E-buoys and HVPC innovation support the energy transition

With a keen focus on how best to achieve the energy transition, electric charging buoys and next generation High Voltage Power Cables (HVPC) are being explored in the MAGPIE and CABLE JIP research projects.

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Electrification of ships is one way of moving towards zero emission shipping. However, for long sailing operations the required battery packs would be too large to incorporate in the ship design. But for specific applications, electric operations are deemed feasible in combination with offshore electric charging. Electric charging buoys or E-buoys, near offshore wind farms for example, are a solution for emission-free maintenance. Furthermore, E-buoys can deliver offshore power to idling ships in waiting areas or to cruise vessels outside small ports.

Offshore loading buoys have been used for decades and are a proven solution for the (off)loading of crude oil. These buoys are mostly used in relatively benign sea states. But in the case of E-buoys being deployed at wind farms specific challenges must be overcome. Rough sea states and the integrity of the electric charging cable challenge the design. Therefore, research projects such as MAGPIE and the CABLE JIP can help to overcome these challenges.

Prototype E-buoy Within the Horizon 2020 project MAGPIE, Bluewater is developing a prototype of the E-buoy. Verification model tests have recently been performed by MARIN. In 2023, the prototypes of the E-Buoy and electric cable will be installed in Dutch coastal waters and the mechanical functionality and approach operations will be evaluated.

CABLE JIP The CABLE JIP is an ongoing research project of MARIN, TKF and Bluewater, aiming to de-risk the use of subsea inter-array power cables in offshore wind farms and to develop more robust solutions. Inter-array cables are a key component of a wind farm, bringing the energy from the turbines to the substation. Typically, a string of 5 to 10 large wind turbines of 8 MW each are interconnected and 5 to 10 of these strings come together at the central substation. The inter-array cables transfer alternating current at a voltage of 66 kV. To further transport the electric energy to shore, it is transformed to voltages up to 225 kV at the substation and transported by high voltage cables to the shore.

Preventing cable damage Where most of the cable is buried beneath the seabed to protect it against trawl fishing, anchoring and other activities, there is also often a short length which is free hanging, for instance between the lower end of the monopile and the first location where the cable dives into the trench. This free hanging part is particularly exposed to the elements, making it especially vulnerable. For floating offshore renewable solutions, the free hanging dynamic part is much longer, depending on the water depth.

Moreover, this cabling has to follow the motions of the floating installations, which makes the design much more complex. When wind turbines are placed on a floating structure they make large excursions when facing big waves, high currents or strong winds. Therefore, the cable has to be able to handle these large excursions to prevent it from being pulled away from its anchor (where the cable enters its trench in the seabed).

Offshore installation of TKF 33 kV subsea inter-array cable for the Hohe See wind farm in the German North Sea, approximately 95 kilometres North of Borkum. The offshore wind farm installation project in 2018 covers 71 turbines in an area of around 40 square kilometres with water depths up to 40 m. The wind park has a capacity of 497 MW and a total of 52 km subsea cables was installed.

Verification model tests of the E-buoy: charging of an offshore wind park Service and Operation Vessel (SOV). Use is made of a Digital Twin of the SOV and Software-In-the-Loop modelling to represent various configurations of the vessel

As evidenced by insurance claims and recent experience from offshore wind farms, there is still a lot of insight to be gained regarding subsea electrical cable technology. Repairing damaged power cables requires specialist ships and jointing experts and repairs can run into months. Detailed reading material about the CABLE JIP project can be found in the RVO summary report at www.marin.nl/jips/cable-2 or in the recent OTC conference paper Wilde,J. et al 2021 at www.marin.nl/publications.[1]

References

[1] Wilde, J. & Nat, C. & Pots, L. & Vries, L. & Liu, Q.. (2021). Cable JIP: A Research Project to Assess the Feasibility of a Semi-Static Electrical Subsea Cable for the Power Take-off from a TLP-type Floating Offshore Wind Turbine. 10.4043/31209-MS.

ir. Govert Wagenaar, Tender Manager at Bluewater:
'Due to the strong growth in the field of floating power generation and power transfer, reliability of subsea power cables is of the essence. Cable JIP II enhances our understanding of subsea cabling and provides the tools to design reliable, durable cable configurations for these applications. Likewise, the cooperation within MAGPIE is an excellent basis to develop a reliable and feasible offshore power transfer concept.'

ing. Laurens Pots, Manager Innovation & Technology at TKF:
'Worldwide demand for sustainable energy is rapidly increasing and this is also what we see at TKF for the demand of subsea electrical cables for the offshore wind sector. As an industry we are still in a learning curve, and we need to bring innovative and reliable solutions. Preventing downtime and reducing (failure) costs is one of the key items within this fast-changing segment. Cables play a fundamental role in the power distribution of offshore wind parks. We already know that a substantial percentage of defects and claims is related to cable installation.'