The Potential Benefits of Direct-to-Shore MVDC Connections for Offshore Wind
Catherine Cleary, Gordon McFadzean, Stephanie Hay, Steve Dixon
TNEI Services Ltd

Abstract
Can Medium Voltage DC technology remove the need for a substation offshore? TNEI Services, in partnership with Scottish Power and Scottish Enterprise, have performed exploratory research into the prospective market for MVDC technology, via stakeholder engagement and technical case studies. This paper highlights the potential for cost reductions if a large offshore wind farm was to use direct to shore MVDC transmission at 60 kV. A cost benefit model has been prepared which considers capital and operational costs using the latest available information. The results of this modelling are supported by wider market analysis and engagement with industrial and academic stakeholders.

Objectives
The objectives of this work were as follows:
• To assess the lifecycle costs of a 1 GW offshore wind farm, using multiple connection topologies (including direct MVDC) and a variable transmission distance;
• To investigate current opinions of MVDC technology within industry and academia;
• To determine if direct MVDC transmission for offshore wind, with no offshore platform, is feasible and whether there is an industry appetite.

Methods
The cost benefit modeling approach is outlined in the figure below:

Results
Comparing Electrical System Costs for 105 km, £120 /MWh

Breakeven Distances for Direct MVDC Transmission

Capital Cost & Availability

- Capital Cost: Direct MVDC has lowest capital cost in every case. This could reduce project risk.
- HVDC: Converter unavailability is very costly, which makes MVDC looks like a better option than HVDC at longer distances.
- Lifecycle Costs: No matter what sensitivities are explored, there is always a breakeven point where MVDC looks like the best option.
- Improvements: Using redundant rings and improving DC protection would reduce availability costs. Larger circuits, or higher voltages, could reduce losses.

Conclusions

References

Stakeholders
Summary of Responses
Developers
Not much interest at the moment. Technology needs to be proven before it is considered, especially generator integration.

Converter Suppliers
Expertise is there, but won’t provide off-the-shelf products without market need. Converters & DC Protection are both critical.

Turbine Suppliers
Minimal activity, some R&D projects. Unlike to change Unless the market demand MVDC collector systems.

Academics
Opinions vary between DNOs, but some think the technology is ready. Demonstration projects could help de-risk converters.

Network Operators
Technical barriers are less severe than market barriers. Academia has focused on HV and LV but interest in MVDC is increasing.

Standards
EN 50160
IEC 61000-4-30
IEC 61400-24

It has been assumed that:
• DC systems can be protected using a single breaker with AC disconnectors
• Generator DC integration technologies are readily available