Reference Cases for Benchmarking Operations and Maintenance Models for Offshore Wind Farms

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Motivation

As offshore wind energy is a new area for operations research, O&M cost modelling software tools are developed to support activities in this field. Lack of real data means there are limited options for verification of these models. A step towards verification and increased model credibility is code-to-code comparison where model results are compared with those from other models [1–3].

Objectives

• Develop and provide reference cases for model developers
• Run reference cases with four models and present results
• Identify and understand important modelling assumptions for estimating performance of the four O&M models and logistics strategies.

Methodology

• Define base case of inputs to compare models with
• Run models
• Define additional 15 cases (Table 1) to compare model sensitivities
• Compare average annual O&M costs and availability from models

Results

Five failure categories were defined based on categories defined in the RELIAWIND [5] project: I. manual reset, II. minor repair, III. medium repair, IV. major repair, V. major replacement. Each category (i) had a corrective maintenance strategy with annual failure rate \( \lambda_i \) and an average repair time for each category: II. \( \lambda_i \times 0.5 \), III. \( \lambda_i \times 2 \), IV. \( \lambda_i \times 5 \), V. \( \lambda_i \times 10 \).

References


Models

- NOWTob model developed by SINTEF Energy Research
- UoS model developed by University of Stavanger
- ECUME model developed by EDF R&D
- Strathclyde CDT Offshore Wind OPEX model developed by Strathclyde University

Conclusions

Different modelling assumptions led to major differences in cases where maintenance resources are highly restricted. It can be concluded that the following model assumptions may have a large effect on the simulation results, and the modeler should therefore pay high attention to these when deciding on a modelling approach:
• Approach on modelling of charter options for heavy-lift vessels
• Possibility to perform parallel maintenance tasks in a shift
• Approach of modelling failures
• Possibility to assign maintenance tasks to vessels when offshore

Table 1: Reference Cases labels and descriptions

<table>
<thead>
<tr>
<th>Case</th>
<th>Case description</th>
</tr>
</thead>
<tbody>
<tr>
<td>More CTVs</td>
<td>2 more CTVs &amp; 20 more technicians</td>
</tr>
<tr>
<td>Fewer CTVs</td>
<td>2 fewer CTVs</td>
</tr>
<tr>
<td>More technics</td>
<td>10 more technics</td>
</tr>
<tr>
<td>Fewer technics</td>
<td>10 fewer technics</td>
</tr>
<tr>
<td>Failure rates down</td>
<td>( \lambda_i \times 0.5 )</td>
</tr>
<tr>
<td>Failure rates up</td>
<td>( \lambda_i \times 2 )</td>
</tr>
<tr>
<td>No HLVs</td>
<td>( \lambda_i \times \text{max} ) = 0</td>
</tr>
<tr>
<td>No weather limits</td>
<td>Weather limits for CTVs &amp; HLVs = inf.</td>
</tr>
<tr>
<td>Historical weather data</td>
<td>No generation of synthetic weather time series. Deterministic time series used instead.</td>
</tr>
<tr>
<td>Manual resets only, Minor repairs only, Medium repairs only, Major repairs only, Major replacements only</td>
<td>( \lambda_i \times 0 )</td>
</tr>
<tr>
<td>Annual services only</td>
<td>( \lambda_i \times 0 )</td>
</tr>
</tbody>
</table>

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References