DC Collection Network Simulation for Offshore Wind Farms

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Abstract

This work provides a study about the simulation of a medium voltage DC grid in an offshore wind farm [1]. The behavior in steady-state and during fault conditions is investigated. The efficiency of the network is determined in full-load conditions. Furthermore, key design aspects of such a grid are illustrated and issues regarding ripple current and converter design are treated.

Objectives

- Steady-state simulation of an offshore wind farm with a 30 kV MVDC grid connected with a HVDC model to an AC grid
- Highlight operational characteristics of a MVDC grid
- Show the voltage/current behavior during fault conditions
- Calculate the efficiency

OFFSHORE MVDC GRID OVERVIEW

Schematic of an offshore DC grid with parallel bus design, HVDC link, grid representation and control strategies responsibilities.

Methods

- Representation of components with electrical models
- Focus on DC/DC converter structure and control
- Implementation in EMTDC PSCAD, 4 Wind Turbines

Additional Components

<table>
<thead>
<tr>
<th>Type/Model</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generator</td>
<td>Synchronous Gen.</td>
</tr>
<tr>
<td>AC/DC Low Voltage Conv.</td>
<td>Diode Bridge Rectifier</td>
</tr>
<tr>
<td>DC/HVDC High Voltage Conv.</td>
<td>Boost Converter</td>
</tr>
<tr>
<td>HVDC/AC High Voltage Conv.</td>
<td>Two-level-Full bridge IGBT D00 - PWM</td>
</tr>
<tr>
<td>MVDC Cable Model</td>
<td>PI-Equivalent</td>
</tr>
<tr>
<td>HVDC Cable Model</td>
<td>Frequency Depended</td>
</tr>
</tbody>
</table>

Conclusions

- DAB DC/DC Converter with high nominal input and output ripple allows stable operation of the offshore wind farm. Furthermore, the MVDC grid needs to be stabilized with additional controls and/or control strategies.
- Due to low inductance, very fast DC breakers (lower than 1 ms) are essential to limit short circuit currents.
- Grid efficiency is found to be 94.4%. (Calculation includes conduction and switching loss of: diode rectifier, DAB converter, MVDC cables)

References