PO.008

How do Humans decide under Wind Power Forecast Uncertainty?

Corinna Möhrlen[1], Ricardo J. Bessa[2], Gregor Giebel[3], Nadine Fleischhut[4]
[1]WEPROG, Denmark [2]INESC TEC, Portugal [3] DTU Wind, Denmark
[4]Max-Planck Institute for Human Development, Germany

Abstract

As penetration levels of renewable energy sources increase and climatic changes produce more and more extreme weather conditions, the uncertainty of weather and power production forecasts can no longer be ignored for grid operation. However, large parts of the industry still have difficulties adopting probabilistic forecasts into their operation.

We work with decision experiments to empirically investigate the potential benefit of probabilistic forecasts for human decision making and to enable stakeholders to understand and explore their value and use. In the first experiment, 120 participants decided whether to trade 100 % or 50 % of the energy of an offshore wind park facing the possibility of a high-speed shutdown. Decisions were based on deterministic and probabilistic forecasts and scored based on a cost function reflecting the high risk of a missed events.

Overall, the majority of the participants benefited from probabilistic forecasts , participants made more correct decisions and took less risk when this was appropriate. Almost all preferred a type of probabilistic forecast for their decisions.

The results encouraged us to develop the second experiment, as we could demonstrate that decision-making can benefit from probabilistic forecasts—and that probabilistic forecasts were also perceived as more useful.

Objectives

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

The experiments are an initiative of IEA Wind Task 36 in collaboration with the Max-Planck Institute of Human Development and part of a larger research effort at the Hans-Ertel Center for Weather Research in order to understand and support human decision making under uncertainty.

Methods

Decision Tools for Experiments:
- 3 independent deterministic forecasts showing the wind power & wind speed
- probabilistic forecast showing wind power & wind speed inclusive uncertainty bands from 75 Ensemble Member of a multi-scheme Ensemble (MSEPS).

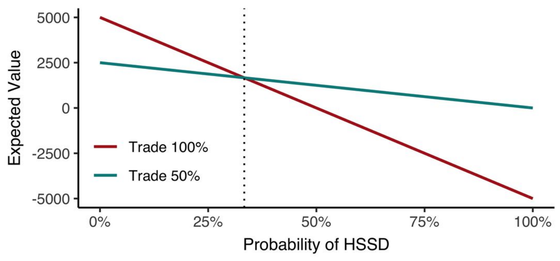
1. Experiment (2020)

Game: Decisions were to be made in 12 cases
- participants make decisions first based on deterministic and can correct their decision after being presented with probabilistic forecasts
- whether or not a high-speed cut-off takes place within the forecast time
- whether to trade 50% or 100% generating power of an offshore wind park

2. Experiment (2021)

Game: Decisions were to be made in 2 times 20 cases
- participants make decisions 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

Cost function for the experiments:

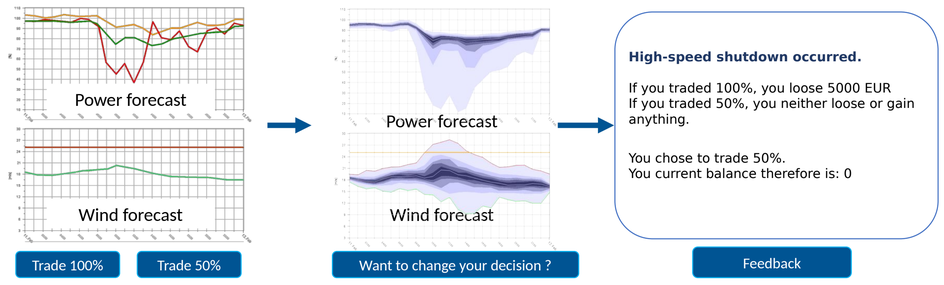


Trading	HSSD*	No HSSD*
100%	-5.000	5.000
50%	0	2.500

* High-speed Shutdown
monetary units

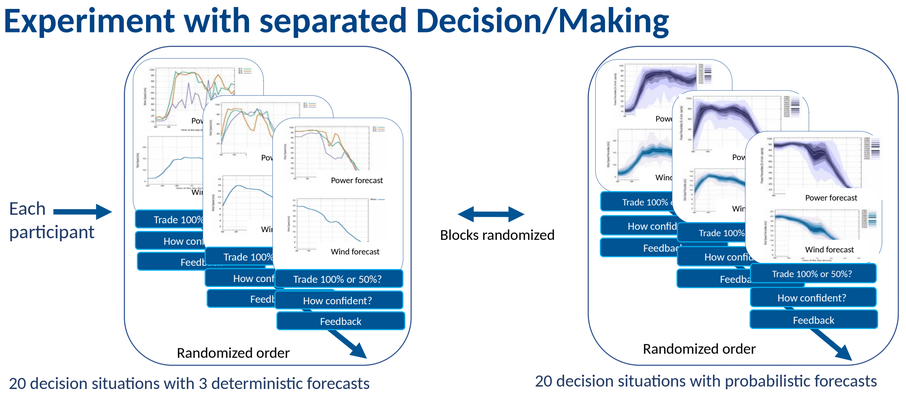
Experiment Setup

1. Experiment with sequential Decision-Making



Participants made a decision on the basis of 3 deterministic forecasts and were able to correct for the decision after seeing the probabilistic ensemble forecasts with uncertainty bands.

2. Experiment with separated Decision/Making



20 decision situations with 3 deterministic forecasts

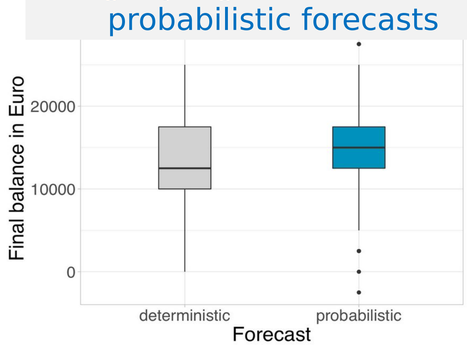
20 decision situations with probabilistic forecasts

Participants make 20 decisions first on the basis of 3 independent deterministic forecasts and thereafter 20 on the basis of probabilistic ensemble forecasts with uncertainty bands built from 75 ensemble members (MSEPS).

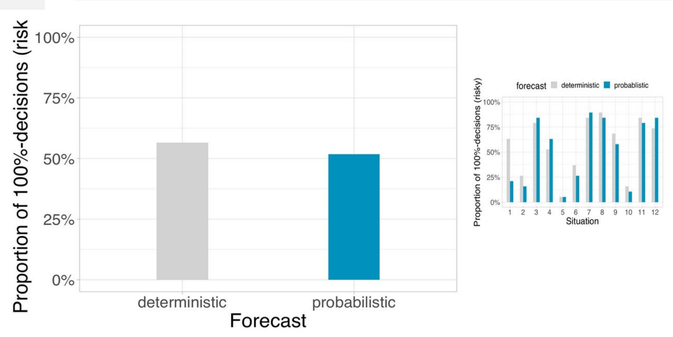
Results & first Conclusions

Summary of the main results from 1. Experiment

Slightly higher income with probabilistic forecasts



Less risky decisions were taken, when this was appropriate



Analysis of the results also showed, that:
- participants changed their mind in 16% of the cases
- 91% of participants changed their mind at least once
- **no one** wanted to make decisions with deterministic forecasts alone

Conclusions from the 1. experiment: One-SIZE DOES NOT FIT ALL

1. Tailor information: Probabilistic information can improve decisions, if the decisions that have to be made are defined precisely

2. Decision support: Define decision strategies based on probabilistic information by:
- providing cues for interpretation (e.g. highlight critical thresholds)
- putting information in perspective (e.g. comparison, typical distribution)
- allowing users to develop decision strategies based on real experience
- providing simple and robust heuristics /decision strategies for users

References

IEA Wind Task 36 Homepage: https://ieawindforecasting.dk → Publications
Initiative: https://www.ieawindforecasting.dk/work-packages/workpackage-3/probabilistic-forecast-games

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