Will 10 MW wind turbines bring down the operation and maintenance cost of offshore wind farms?

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Abstract

In the deployment of offshore wind power, a clear trend towards larger wind turbines can be observed. Prototypes of 7 MW offshore wind turbines are currently being installed, and plans and designs for 10 MW turbines are being developed, such as the reference turbine of the NOWITECH research programme. Larger wind turbines are believed to be advantageous from an investment and installation perspective. However, it is more uncertain, whether and to which extent larger wind turbines can contribute to a reduction in operation and maintenance (O&M) cost. This analysis will investigate this question.

Objectives

Main objective: Analyse how O&M costs are likely to be affected due to the transition from 5 MW wind turbines to 10 MW wind turbines.

High uncertainty of future O&M costs is mainly due to the uncertain development of failure rates, maintenance durations and spare part costs when scaling up the rated power of wind turbines. The analysis will therefore take into consideration the effect of the uncertainty in these parameters.

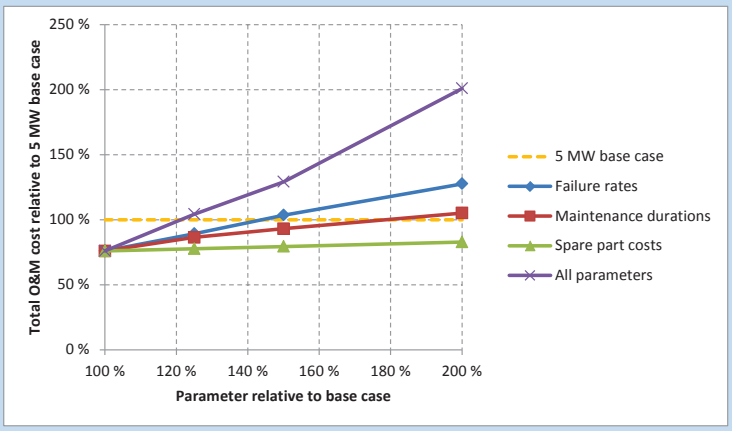
Method

A simulation study was performed using the NOWIcob model, which is a discrete-event simulation model for the operational phase of an offshore wind farm, focusing on maintenance tasks and related logistics. The study compares two hypothetical wind farms, each having a total rated production of 400 MW: One wind farm consisting of 80 x 5 MW turbines and the other wind farm consisting of 40 x 10 MW turbines. As a base case, it is assumed that one is able to achieve the same failure rates, the same durations of corrective and scheduled maintenance tasks, and the same spare part costs for 10 MW turbines as for 5 MW turbines. This has to be understood as the starting point for the analysis and not as a realistic assumption. Starting from this base case, the three parameters are sequentially increased to find the limit where the total O&M cost of the 10 MW turbine wind farm exceeds the O&M cost of the 5 MW turbine wind farm. Total O&M cost includes lost income due to downtime.

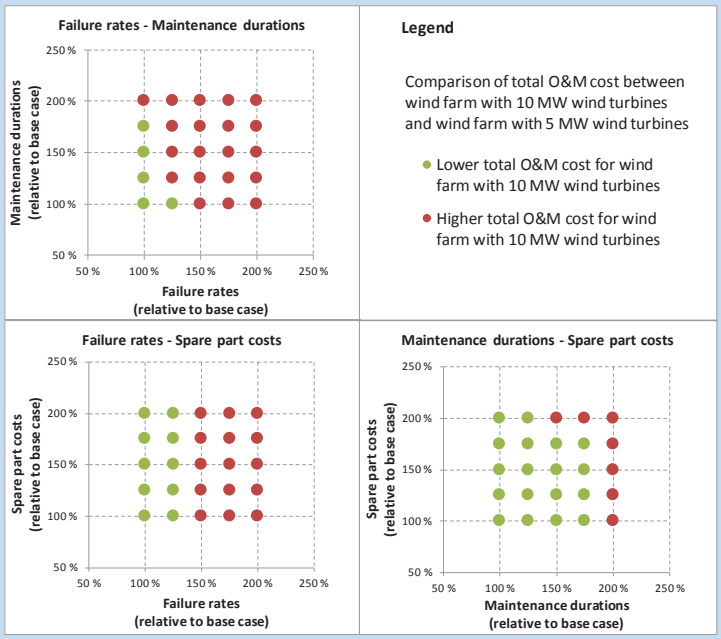
The approach assumes the same logistic setup for all cases: 3 crew transfer vessels, 1 field support vessel, 1 heavy-lift vessel and 25 technicians. This can be unrealistic for some of the cases. Therefore a careful examination of this assumption is undertaken by means of a sensitivity analysis.

Results

The simulation results show, not unsurprisingly, a decrease of ca. 24 % in the total O&M cost when replacing two 5 MW turbines by one 10 MW turbine, all other parameters being equal. However, as presented in the figure below, the O&M cost are highly dependent on how important maintenance parameters will develop.



The results show that the O&M cost is highly sensitive to an increase in failure rates or an combined increase of the maintenance parameters. The following figures give an insight into how much the maintenance parameters can increase before larger wind turbines are turning less beneficial compared to 5 MW turbines.



A parallel increase of the maintenance durations and failure rates by only 25 % already leads to an increase of the total O&M cost of a wind farm consisting of 10 MW wind turbines above the level of a similar wind farm consisting of 5 MW wind turbines. Spare part costs have only a minor effect on the total O&M cost.

The additional sensitivity analysis of the logistic setup showed that the setup is sufficient for all cases, even though it may not be the optimum. Total O&M cost for logistic strategies closer to the optimum are only up to a few percentages better. The assumption of equal logistic setup should therefore not bias the results.

Conclusions

The total O&M cost of wind farm with 10 MW wind turbines will not necessarily be lower compared with existing wind farms. Whether larger wind turbines are beneficial from an O&M perspective are first and foremost dependent on how the failure rates for such wind turbines will develop compared to 5 MW wind turbines. Also the maintenance durations have a major effect on the O&M cost. It is therefore difficult to say whether moving to 10 MW wind turbines by itself can help to reduce the O&M cost.

Based on the results of this analysis, it can be concluded that higher failure rates quite fast will counterbalance the benefits of larger wind turbines. One therefore has to focus on the reliability of the wind turbines, and further work should look more into the uncertainty around estimates for reliability of future 10 MW wind turbines.

References

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