# An Experimental and Modelling Approach for Assessing Dynamic Cable Capability to Withstand Operational Constraints

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## ABSTRACT

*The norms for designing and testing dynamic cables for floating offshore renewable energies devices are still prospective. These cables need to resist to high levels of coupling between mechanical and thermo-electrical loads, which is very specific. This paper proposes a methodology for assessing the importance of this coupling in the degradation mechanisms of dynamic cables. This methodology will be set up via more than 18 months of fatigue tests on a dynamic cable specifically designed for a floating wind turbine. The results of these tests will give input on the legitimacy of actual norms and numerical models for mechanical behaviour.*

## KEYWORDS

*Experimental campaign ; Umbilical ageing; FOWT ; Fatigue life*

## INTRODUCTION

FORE (Floating Offshore Renewable Energy) devices need dynamic umbilical cables for taking the produced power to the static export cable, linking the offshore energy farm to the on-land network. An example of dynamic cable configuration adapted to a floating wind turbine appears on Figure 1. The typical behaviour of that sort of cable is close to the behaviour of underwater dynamic umbilical and risers used in deep water Oil & Gas industry, but they also have similarities with static cables. The latter are of higher voltage than what is usually used in O&G. The degradation process of these static cables is mainly driven by thermo-electrical constraints. In comparison, O&G umbilicals are mainly subject to strong and constant dynamic hydro-mechanical loads, as they are designed for small power at low voltage. Their degradation process is mainly driven by mechanical constraints. FORE dynamic cables gathers the worst constraints of both these domains. Indeed, they are expected to be of mean power (30MW) and mean voltage (20kV to 66kV today ) imposing a large cross-section, and they need to resist to strong dynamic mechanical loads. Both degradation processes (thermo-electrical and hydro-mechanical) being present at the same time and possibly coupled, it is not possible to accurately predict the dominant degradation mode and to use existing methodology for design and tests.

In this paper, a consortium consisting of industrial and academic partners outlines a methodology, developed within a project called OMDYN2. The main goal is to estimate the importance of this coupling in the calculation of cable lifetime. The proposed methodology is based on an experimental campaign that is defined to evaluate the level of coupling and to assess the difference in lifetime, with or without taking into account the coupled constraints. In parallel to that experimental approach, a numerical approach, using global configuration and cross section models, is developed for a better prediction of fatigue life.

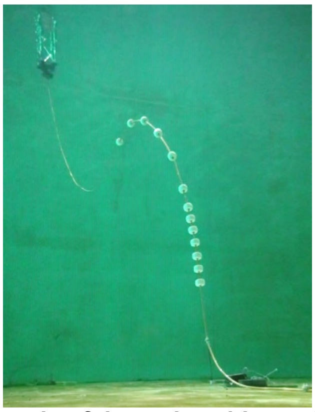

**Figure 1: Example of dynamic cable configuration, as tested during OMDYN1 at Centrale Nantes basin test facilities**

## CONTEXT

### Floating offshore renewable energies cable applications

The most obvious specificity of dynamic umbilical cables for FORE applications is that they operate in an environment with strong dynamics and with mechanical, electrical and thermal loadings that vary a lot from one period to another. Indeed, power production, from which electrical and thermal constraints are derived, is directly related to the wind speed. Similarly, the sea state can generate movements of the floater, potentially inducing high bending and traction cycles and hence mechanical stresses inside the cable. Moreover, movements of the cable generate additional mechanical constraints due to drag force in water, especially if the cable is covered with biofouling. It shall be noted that the worst wave-induced movements are not necessarily induced by the worst sea states.

Besides, as dynamic cables are directly exposed to sea water and mechanical cycles, the risk of water treeing is high. This is a huge concern, especially for high voltage cables (above 66 kV). Another risk to be taken into account is the development of biofouling on the cable, which generates mechanical and thermal constraints.