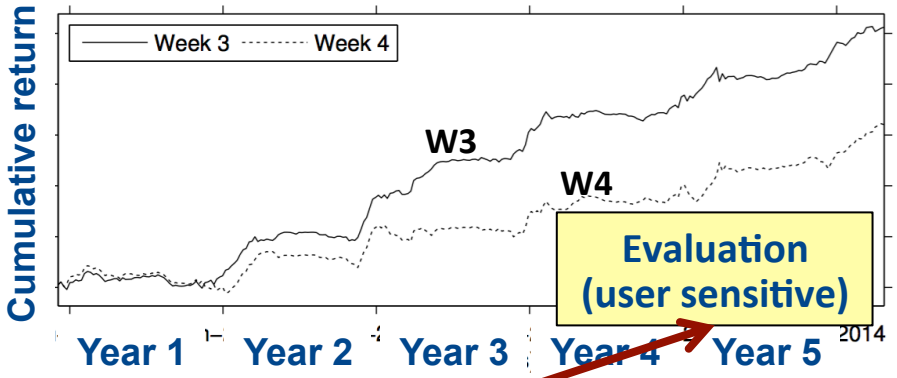
Demonstrating value in decision-making

★ Previous work with ECMWF month-ahead forecast

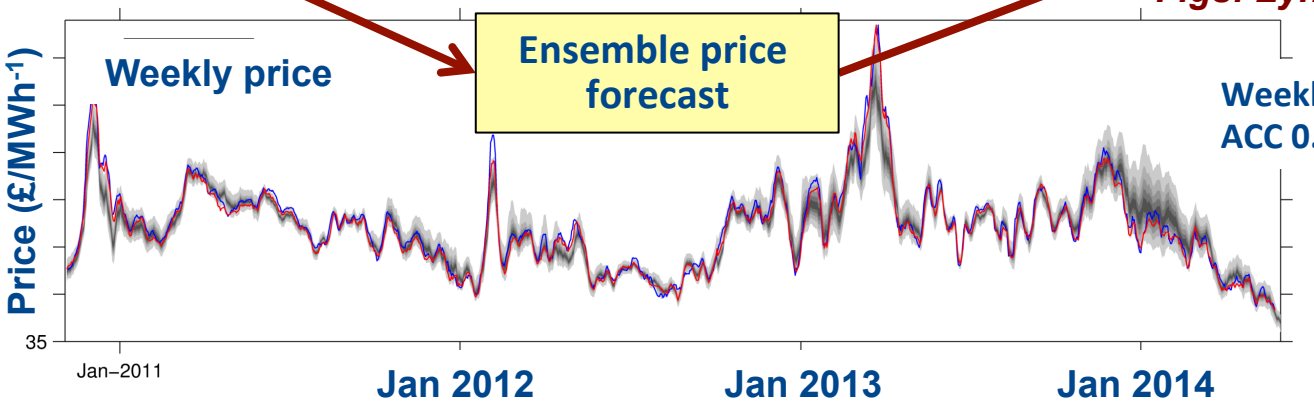




Evaluation (user sensitive)

Optimize trading strategy (user risk preference)

Figs: Lynch et al (2015, MWR; thesis in review)



Weekly price 3-week ahead forecast:
ACC 0.53; CRPS 0.15 (99% confidence)

Would a similar exercise be helpful in ECEM?

Key Questions – help us to help you!

- Are there any **historic climate events** that have been particularly challenging to the energy sector and could an ECEM service have helped anticipate/manage/ predict them?
  - How do you see these events changing into the future? (changes to the power system, changes in the climate)
- What **decisions** could be better informed using ECEM data (including both climatologies and seasonal forecast data)?
- What **barriers** prevent more uptake of climate information in energy applications? Can "demonstrations of principle" help to overcome them?
- What sort of **information** is most useful?
  - Exceedence of key risk thresholds? Estimates with uncertainty? Anomalies or absolutes?
  - "Weather" or "energy" variables?