Using Probability Bounding to Improve Decision Making for Offshore Wind Planning in Industry

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Large scale industry projects, such as those in offshore wind, hinge on adequate uncertainty quantification to mitigate risk against adverse events such as failures and poor environmental conditions. In the project planning stage, this can be particularly difficult, especially when aspects of the system are subject to severe uncertainty. In such cases, investors and developers are often dissuaded from taking risk without further analysis, as they do not have the appropriate tools to analyse severe uncertainty. However, robust methods that are developed in the imprecise probability community, such as those that use lower previsions [5], can help alleviate those risks by allowing developers to specify bounds on their probabilities. With careful quantification, this leads to a more convincing decision analysis [4], which can be helpful for developers to understand what avenues to explore, and their potential financial impacts.

In previous work [1, 2], we analysed the impact of severe uncertainty on planning and operation of offshore wind farms. Following this work, combining state-of-the-art engineering expertise with advanced statistical tools from the theory of lower previsions, we developed economic models, along with software and visualisation tools, to better support developers needing to take decisions about how to plan and design their offshore wind farms and their transmission infrastructure. The primary aim is to robustly estimate valuations of different configurations and operations of a wind farm, to help inform investors, developers, and other decision makers in the field. Such valuations typically depend on capital and operational expenditures, as well as the income from the variable energy supplied, and have a form similar to the net present value:

$$\mathrm{NPV} = \sum_{t=0}^{T-1} \frac{\mathrm{INCOME}_t - \mathrm{CAPEX}_t - \mathrm{OPEX}_t}{(1+d)^t} \tag{1}$$

where T is the lifetime, and d is a discount rate. In offshore wind, aspects of operational expenditures and energy supplied are subject to severe uncertainty, particularly in some of the failure and repair processes. Therefore, we used simulation methods for imprecise stochastic processes [3] to quantify the impact of severe uncertainty on valuations of the system.

This poster aims to show how these methods are being implemented into a commercial product, developed by Kinewell Energy, in collaboration with Durham University and the Offshore Renewable Energy Catapult. This showcases the exciting process by which theory turns into application. We hope to inspire further applications, by demonstrating the industrial value of the theoretical work that goes on in the imprecise probability community, delivering real world impact from research.

References

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