Offshore wind: cable routing considerations and constraints for developers

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The following article is based on a forthcoming White Paper on the subject of cable routing.

The planned development of wind farms off the east coast of the United States brings into sharp focus some of the key considerations and constraints associated with their installation, and the maintenance of offshore and inter-array cables.

Although I'm discussing the US, the principles will be the same wherever a wind farm array is planned and are therefore applicable to the industry as a whole. This short article aims to give potential developers an outline framework for consideration early in the planning process of the engineering of cable routes of a newly proposed offshore wind farm installation.

The main focus on the routing of the cables must be the facilitation of safe access to the site during its construction, and later maintenance operations throughout the windfarm's operational life.

The considerations that need to be made for offshore wind farm cables are pretty much the same as for other linear seabed infrastructure. These can be examined in detailed Desktop Studies, and will generally include the following: geohazards, including geological faults, slope instability, mobile bed-forms, pock marks, and the type and consistency of the seabed; anthropogenic factors, including the activities of other marine stakeholders/users, such as fishing, maritime traffic, and risks from anchors, military activities, aggregate extraction, recreational activities, other cables and pipelines, and existing offshore energy projects; environmental factors of marine protected areas and their associated restrictions; archaeological marine protected sites and unexploded ordinance and the avoidance and/or removal of munitions found near cable routes.

Cable position considerations

The minimum separation between export cables is really dictated by the ability to repair the cable, post installation. It's normal to select a route that allows for the cable to be repaired at all points of its length, without compromising neighbouring cables. In practical terms, this means the ability to lay out the repaired section of cable onto the seabed, without it crossing adjacent cables and to allow for its reburial, if needed.

In most cases, the repair will require two joints. After the second of these joints to the export cable has been made, a repair bight, sometimes called an omega, would normally be laid on the seabed. This would be deployed by the installation vessel to one side of the original cable route, and naturally the prevailing weather conditions and the local seabed must also be considered.

There are four dimensions that make up the repair bight length. These are water depth; the freeboard distance from the water surface to the cable chute; the deck length from the cable chute to the jointing space; and crown of the cable bight.

If the floated section of a shore end pull is beyond practical distances to be managed due to shoal waters, it is possible to use a shallow-draft barge, many of which have multi-point anchor systems for holding position, to achieve a practical distance. When such a solution is used, it's important to consider where anchors can be placed, especially where multiple export cable routes are being designed in close proximity.

The adoption of an anchor vessel solution is one of several factors that will inform the width of the survey corridor. Other considerations include the number of export cables and the maximum water depths at the wind farm site. Additionally, differing amounts of space across the corridor may be needed, due to the variance in HVDC and HVAC cable configurations.

Planning ahead of time and taking into account all possible scenarios will assist in determining the initial survey corridor width.

It's also worth noting that bedforms and other obstructions may require micro-rerouting of cable routes.

Proximity guidelines

There are proximity guidelines and setback calculations published in the UK by Red Penguin Associates, on behalf of The Crown Estate. The main goal of its *'Submarine Cables and Offshore Energy Installations – Proximity Study Report'* is to facilitate risk-assessed access for cable repairs. These take into account the technical performance of the vessel involved, as well as its dynamic positioning.

The proximity limit for other factors is determined by the capability of the vessel conducting the repair operation. In the case of a power cable repair in the vicinity of a wind farm structure, it's likely that the vessel will have a minimum DP2 Class positioning system. As well as the vessel's DP class, there are two other scenarios which can affect the proximity of the wind farm structure, these are whether the vessel conducting the repair is in the lee of, or on the weather side of the wind farm array. Details of IMO DP Classification are available from https://www.konsberg.com/maritime/support/themes/imo-dp-classification/.

The minimum approach distance between the repair vessel and the WTG structure in order to deploy a repair bight is based on a factor of five dimensions. These are: depth of water; length of the vessel; the distance from the water surface to the cable chute; the deck length from the cable chute to the jointing space; and lastly the distance of minimum approach.

In the telecoms cable industry, cable repair agreements are typically contracted to use DP1 Class vessels which can place limitations on working inside an array, and where possible repairs are normally conducted on the lee side of the wind farm structure.

Crossings and crossing design

Large offshore wind farm developments have the potential for a high concentration of crossings by multiple export and/or inter-array cables over existing cables on the seabed. As a result, the space available for cable repair vessels to operate is restricted and may hinder recovery/replacement and repair operations at the crossing area.

So that future maintenance and recovery operations are as safe and practical as possible, ESCA's 2016 document, 'Guideline No.6' recommends that crossings less than 500m apart are considered a single entity, thus 'sterilising' the area of seabed over the existing crossed cable. Should the crossed cable require repair in the future, it would be cut either side of the multiple crossings and the new repair section laid over the top across potentially multiple array or export cables.

There is a route engineering approach which can improve the amount of sterilised seabed, improve access to the crossed cable and reduce the amount of repair cable used if a repair should be required in the future. By planning array cable routes so that they use mutual crossing points the number of crossing locations is reduced and the spacings between the cable crossings are increased. The use of mutualised cable crossings can be a very effective strategy when the array site is located over the top of existing in-service cables.

Offshore wind, especially given the present state of uncertainty around the affordability of oil and gas and the instability of their prices, has a great future. Its future key position in the renewable energy mix, makes it even more essential that fixed or floating wind farms are planned with ease of maintenance and repair in mind from the start, to help the world towards greater energy security and a zero-carbon future.

The full whitepaper, from which these abstracts have been taken, will be published later this year by Ocean IQ.

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