

Modelling of Marine Operations in the Installation of Offshore Wind Farms

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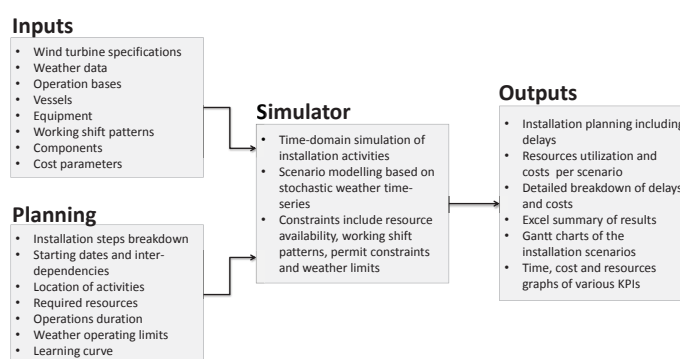
Introduction

Installation is critical to the profitability of offshore wind farms, due to the complexity of offshore works and the dependency on weather uncertainties. Thorough planning, quantification of uncertainties and minimization of project risks are required.

ECN's tool *ECN Install* models the complete installation process of an offshore wind farm in the time-domain. The benefits of the installation modelling include:

- Quantification of project delays, risks and associated costs
- Optimization of resource management and strategy selection
- Testing of innovative installation concepts and vessels
- Dissemination of knowledge between all relevant actors.

ECN Install



Objective

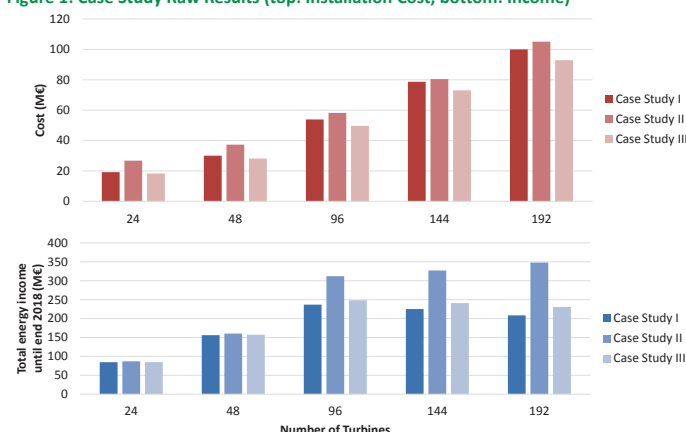
This study aims to understand the most cost-effective installation strategies in context of the trend towards ever larger wind farms and wind turbines.

The following case studies are simulated for different numbers of 8MW turbines, using weather data from the Borssele site:

- One medium-sized jack-up vessel
- Two medium-sized jack-up vessels
- One large jack-up vessel

The jack-up used in Case Studies I & II carries 3 foundations, or 4 turbines. The jack-up in Case Study III carries twice as many units.

Figure 1: Case Study Raw Results (top: Installation Cost; bottom: Income)



Results

Fig. 1 shows the raw results from the three case studies, where the medium and large jack-ups are both assumed to cost €150k/day. The total production of the wind farm and the total installation costs are next used as the basis to compare the case studies.

Fig. 2 demonstrates, from a comparison of Case Studies I and II, that when the total farm size exceeds 50 turbines, using two medium-size jack-up vessels is a preferable strategy.

Finally, Fig. 3 examines the vessel day rate which would make use of one large jack-up (Case Study III) preferable to use of one smaller jack-up (Case Study I). As the farm size increases, the ratio of vessel day rate at which the wind farm breaks even increases.

Figure 2: Comparison of Case Studies I and II (one vs. two medium jack-up vessels)

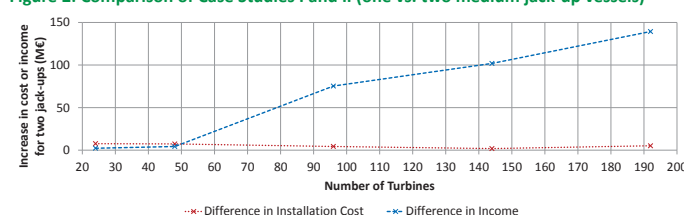
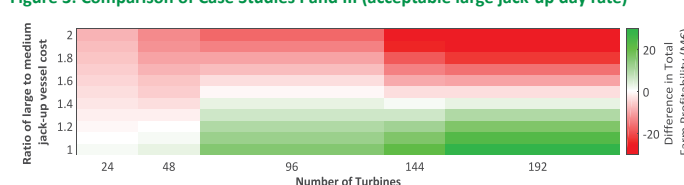


Figure 3: Comparison of Case Studies I and III (acceptable large jack-up day rate)



Conclusions

1. *ECN Install* assists wind farm developers, contractors and investors in planning and installation scheduling of their large and upcoming offshore wind farms.
2. *ECN Install* supports the vessel manufacturers to plan their capacity and operational design parameters based on wind turbine market development.

3. Parallel installation of wind turbines by multiple vessels is a cost-effective solution especially with the gain in income due to early production.
4. Use of larger jack-up vessels with more capability are profitable depending on the logistic characteristics of the wind farm to be installed.