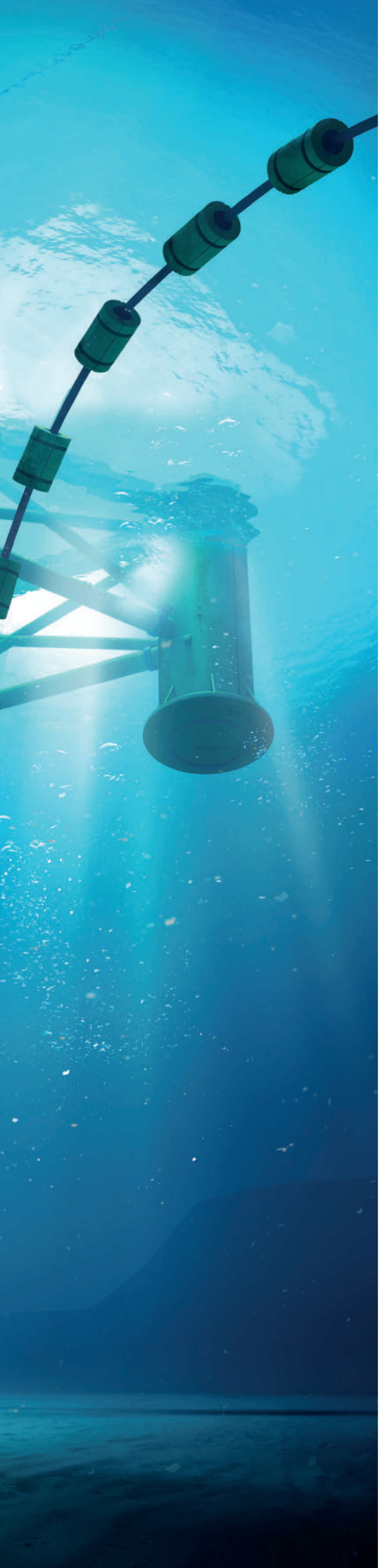
Digital solutions for offshore windfarm cable protection and life extension

Words: Richard Beesley, Innovation and Business Development Director, Trelleborg Applied Technologies



With the increasing trend toward cleaner energy sources, offshore wind technology plays a vital role in supporting the global transition to renewable energy. Development of shallow water locations is increasing in volume and pace, with the industry moving toward the more substantive wind energy resources that are found offshore in deeper waters, through the application and development of floating offshore platform technologies.

By 2025, it is anticipated that close to 20,000 turbines with 250 plus offshore substations will have been installed offshore. Even with the development of larger turbines, these quantities are expected to increase by a factor of three plus by 2050*.

Critical to their successful operation are the subsea power cables that have the essential function of transmitting generated power from the turbines to the substations (electric hub of the windfarm), and then onward to shore.

Digitization in renewable energy

Digital technology development continues at a rapid pace, increasing in functionality and accessibility, while supporting gains in productivity, efficiency, visibility, and informed decision making. With growing competition in renewable energy markets and ever more remote and demanding deep-water conditions, the renewables industry is looking at advanced digital solutions to enable new efficiencies and maximize return on investment.

The continued reliable performance of subsea power cables is essential to avoid costly repairs, replacement, and lengthy downtime. Digital solutions that provide insight through continuous monitoring can address existing design validation and performance assurance challenges, presenting new opportunities for the integrity management of these critical offshore power cables and the realization of new operating efficiencies.

Key factors impacting integrity management of offshore power cables

The key factors driving the design and longevity of an offshore power cable can vary depending on the environmental conditions, with the performance demands increasing as the industry identifies field locations that are further from shore and in deeper water locations. If the key factors impacting the integrity of these cables can be monitored, it provides owners and operators with extremely valuable insight, enabling knowledge-based decision-making on aspects such as: reliability and safety, operational parameters, risk mitigation, life extension and inspection frequency; all with the end goal to reduce CAPEX and OPEX.

Integrity monitoring through the use of fiber optic cables along the power line, is an established methodology and provides the capability to monitor temperature, strain and vibration in order to identify potential vulnerable locations and areas of potential failure such as 3rd party intrusion, dropped object impact damage, electrical arcing and cable exposure.

However, in critical locations where the cable is directly exposed to harsh dynamic sea conditions, either by design or unexpectedly, a greater depth of accuracy in monitoring of motion and strain can often be necessary. To provide this localized monitoring, dedicated motion sensors can be located on the cable to continuously collect data that can be used to quantify the extreme and fatigue conditions the cable is experiencing.

Whilst continuous monitoring of these key factors can provide the necessary insight to support informed decision making in relation to integrity management, it has not yet become common place in the offshore wind industry. Historical negative experiences of users include difficulty attaching and deploying the necessary hardware, limited battery life, data inaccuracy and the overall cost of monitoring hardware, have hindered its wider adoption.

A new approach to offshore power cable monitoring

Recognizing the value that monitoring provides, Trelleborg's applied technologies operation is applying their in-depth knowledge and experience of cable protection in harsh dynamic conditions. It is

Figure 1: Trelleborg's dynamic Njord BS (Bend Stiffener) powered by Mimir Digital Intelligence

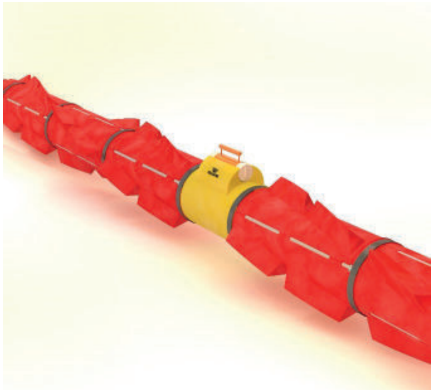


Figure 2: Trelleborg's Tri-Strakes® powered by Mimir Digital Intelligence

Figure 3: Trelleborg's Mimir MC (Motion Clamp)

tackling the challenges holding back the wider accessibility and adoption of monitoring offshore power cables, by simplifying the ROV or diver installation process, and increasing technology reliability and endurance.

The operation is offering a new approach to offshore cable monitoring, by developing digital monitoring technology. This can be either integrated into nearby ancillary protection products such as bend control or cable protection systems, or attached retrospectively via a standalone clamp system, removing the need for specialist support. By engineering reliable, cost-effective sensing technologies, which are easily accessible, deployable and recoverable, this new technology provides operators with reliable data that is easily validated and processed.

Aligned to Trelleborg's existing wind energy protection portfolio, the initial monitoring solutions released are designed to capture data on two key factors that commonly cause damage and fatigue of cables exposed to dynamic sea conditions: motion and bending strain. Applications where sections of offshore power cables can be particularly susceptible to these factors include:

- Points where the cable connects to fixed and floating foundations
- On free spans (by design or unexpectedly) due to seabed scour or geological features
- At seabed touch-down zones of dynamic cable riser sections connecting to floating foundations
- Close to clamping locations where a cable experiences a change in stiffness.

The key features of Trelleborg's Mimir Digital Intelligence monitoring devices include:

1. Subsea Electronic Module (SEM) with advanced sensor technology

Modularly reconfigurable circuit board array with over 20 advanced sensors capable of monitoring all cable motions and strains, incorporating a wide range of use applications.

2. Independent, extended life

Designed as long-lasting, battery powered monitoring units, capable of continuous monitoring beyond five years due to the built-in selection of low power electronics and cutting-edge industrial microelectromechanical systems (MEMS) sensors.

3. Simplistic installation: integrated or stand-alone

The SEM can be simply integrated into Trelleborg's other ancillary products such as a dynamic Njord BS (Bend Stiffener) (Figure 1), Tri-Strakes® (Figure 2) or provided as a standalone, retrofitted clamp solution (Figure 3). In these cases, the SEMs can be inserted and deployed with the power cable or later inserted or attached via ROV, simply affixed to the pipeline by an intermeshing or

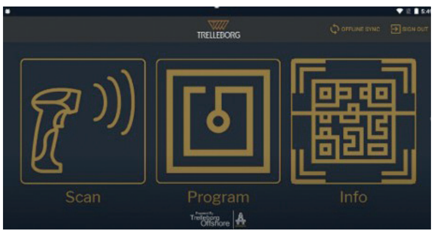


Figure 4: Trelleborg's Mimir Digital Technician App

parallel acting manipulator jaw, in a single 'locate-and-rotate' actuation.

4. Attachment assurance

Reliable attachment is vital to ensure the SEM attachment arrangement stays locked in position regardless of subsea environmental conditions, for the data recording to maintain a firm datum. Existing clamping knowledge has been applied to the new devices including the consideration of variable parameters such as expansion, contractions, creep of coatings, temperature range, loadings and motions in the design.

5. Hot swapping SEM

The SEM is designed for simple hot swapping by a diver or ROV with parallel jaw manipulators. Based on its small size, it is possible for the diver or ROV to collect and replace several sensor modules in a single deployment.

6. Workflow based app

All clamp communication and operational documentation, including visual installation documents, material information, design assurance and factory acceptance testing are provided digitally to the operator directly via the Mimir Digital Technician App (Figure 4) in a ruggedized tablet for ease of installation. This removes the requirement for an onsite specialist technician to be present.

7. SEM pressure vessel

The pressure vessel protecting the electronics hardware is engineered with safety and longevity in mind. The design allows repeated reuse to enable future swap-out of batteries and upgrade of the modular electronic boards.

> 'The increased knowledge that can be generated from sensor technology can allow fine-tuning of systems and processes, better quantifying and informing operators.'

Richard Beesley

Further developments

Since the initial concept, Trelleborg's applied technologies operation has further developed the performance and functionality of its Mimir Digital Intelligence monitoring devices to include hot swapping data logs (small, easy to retrieve data modules that can be retrieved and replaced without interruption to the sensors) and simple subsea optical communication, allowing any diver or ROV an opportunity to check and understand the monitoring device's status whilst subsea, and recognize if intervention is needed. For example, the device will signal if it has experienced a significant event, the battery power is low, or memory is close to full.

Summary

By increasing the accessibility, reliability and cost-effectiveness of offshore cable monitoring, such systems can become more widely adopted within the renewable energy industry at critical dynamic locations, both as additions to new cable installations or retrofitted onto existing cables, providing operators with insights and intelligent data.

The increased knowledge that can be generated from sensor technology can allow fine-tuning of systems and processes, better quantifying and informing operators. Furthermore, their deployment can reduce the risk of costly cable failures and power disruption. The data gathered provides key performance insight and modelling capabilities to support subsea asset integrity management, realizing value through design and operational efficiencies and increasing return on investment by enabling field life extension.

* Rystad and IRENA

www.trelleborg.com/applied-technologies

About Richard Beesley

As the Innovation and Business Development Director at Trelleborg's applied technologies operation in Skelmersdale, England, Richard is responsible for the development and improvement of product technologies and solutions for subsea pipeline and cable protection applications, alongside developing new market applications.

After graduating from Loughborough University, Richard joined Trelleborg initially in a design and engineering capacity. Richard has worked within the Trelleborg group for over 20 years, holding senior posts in England, US, Asia Pacific and Brazil, and is the inventor on patent for Trelleborg's Diverless Bend Stiffener Connectors.

Richard is married with two teenage daughters, and when not at work can be found out running with his local club in Liverpool. Richard is currently training for the 2020/21 London Marathon.