Joint Industrial Project on subsea Cable Lifetime Monitoring (JIP CALM)

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ABSTRACT

The joint industry project was initiated by the author's companies in collaboration with industry partners to reduce subsea power cable failures. The project consisted of four main tasks. For the first task, 135 failures were analysed and highlighted the immediate risks and their prevention. The second task is to develop and test a Fibre-Optic (FO) based sensing technology that continuously monitors the mechanical loading of submarine cables. The third task focusses on the assessment of seabed and its importance for submarine cables. The fourth task detailed a model of the cable installation process and validated it with real wind farm cases.

KEYWORDS

Cable failure cause, cable lifetime monitoring, fibre optic, distributed sensing, bending, interrogator, seabed mobility, landfall, cable route optimization, cable burial detection, LCOE.

INTRODUCTION

Given the increasing dependency of society on renewable energy sources, it is important both from a societal and financial point of view to increase the reliability of supply of renewable energy offshore by reducing the number of power cable failures and lower the costs of both existing and new offshore wind farms. As a main bottleneck regarding reliability of offshore wind farms lies in power cable failures, these power cables must become more reliable. Exactly this is the overall high-level goal of the Joint-Industry-Project CAble Lifetime Monitoring (JIP CALM).

JIP CALM, a research project with 31 industry parties, was initiated in July 2019 with the objective to make offshore wind energy more reliable and to help reducing costs due to cable failure. The research looked at aspects related to subsea power cables, which play a crucial role at getting offshore wind energy to our homes. This paper explains the work that was performed in the JIP CALM project in the period of 2.5 years; from July 2019 till November 2022. This report summarizes all activities that were executed in the framework of JIP CALM. The paper discusses the cable failure root causes, cable lifetime monitoring, development of a test for stick-slip, burial depth detection using distributed acoustic sensing, cable-seabed interaction, temperature model for burial depth and logistics and cost impact assessments. Finally, a summary of the conclusions from the project is presented.

CABLE FAILURE CAUSE

Failure data sets and statistics

A total of 135 unique and different submarine power cable system failures were analysed by experts, comprising of 114 failures in the cable sections (85% of the entire dataset - 45% with AC-XLPE insulation, 4% with DC-XLPE insulation, 2% with EPR insulation, 1% of SCFF, 6% of MIND, and 42% could not be associated with insulation type), 10 joint failures (7% of the entire dataset) and 11 termination failures (8% of the entire dataset), see Figure 1.

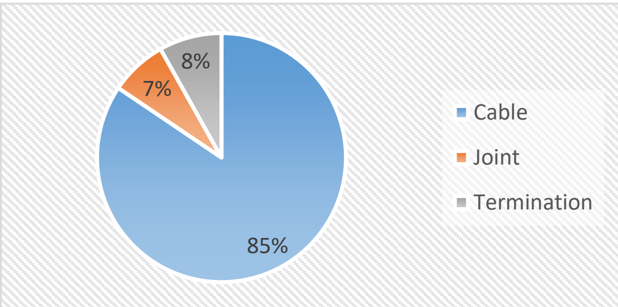

Figure 1: Classification of the received dataset in percentage of the cable system component type.

It is worth noticing that the percentages show failures related to the whole dataset, not the percentage of failures related to the subpopulation of one specific insulation material. Hence, it cannot be concluded that XLPE tends to fail more often than other materials. The dataset comprised failures in cable systems of MV(AC) class (1.2 kV≤Um≤36 kV- 31% of the cable dataset), HV(AC) class (36 kV<Um≤170 kV - 25% of the cable dataset), EHV(AC) class (170 kV<Um - 6% of the cable dataset) as well as HVDC (12% of the cable dataset) cable systems. In addition, 26% of the failures could not be related to a voltage range, see Figure 2.

The termination failures are all from the MV(AC) class, and for the joint failure records, 70%, 20% and 10% belong to the MV(AC), HV(AC) and EHV(AC) classes, respectively. As most of the JIP CALM project partners originate from Europe and operate in Europe, multiple failure records