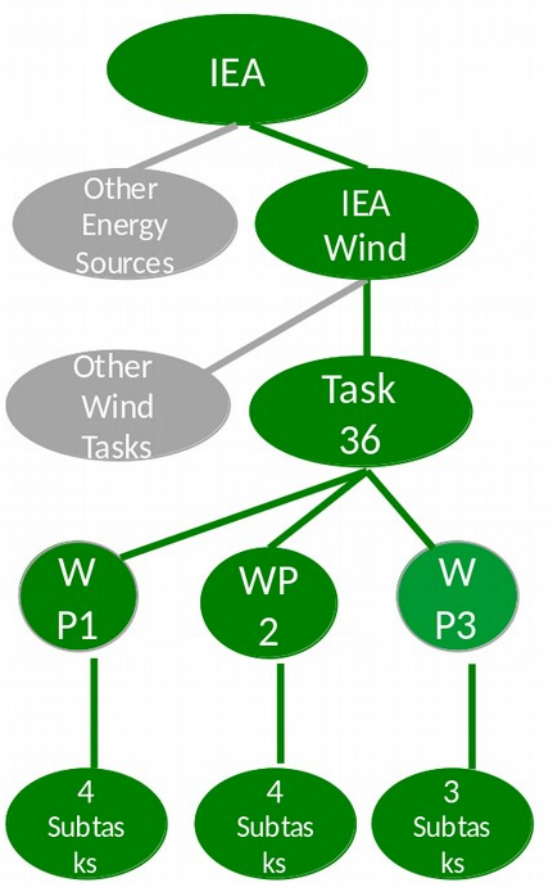
Task 36

Insight on Human Decision-making from Probabilistic Forecast Games and Experiments: an IEA Wind Task 36 initiative

Wind Integration Workshop

ONLINE, 12.11.2020 – Session 6A -

IEA Task 36 - Forecasting for Wind Energy



What is the IEA (International Energy Agency)? (www.iea.org)

- International organization within OECD with 30 members countries and 8 associates
- Promotes global dialogue on energy, providing authoritative analysis through a wide range of publications
- **One activity: convenes panels of experts to address specific topics/issues**

Task 36: Forecasting for Wind Energy: (www.ieawindforecasting.dk)

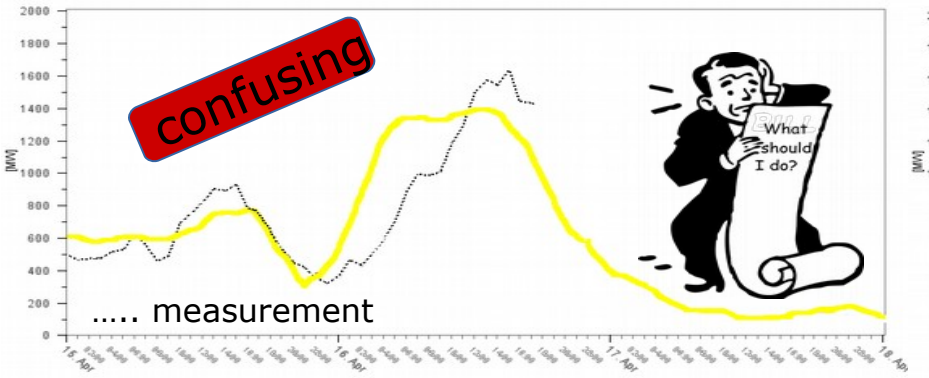
- One of 17 Tasks of IEA Wind: https://community.ieawind.org/home
- Phase 1: 2016-2018; Phase 2: 2019-2021
- Operating Agent: Gregor Giebel of DTU Wind Energy
- Objective: facilitate international collaboration to **improve wind energy forecasts**
- Participants: (1) research organization and projects, (2) forecast providers, (3) policy-makers and (4) end-users & stakeholders

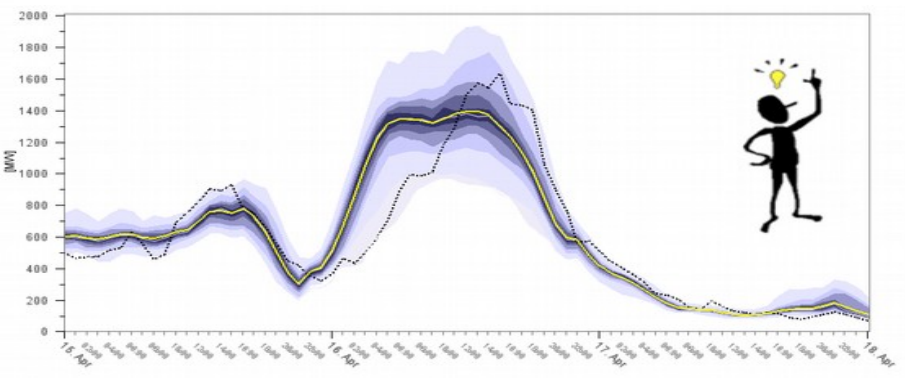
Task 36 Scope: Three "Work Packages"

- WP1: Global Coordination in Forecast Model Improvement
- WP2: Benchmarking, Predictability and Model Uncertainty
- WP3: Optimal Use of Forecasting Solutions

Task homepage: http://www.ieawindforecasting.dk/

Background for the Initiative





Situation

→ Deterministic methods “hide” inherent uncertainty of forecast

→ Climate change requires more focus on extremes

→ Increasing penetration levels change system security levels

Background for the Initiative

Why change to probabilistic forecasts:

→ Decision making with probabilistic information has the potential to be better

→ When forecast is challenging users keep focus and confidence when using probabilistic information

→ Reduction of vulnerabilities in electric grid: grid congestion, strong and fast ramping events

→ Leads to more robust prediction models

→ Improves judgement and decision making in critical situations

Background for the Initiative

Major Challenges:

1. **technical issue**: current energy management systems simply cannot operate with probabilistic forecasts.

2. **the human factor:**
   New methods and approaches are bound to fail, if end-users do not know how to harness new forecast methods and systematically integrate uncertainty in their decision-making processes

Background for the Initiative

Our Goal and Objectives:

→ **Using a unified and inter-disciplinary approach**

→ **Bringing together hitherto separate fields and competencies**

Meteorology
Behavioural Science
Cognitive science
(Renewable) energy sector

→ **Using behavioural decision experiments** to

simulate real-time problems for specific user groups using ensemble data
formulate strategies for further research from the results and feedback
design experiments and games for learning and teaching

...the overarching goal is to demonstrate the value of using probabilistic forecasts in the Renewable Energy Sector

First Experiment: Forecasting Game "Offshore wind power trading in extreme events"

Forecasting game designed in collaboration with and and run at the Max Planck institute for Human Development in Berlin

Overall objective was to investigate the:
→ Barriers of using probabilistic forecasts from a psychological view
→ Finding new ways of communicating uncertainty and probabilistic forecasts
→ Making it easy to understand the value and benefits through "gamification"

3 Postulates:
→ Trading success is highly dependent on costs of balancing power needed due to forecast errors
→ 5% of the cases with large forecast errors are responsible for 95% of costs in a month/year
→ Reducing these costs is more important than improving the general forecast by 1-2%.

1st Experiment: Forecasting Game
"Offshore wind power trading in extreme events"

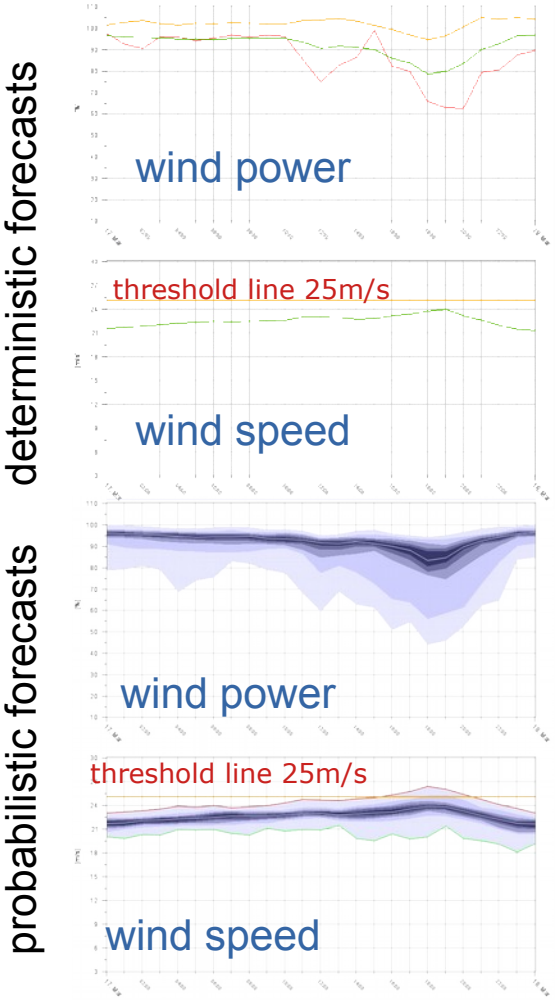
The Game:

Decisions to be made whether or not a high-speed cut-off takes place within the forecast time

- in 12 cases
- whether to trade 50% or 100% of the generating power of an offshore wind park

Decision Tools:

- 3 deterministic forecasts showing the wind power & wind speed
- probabilistic forecast showing wind power and wind speed inclusive uncertainty bands



Participants:

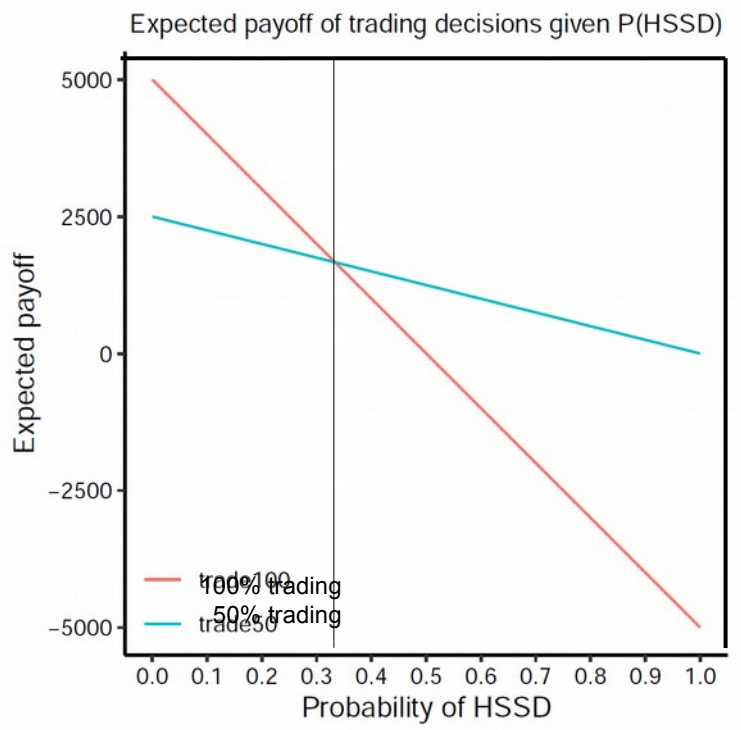
105 participants were registered at closing date in July 2020

People stayed anonymous, no information about them was saved.

Game was introduced at the IEA Task 36 workshop in Glasgow in January 2020 and announced to the IEA community

1st Experiment: Forecasting Game
"Offshore wind power trading in extreme events"

Cost Function



Percentiles in Forecast graphs

- min – p10
- p10 – p20
- p20 – p30
- p30 – p40
- p40 – p50
- p50 – p60
- p60 – p70
- p70 – p80
- p80 – p90
- p90 – max

Some interesting aspects of the cost function:

- if the probability of a HSSD exceeds 33% trading 50% will give higher payoff

- if the probability of a HSSD < 33% trading 100% will give higher payoff

<u>Could participants read this out ?</u>
Deterministic forecasts: no information

Probabilistic forecasts:
→ percentiles provided information about the probability in wind and power !

High-level SUMMARY and lessons learnt

For the game and this group of 105 participants, using probabilistic Forecasts lead to…

- ➔ 70% had an equal or better final outcome
- ➔ Higher ratio of high-scorers among prob. forecast decisions
- ➔ More correct decisions
- ➔ Less risky decisions, where appropriate
- ➔ More "safe" decision, where risk was visible

…more testing to come with systematic experimental design, more representative test cases, …

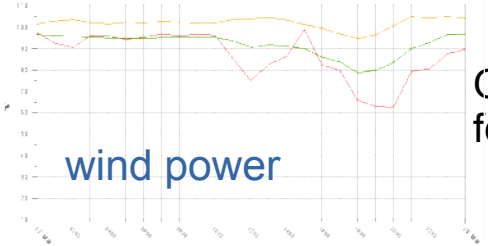
- ➔ Participants changed their mind in 18% of all decisions
- ➔ 90% of participants changed their mind at least once

Noticeable: no one wanted to make decisions with deterministic forecasts alone!

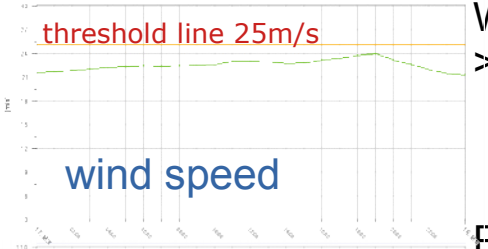
Forecast Game 1: Offshore wind power decision making in extreme events

Could a weather plot provide additional information ?

deterministic forecasts

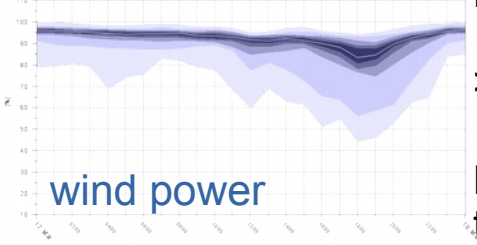


Only 1 of 3 power forecasts with HSSD

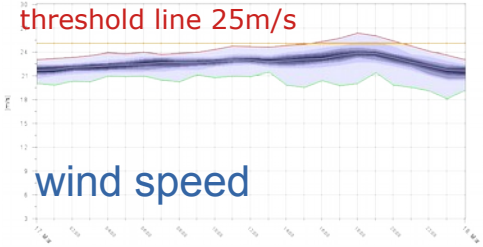


Wind speed > 25m/s

probabilistic forecasts



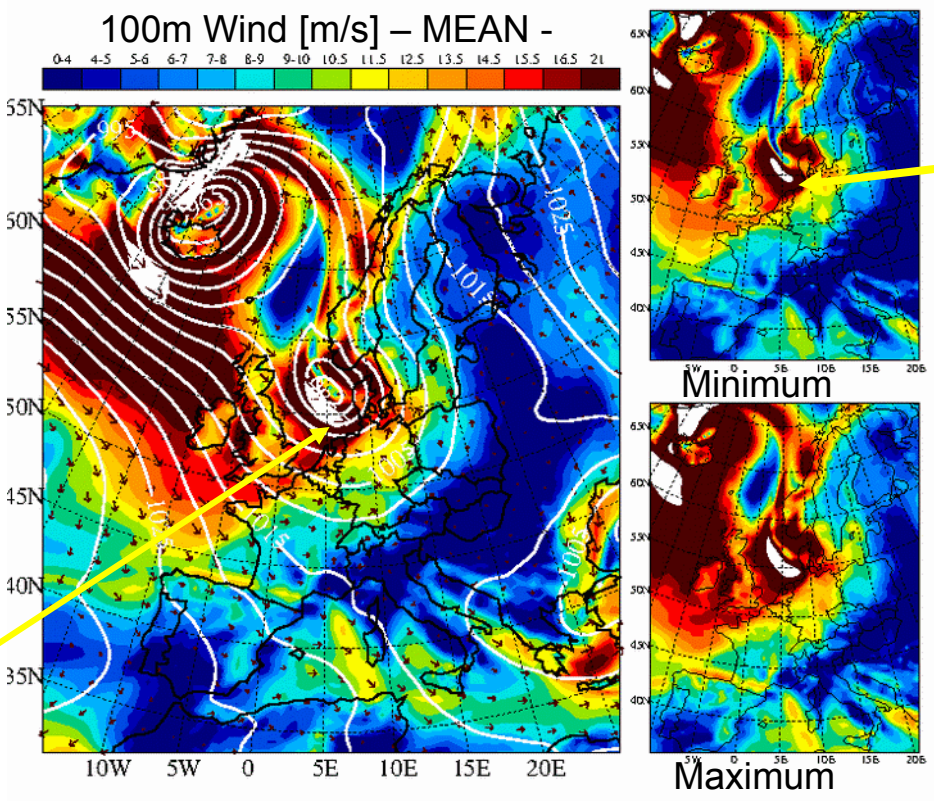
Probability for HSSD in wind power > 33%



P80 exceeds threshold...

Weather maps are unambiguous...

Weather Map at time of highest HSSD probability



Forecast Games and Experiments

Questions we want to answer in the next round of experiments:

Our structure to answer, whether probabilistic wind power forecasts benefit decision making:

- **Empirical:** How are probabilistic forecasts used & do they benefit decisions?
- Simulation: Demonstrate objective value of forecasts for optimal decision strategy
- Training: supporting decision making by examples in a platform

Forecast Games and Experiments Initiative

Scenarios we want to design in the next round of experiments:

- Featuring Methodology:
  Scenarios with wind speeds extremes, where only certain uncertainty forecasts methodologies are able to capture the event – assist in methodology selection

- Featuring Economic Extremes
  Scenarios with extreme balancing power prices, where forecast errors in one direction can be highly penalized (this sometimes occurs in the Nord Pool or EPEX market)

- Featuring Changed Information Levels
  Presenting percentiles versus all ensembles members or probabilities as numbers to the decision-maker to investigate how decisions may change with different presentation forms

- Featuring Risk Assessment
  Investigate whether decision-makers are more risk averse or prone given probabilistic forecasts and whether the amount of uncertainty makes a difference

Forecast Experiments and Games Initiative

- SUMMARY and TAKE-AWAY -

Education need – but also experience in how to communicate uncertianty forecasts

Potential impact is not a statistical value that can be easily computed in advance – return of investment difficult in "holistic" applications

Uncertainty forecasts show what is hidden in deterministic "best guesses": decision making is not more simple, rather "more honest"

Which decisions can be automated ?

→ Decisions that can be categorised – decisions that have multiple components are difficult to automate (e.g. HSSD with respect to wind, power and costs)

→ Decisions that have a clear target or target ranges (e.g. ramping) can better be automated

Value of probabilistic forecasts may also be a new & better understanding of forecasts, e.g. a forecast error is no longer a forecast that is "mystically" wrong….

THANK YOU FOR YOUR ATTENTION

Follow us:

NEW *IEA Wind Task 36 Chatchannel* **@** Mattermost (register with one of us or Gregor Giebel):

General & **WP3-2 channel**: https://mattermost.windenergy.dtu.dk/iea-task-36

Project webpage http://www.ieawindforecasting.dk/

Task-page: https://www.ieawindforecasting.dk/work-packages/workpackage-3

Publications: https://www.ieawindforecasting.dk/publications

YouTube Channel: https://www.youtube.com/channel/UCsP1rLoutSXP0ECZKicczXg

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