Development of dynamic submarine MV power cable design solutions for floating offshore renewable energy applications

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Floating offshore renewable energy (ORE) can potentially provide a significant share of the future energy generation mix. Floating foundations may greatly expand offshore wind deployment areas by overcoming water depth constraints. Additionally, floating wind gives access to manufacturing and deployment practices that may deliver significant cost reductions. Few full size floating wind prototypes have been installed with more deployments announced. Developers of both wave and tidal energy converters are also deploying an increasing number of floating prototypes. Most floating ORE connections to the power grid require submarine power cables capable of withstanding continuous dynamic mechanical loading regime during their lifetime.

NSW have considerable experience in the design and development of dynamic cables, mainly for oil and gas applications. While design practices are transferrable, typical floating ORE system configurations and operating modes result in distinctive power cables loading regimes and functional requirements that demand specific design solutions. This paper reviews approaches to design, modelling and testing of submarine dynamic power cables for floating ORE systems requirements. It mainly focuses on loading regime estimation in highly dynamic working conditions, mechanical design methodologies and assessment of cable strength and fatigue life.

In order to account for the variety of floating ORE devices characteristics, a loading regime envelope is defined for both extreme and cyclic loads based on the analysis of a representative selection of floating ORE technologies. Global load regimes are estimated and the related stress distribution within the cable structure is calculated using a combined approach of FEA modelling and cable structural analysis. Some examples of different cable structural arrangements are presented together with their performance assessment under the given loading conditions including the identification of critical components damage and failure modes.

Design assumptions were validated and/or calibrated through a test program that subjected a selection of cables and associated components to both extreme and cyclic loading regimes. The test program especially focused on the assessment of fatigue failure modes and fatigue life estimation methods. It included a combination of standard methods, novel test configurations and detailed component and materials analysis.

The modelling and test results informed the design of a prototype cable that was manufactured and then subjected to a further cycle of accelerated testing. The paper presents the cable performance assessment results.

The project enabled to further strengthen NSW’s capabilities in modelling, design and testing of dynamic submarine power cables, with a focus on specific solutions for floating ORE systems requirements.