PO.114

Extreme Event Decision-Making in a high-wind Energy System

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Abstract

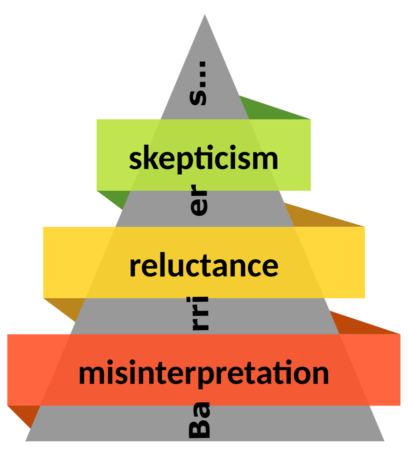
Recent experience has shown that wind penetration levels above 30-40% of demand and collective penetration levels of wind and solar above 50% of demand are game changers when it comes to the integration of renewables into the electric grid. An electric grid is difficult, if not impossible, to keep stable in the future without the right tools to predict and act upon the variable wind power generation and, even more important, without a proper understanding of the probabilistic nature of forecasts for decision-making. Key tools to solve the identified challenges for the integration of massive amounts of wind power into the electric grid are to use probabilistic forecast tools.

The goal of the IEA Wind task 51 "Forecasting for the weather-driven Energy System" initiative "Probabilistic Forecasting Games and Experiments" in collaboration with the Max-Planck Institute for Human Development's WEXICOM project is to break down barriers for the adoption of probabilistic forecasts. Here, we present and discuss results from our second experiment. We observed e.g. that the skepticism of managers not always matches that of their staff at the front line, that reluctance also has to do with confidence and that misinterpretation is in large a lack of understanding of the tools, their benefits and training in the decision making processes.

Objectives

By developing a series of games and experiments, our objective is to provide training tools that simulate realistic decision scenarios with feedback and thus allowing people to learn from an own experience of using probabilistic forecasts.

The experiments are part of a larger research effort to better understand, support and reduce known barriers in human decision making under uncertainty and with aid of probabilistic forecasts: skepticism, reluctance & misinterpretation



Methods

Decision Tools for Experiment:

- 3 independent deterministic forecasts showing the wind power & wind speed
- probabilistic forecast showing wind power & wind speed as uncertainty bands from 75 Ensemble Member of WEPROGs Multi-Scheme Ensemble (MSEPS).

Game: Decisions were to be made in 2 times 20 cases

- participants make decisions regarding high-speed shutdown events (HSSD) based on deterministic or probabilistic forecasts
- request on participant's confidence level regarding their decision
- real-time environment, e.g. participants may be surprised by forecasts that fail to warn or over-predict
- asymmetric cost function: 100% trading at No-HSSD counts 5000units, but penalises with -5.000units at HSSD, while the safe decision with 50% counts 2.500units at No-HSSD, and no penality at HSSD.

Experiment Setup

Experiment with separated Decision/Making

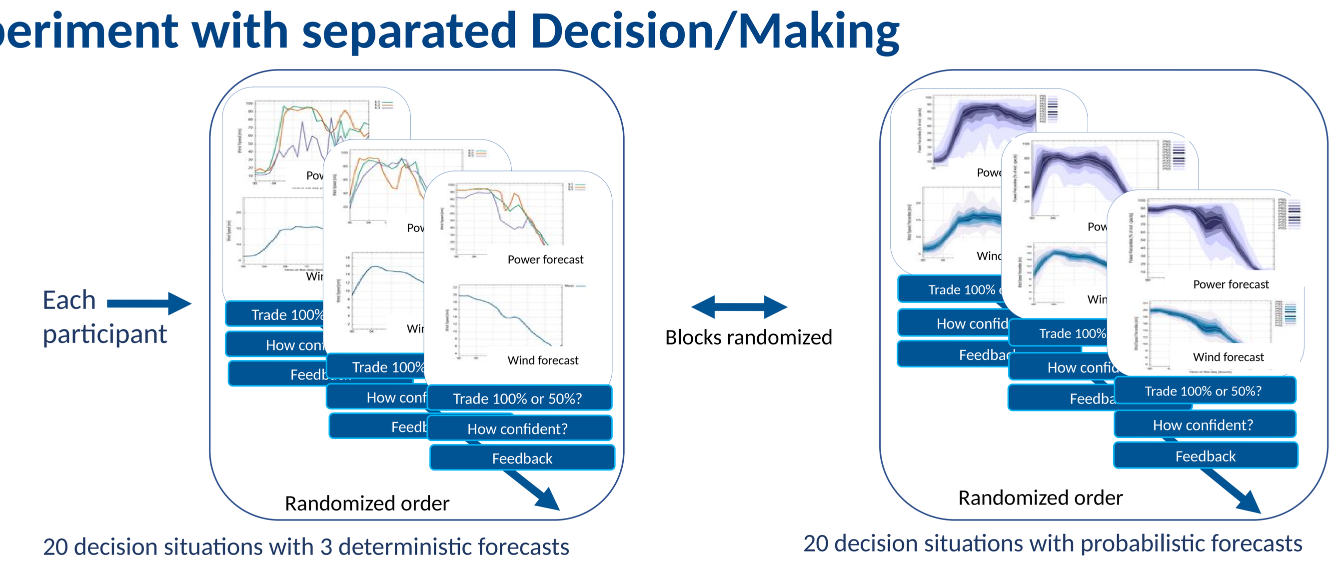


Figure 1: Setup of the experiment with blok and case randomised 2 x 20 decisions to be made.

Participants make 20 decisions on the basis of 3 independent deterministic forecasts and 20 on the basis of probabilistic ensemble forecasts with uncertainty bands built from 75 ensemble members (MSEPS). Both blocks and cases were randomised.

Results

The preliminary results have been generated with 162 participants that finished the game. Those that played multiple times have been filtered out. Most participants were recruited within wind energy community. The most stunning result so far is that independent of the forecast type, the outcome was (1) only slightly better than chance and (2) worse than a all-safe strategy that ignores the forecast and just applies the defensive decision in all cases.

Final Balance

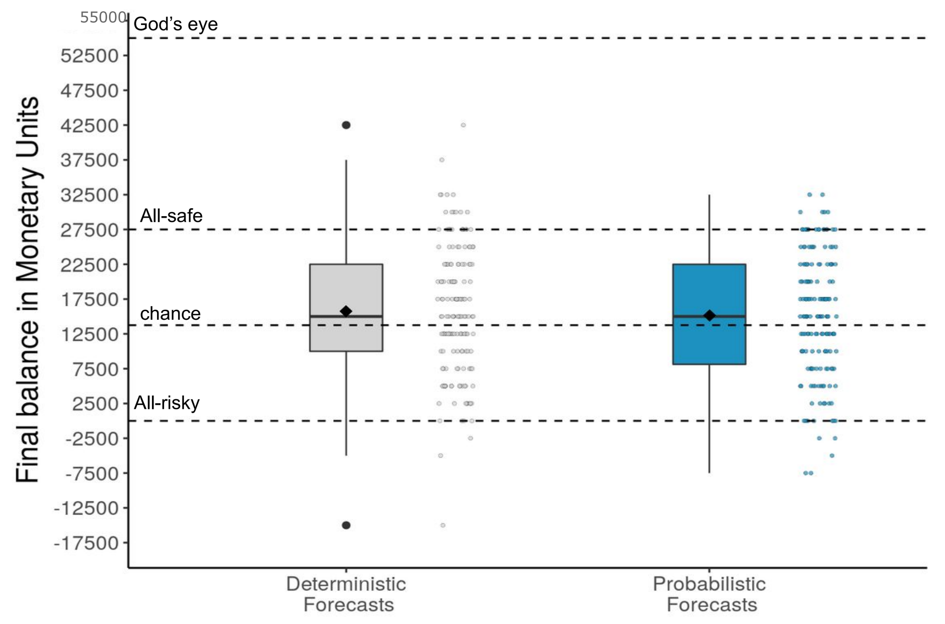


Figure 2: Final balance in a box-plot inclusive the distribution per forecast type. The lines indicate the level of interpretation knowledge

Forecast / Score	Mean Score	Standard Deviation
Deterministic	15.741	9.254
Probabilistic	15.154	8.954

Table 1: Scores of the final balance

The significance of this outcome can be described as a lack of understanding, i.e. the step from deterministic to probabilistic forecast tools requires much more training and education than expected so far.

Proportion of correct decisions

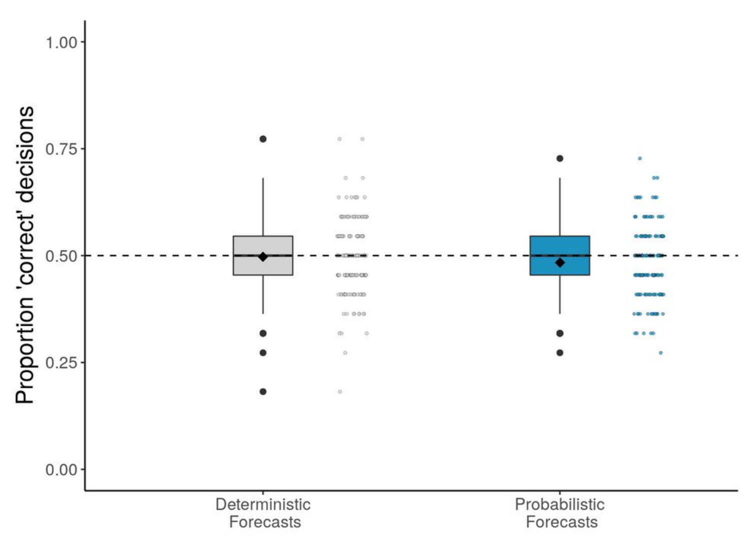


Figure 3: Proportion of correct decisions for all 40 decisions in a box-plot inclusive the distribution per forecast type.

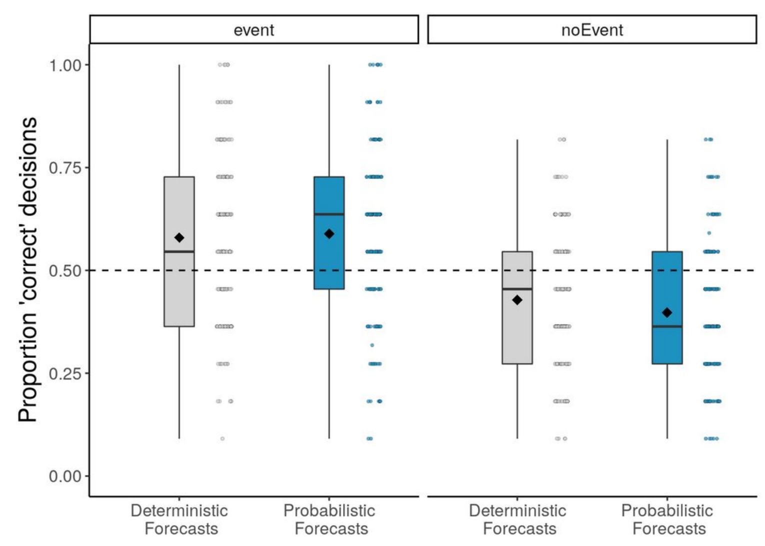


Figure 4: Proportion of correct decisions as Fig. 3, here separated for the two event categories HSSD and No-HSSD

The averages in Fig. 3 seem to show more correct decisions with the deterministic forecasts at first glance. When separating the categories for event and no-event, we see the following for the decision on high-speed shutdown (HSSD):

HSSD cases: A good bit better with probabilistic forecasts

No-HSSD cases: Worse with probabilistic forecasts and far below chance level

Can we draw conclusions ?

This outcome can be a result of better identification of HSSD with probabili-stic forecasts (to be expected) and that probabilistic forecasts lead to a higher level of risk averse decision-making due to the increased awareness of the risk. However, it can also be a reflection of the asymmetric payoffs, i.e. that reducing the loss is more important than increasing the income.

Main Results from the second experiment

- Participants are not well „calibrated" (in-/correct decision = low/high confidence)
- People get slightly more cautious/risk averse with ensemble forecasts
- Risk averse behaviour is most pronounced in "uncertain" forecasts
- Our experiments show that benefits only come from "proper" understanding

References

1. Möhrlen, C., Bessa, R. J., & Fleischhut, N.(2022). A decision-making experiment under wind power forecast uncertainty. Meteorological Applications, 29(3), e2077. https://doi.org/10.1002/met.2077 ++OPENAccess Article ++
2. Möhrlen, C., Giebel, G., Bessa, R.J. and Nadine Fleischhut (2021), How do Humans decide under Wind Power Forecast Uncertainty — an IEA Wind Task 36 Probabilistic Forecast Games and Experiments initiative, Journal of Physics: Conference Series, Vol. 2151, DOI: 10.1088/1742-6596/2151/1/012014 ++ OpenAccess Article ++

IEA Wind Task 51 Homepage: www.iea-wind.org/task51/ → Workstreams → DecisionMaking

Initiative: https://iea-wind.org/task51/task51-work-streams/ws-decision-making-under-uncertainty

Games: https://meteorology.mpib.dev/wind-power-decisions

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