The Effect of Upscaling and Performance Degradation on Onshore Wind Turbine Decision Making

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Abstract

Ever greater rated wind turbine generators (WTGs) are reaching their end of design life in the near future. In addition, first approaches quantified the impact of long-term performance degradation of WTGs. As a consequence, this work is aimed at discussing and analysing the impact of upscaling and performance degradation on the economics of wind turbine lifetime extension. Findings reveal that the lifetime extension levelised cost of energy (LCOE) of an 18 MW wind farm comprising of 0.5 MW rated WTGs are within the order of £23.52 per MWh. Alternatively, if the same wind farm consists of fewer 2 and 3 MW WTGs, the LCOE reduces to £16.56 and £15.95 per MWh, respectively. Further, findings reveal that an annual performance degradation of 1.6% (0.2%) increases LCOE by 34-41% (3.6-4.3%).

Objectives

1. To present turbine statistics and the future size distribution of assets reaching their end of design lifetime. Apply upscaling parameters on the economics of lifetime extension decision making.

2. To review long-term performance degradation metrics and apply findings on the economics of lifetime extension decision making.

Methodology

- The applied lifetime extension framework is schematically illustrated above. In the model, Rubert et al. propose to treat the lifetime extension period as a separate investment by considering the LTI expenditure as an overnight cost consisting of visual inspection, operational and loads analysis, as well as administration. Operational expenditure is modelled as a fixed annual cost, while inter-annual variability of the wind resource is not modelled.
- Based on the achievable cost per MWh for a given scenario, an informed decision can be made on extending the life of an asset.
- Once a decision has been made to extend the lifetime, a contingency framework enables to keep a project within set economic boundaries if unforeseen repairs, retrofits or the installation of condition monitoring systems are necessary.

The input data is presented on the right, while the yield output, capacity factor, and turbine input assumptions are presented in the bottom graphs (a-e).

Results

Results for the upscaling are presented below. Overall, the cost per energy reduces substantially. The available contingency increases too.

Conclusions

- Reductions in cost of energy are achievable based on upscaling.
- Greater rated turbines may operate at lower profit margins due to higher economies of scale in power output.
- Investment based LTE is more applicable to multi-MW turbines due to greater annual revenues.
- If performance degradation is encountered over the design life, this effect is advised to be accounted for in LTE calculations.

References


Wednesday: 09:30-10:45 in Room G105

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