Risk based approach to the engineering of offshore cable routes

Daniel **LIEFFERINK,** TenneT, (Netherlands); Wino **SNIP**, TenneT, (Netherlands); Frank **DE VRIES;** TenneT, (Netherlands);
Daniel.liefferink@tennet.eu, Wino.snip@tennet.eu , Frank.deVries@tennet.eu.

ABSTRACT

TenneT has developed a technical offshore calbe route design process based on probabilistic engineering. The probabilistic engineering model include vessel traffic information and the probability on cable damage due to external hazards of sinking ships, dropped and dragged anchors, lost cargo and dragged fishing gear. The resulting routes make efficient use of limited space available offshore, have acceptable residual risk on external failures against minimised lifecycle costs to society.

KEYWORDS

Offshore cable route engineering; probibalistic design; modelling external cable damages, acceptable probability of failure; cable corridor; cable spacing.

introduction

TenneT as TSO has developed a technical policy, based on probabilistic cable route engineering, which aims to make efficient use of the limited space available offshore, with an acceptable residual risk on external failures to the cables, against minimised lifecycle costs to society.

In the Netherlands, TenneT is appointed as offshore grid developer and is therefore responsible for the timely and cost-effective connections of all the offshore wind farms to the grid onshore (Figure 1). As the Dutch North Sea is full of shipping lanes, windfarms, buffer zones between the two, anchorages, separation areas, sand borrow areas, military exercise areas, nature reserves, subsea assets with exclusion zones and as parts of the seafloor are shallow and highly dynamic, finding suitable routes for export cables is an engineering challenge.

Soil cover is to protect the cables against external threats. More distance between parallel adjacent cables minimises the probability on failure due to a common cause. Routing cables through areas with low traffic density lowers the risk on cable damage due to shipping related external threats. These factors are taking into account in the process of designing a cable route.

Route engineering is started by TenneT in an early development phase of a project, in consultation with the government and permitting authorities. It is often a trade-off between the interests of the parties involved. TenneT is challenged to minimise the spatial footprint by bringing multiple parallel export cable circuits closer together. TenneT's interest is to design the cable route such that a high security of supply is reached at minimal risk and at minimal life cycle costs to society, with costs in terms of financial costs, impact on the environment and disturbance of activities of others at sea. Also, the grid connection needs to be maintainable and the possibility for a safe installation and operation is a high priority.

The impact of the 2 GW concept on security of supply

TenneT has developed the 2 GW standardised offshore wind connection system, to be able to connect the challenging amount of ~48 GW of offshore wind power until 2040. Figure 2 shows a schematic overview of the grid connection system divided into 3 standardised lots: 1) Offshore platform, HVDC system and automation system, 2) Export cable system, 3) Land station.

The 525 kV HVDC bi-pole 2 GW cable system consists of a bundle of four cables. The 525 kV plus pole, the 525 kV minus pole, the dedicated metallic return cable and the separate fibre optic cable for communication with the control systems offshore. The four cables will be buried together into one trench in the seabed to be protected against external threats.

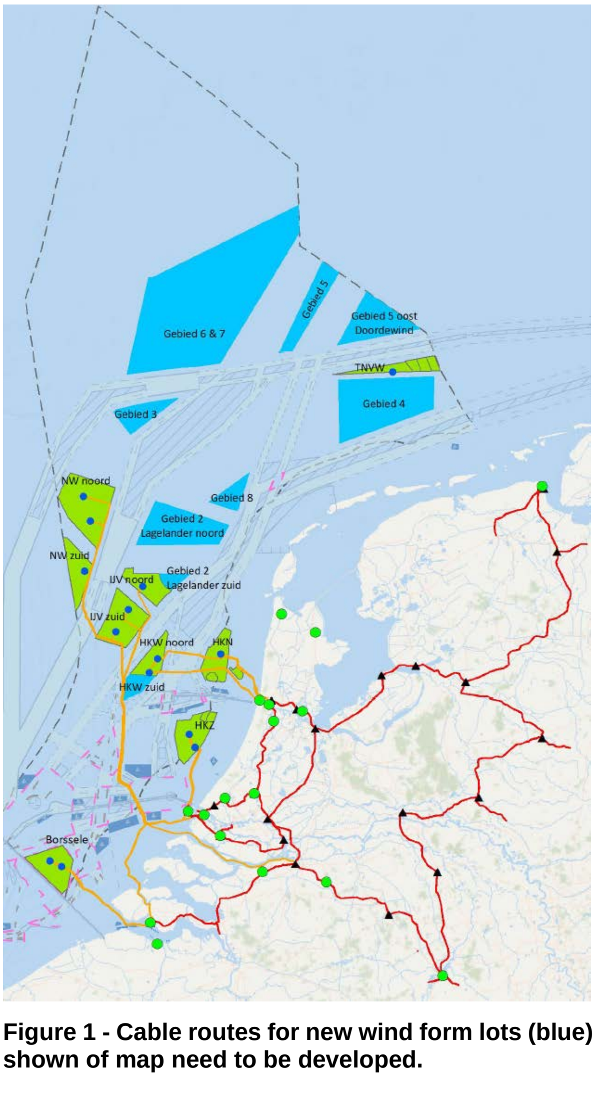

Figure 1 - Cable routes for new wind form lots (blue) shown of map need to be developed.