

**Access.
Connect.
Grow.**

**Tackling reliability and
performance of subsea cable
systems**

Whitepaper

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Overview – The Need and The Opportunity

Subsea cable systems are critical elements of offshore wind infrastructure, essential to transmitting electricity from offshore windfarms to the grid.

Globally, over \$800 billion of investment in offshore windfarms is anticipated by 2030 and, for the world to hit net-zero emissions by 2050, the generating capacity from offshore wind must increase by a staggering 1,120 GW. Closer to home, the UK government has set ambitious targets of 50GW of installed capacity by 2030.

This scale of expansion, in both fixed and floating offshore wind, can only be achieved by installing and maintaining hundreds of thousands of kilometres of reliable subsea cables.

The performance and reliability of these cables is therefore crucial to delivering the UK's clean offshore power ambition and global net zero targets.

However, these cables are highly susceptible to damage during installation and operation leading to substantial insurance claims and costly downtime.

Cable reliability not only makes offshore wind projects more economically viable but also ensures the energy supply is uninterrupted. It is therefore paramount not only to developers, investors and the industry, but also to the whole country which will increasingly rely on the power that passes through them.

With a world-leading installed base of offshore wind capacity and a strong project pipeline, combined with a stable policy framework, there is a significant opportunity for the UK's underwater supply chain to lead the way in subsea cable systems.

In 2024, the Offshore Wind Industrial Growth Plan identified future electrical systems and cables, and the next generation of offshore installation, operation and maintenance, as two of five areas in which the UK should be a world-leader. These areas were chosen because of the size and growth of the domestic and international markets, existing UK capabilities, and the country's track-record of developing solutions to complex technical challenges. That includes the deployment of the world's largest fixed offshore wind farms, coupled with the expertise honed in the oil and gas industry over the last five decades.

But, there are major hurdles to be overcome varying from supply chain constraints and cost escalation to cable reliability.

Global Underwater Hub (GUH), the trade and development body which represents the UK's £9.2 billion underwater industry, has identified cable performance and reliability as a major issue which needs to be solved, especially as floating offshore wind, which requires even more complex dynamic cables, becomes an increasing percentage of the overall installed base.

Unlike fixed offshore wind, floating offshore wind has few standards and no established supply chain. Starting with this "clean slate" and leveraging the vast experience honed in offshore oil and gas, the UK has an opportunity to create a new generation of products and services to meet a £270bn domestic market and a £1 trillion export market.

This White Paper sets out the challenges and presents a solution for how the UK can tackle cable performance and reliability and, through first-mover advantage, become a centre of excellence for subsea cable systems in floating offshore wind.

Insight

In May 2023, Global Underwater Hub (GUH) held the first Subsea Cable Insurance Conference & Workshop in London. The one-day event brought together representatives from across the supply chain with the cable insurance community to focus on the critical area of the reliability of subsea cable systems.

Five key areas across the lifecycle of a cable system formed the basis of discussion. These were:

1. Design
2. Manufacturing
3. Handling & installation
4. Operations & maintenance
5. Insurance risk

The workshop highlighted that industry faces significant challenges related to subsea power cable systems.

There were several common findings from the workshop sessions:

- Adoption of **systems-based design** methodology: especially critical as the industry moves into floating offshore wind.
- **Standards development**: it is key that standards are clear and tackle the system as a whole, integrating across the supply chain and the whole cable lifecycle
- **Data sharing**: enabling access to data is critical to driving long-term improvements - without this feedback may be unfocused.
- **Quality control**: resources need to be focused on critical-to-quality parameters to drive control and improvement.
- **Risk allocation**: there are challenges in the disproportionate allocation of risk between stakeholders, with the need to incentivise failure prediction to reduce insurance claims.
- **Industry collaboration**: there is a need to increase collaboration across the entire cable system supply chain to present solutions to the common problems.
- **Collaboration with the innovation and manufacturing eco-system**: this includes, but is not limited to, universities, Catapult centres (High Value Manufacturing, Offshore Wind and Energy Systems Catapults) and RenewableUK, the trade association that advocates for the UK renewable energy industry.
- **Engagement with Governments**: to help them deliver the *UK Clean Power 2030 Action Plan* and (forthcoming) *Industrial Strategy White Paper* (priorities include advanced manufacturing and clean energy industries), and The Scottish Government's *Green Industrial Strategy*; this includes issues such as innovation, skills, standards, procurement and a host of infrastructure and supply chain capacity challenges.

The output of this first workshop serves as a key insight for Global Underwater Hub and the subsea cable industry when considering how to drive improvements as a united supply chain. It is a necessity that the supply chain is central to developing solutions to these systemic challenges.

The Challenges

As part of the critical infrastructure of offshore wind farms, subsea power cable systems have been shown to be affected by damage, operational stress and variations in the environmental conditions. As a result, insurance claims have increased significantly in recent years, with available data pointing to 80% of failures related to the cable system and repairs ranging from £10-40m, and with the addition of downtime of at least 40-60 days, this can increase costs dramatically.

Such a high level of claims, related to several causes from installation damage and operational stress to poor termination and failures in the cables themselves, makes it critical that we consider the entire system when addressing cable related failures.

The risk allocation between the stakeholders often means that failures rarely represent a chance for the industry to improve, with root cause analysis taking excessive time, often without all the data, especially operational, being made available. This leads to disputes and inconclusive outcomes which fail to drive improvements in future reliability as they are unavailable or unable to be incorporated into guidance, testing requirements or standards.

The industry also sees a resistance to the adoption of failure prediction and intervention as this knowledge of a developing fault could compromise future insurance claims. There are several drivers for change:

Reliability

Subsea power cable systems play a critical role in offshore wind and their reliability is therefore crucial to delivering the energy transition and realising net zero targets.

Ensuring continuous power supply: Any failure in these cables can lead to significant disruptions in power supply and energy security. Reliable subsea cable systems ensure that the electricity generated offshore is consistently delivered to the power grid.

Minimising downtime and maintenance costs: Failures in subsea power cables can result in prolonged downtime and high repair costs. Repairing subsea cables is a complex and expensive process requiring specialist vessels and equipment. Improving their reliability not only makes offshore wind projects more economically viable, but also ensures that the energy supply remains uninterrupted, which is critical for achieving net zero targets and energy security.

Enhancing economic viability: The economic viability of offshore wind projects is closely linked to the reliability of subsea power cables. High failure rates and associated repair costs can deter investment in offshore wind projects. Reliable cable systems, on the other hand, can attract more investment by reducing the financial risks associated with these projects. This increased investment is essential for scaling up offshore wind capacity to meet net zero ambitions.

As floating offshore wind develops as a percentage of the overall installed base, the reliability challenges experienced by the subsea cable system will only increase as the number, complexity and type of components expands.

Insurability

The combination of high failure rates, costly repairs, and the increasing risk perception among insurers is making the insurability of array and export cables a critical issue.

The offshore wind industry must continue to enhance design, installation, and maintenance practices to mitigate these risks and ensure the continued viability of offshore wind projects.

To address these actual and perceived risks, the industry must focus on improving standards and practices. For instance, new codes of practice like IMCA M264, which aim to reduce installation-related damage.

Increasing complexity with floating offshore wind means that there must be an increased focus on design and interface management, pushing cross-supply chain collaboration to the forefront.

Supply Chain

The Offshore Wind Industrial Growth Plan, released in June 2024, and the Supply Chain Capability Analysis, released in 2023, both identify cable systems as an area of focus and opportunity for the UK.

Within the five areas identified where the UK should be a global leader, it can be considered that two fall directly into a strong relationship with subsea cable systems: Future Electrical Systems and Cables and Next Generation Installation and O&M.

With cable demand expected to grow more than ten fold in Europe by 2030, this will lead to constraints in the system for supply of cables, connectors and ancillaries, even with new plants and suppliers coming onstream.

The IGP (2024 Offshore Wind Industrial Growth Plan) has recognised cable reliability as an issue to be addressed, but has only assigned £1m-5m to solve the issues of cable reliability (not covering the entire cable system), a figure the cable industry considers low given the impact of failures on current windfarms.

Cable system reliability will require an integrated supply chain approach and, without demonstrable improvement in reliability, the issues surrounding insurability and the perceived risks will remain. This does not consider the higher risk profile of FOW. The IGP has recognised commercial and insurance as an existing strength and is therefore not identified for intervention.

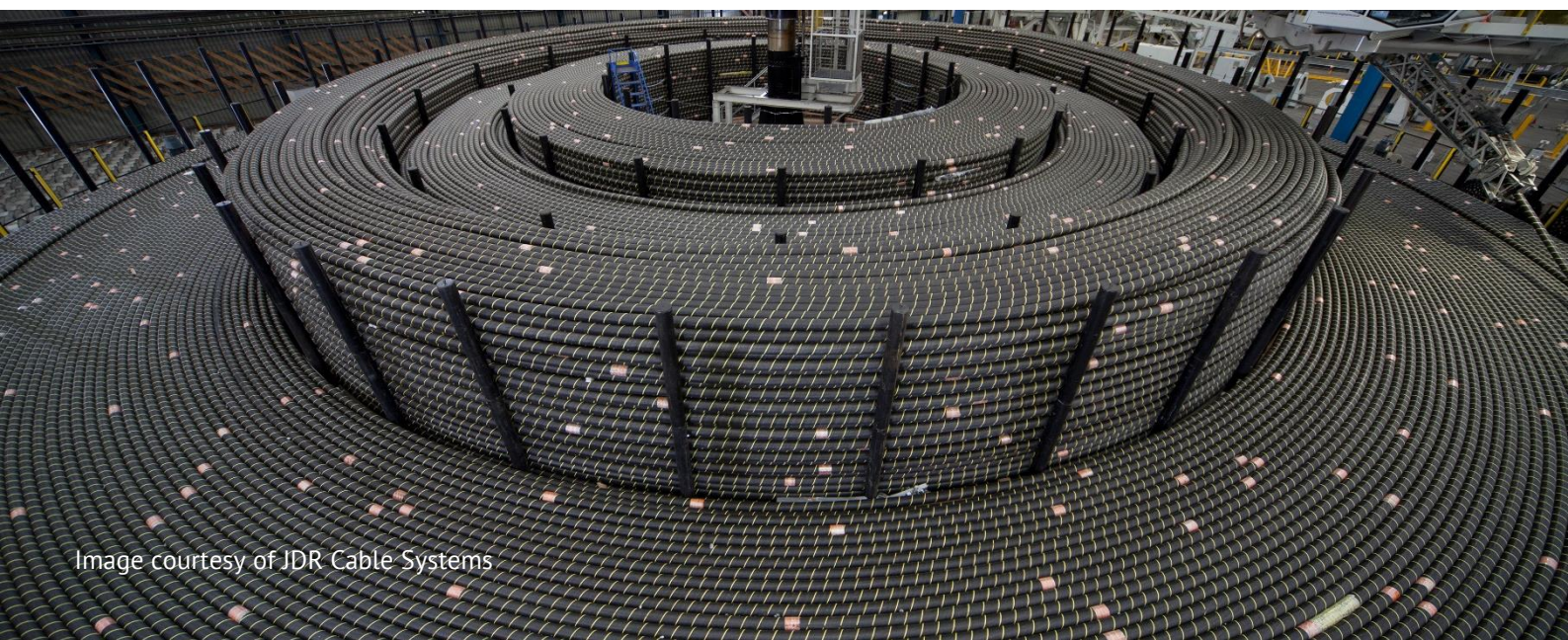


Image courtesy of JDR Cable Systems

The UK Subsea Cable System Forum

Following last year's conference and discussion with partners across the industry, GUH has recognised there is a gap within the industry to bring the supply chain together and provide a single voice to feedback to industry and government regarding how the supply chain can support the UK's offshore wind and net zero goals.

Our solution is to establish a forum that is supply chain-informed, rather than being developer-driven, and includes the entire breadth of the supply chain. The UK Subsea Cable System Forum will create a space for open dialogue which drives action on quality and reliability through the removal of constraints of commercial competition, thereby supporting the UK's net zero ambitions and delivering the LCOE (Levelised Cost of Energy) within a sustainable supply chain.

GUH's knowledge, robust relationships and collaboration with its members, international partner organisations, such as IMCA, industry bodies and developers will ensure the forum is the fulcrum of change.

The oil and gas industry has benefited from a few supplier-led initiatives such as the Umbilical Manufacturers' Federation, which itself has recently sought to broaden the involvement of its own supply chain. The development of the UK Subsea Cable System Forum will allow the offshore wind sector to benefit from a high level of collaboration to drive industry wide issues.

Proposed Approach

The UK Subsea Cable System Forum is not designed to replace any existing organisations in the offshore wind sector, but to allow GUH, as the voice of the supply chain, to bridge the myriad of sources of information and challenges within offshore wind. That way they can be transformed into actionable areas for the supply chain to exploit, while collating and feeding back relevant guidance and best practices from the supply chain to all stakeholders.

GUH has established a core steering group of primary cable system suppliers (cables, ancillaries and connectors and cable monitoring) and the extended cable system supply chain, with involvement of several developers and government organisations.

The core forum steering group, which is focused on the key parts of cable systems - cables, terminations and ancillaries -, will act as the steering committee for the development of the forum roadmap. This includes actively contributing to the clear guidance notes on application of testing, gaps in specifications and ultimately to allow the supply chain to feed into the development of future standards by ISO, IEC, Cigre etc.

Steering Group Membership Composition

Chair, GUH Lead, GUH Secretariat Support

Supply Chain Members: Cable System Suppliers (x2), CPS & Ancillaries (x2), Connector Suppliers (x2), O&M (x1), Cable Monitoring (x1)

Advisory Members: Developers (x2), Others (x1)

Meeting at least four times per year to agree priorities, assign actions and respond to industry issues, the steering committee will provide the direction for a continually evolving roadmap to ensure the supply chain is firmly at the centre of delivering solutions and capitalising on opportunities.

GUH sees the need for several sub-groups to be action-orientated on the delivery of guidance, response to standards and, where necessary, the generation of best practice standards.

These sub-groups include, but are not limited to, the following:

- Monitoring, operations & maintenance
- Insurability
- Testing, verification and qualification
- Handling & installation
- Design & manufacturing

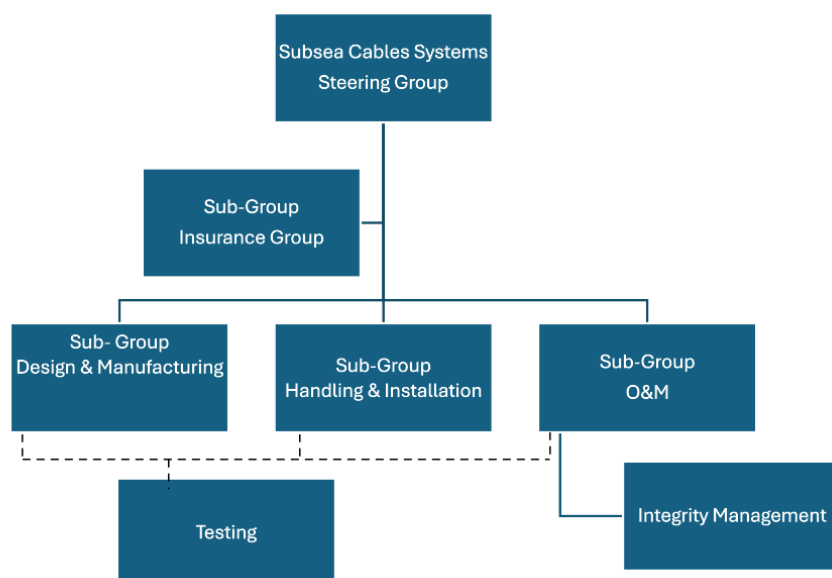
The meeting schedule for the sub-groups will be more regular as they will focus on the output of guidance, responses to industry issues and creation of best practice standards to close gaps in the industry. These small expert groups, focused on tight defined tasks, will be empowered to deliver quick responses to these industry issues.

GUH will involve the extended membership through bi-monthly events, both in-person and virtual, through its network of locations in the UK. These focused updates will allow GUH to interact across the entire lifecycle and supply chain of subsea cable systems to include design and testing, handling and installation, operations, maintenance and repair, cable monitoring and the insurance risk, presenting the latest on challenges and issues.

As floating offshore wind develops, GUH envisages the involvement and expansion of its moorings and anchors forum, currently in its early stages, into the UK Subsea Cable System Forum, to enable a fully integrated approach as floating offshore wind matures.

GUH envisages that the wider supply chain group will meet as a plenary session before GUH's annual Subsea Cables Conference, enabling both industry and technical issues to be covered over two days, adding more value to the already popular event.

An example of the possible structure of the forum is shown below.



Roadmap

The roadmap for the UK Subsea Cable System Forum is aligned to GUH's strategic programme design, which aims to achieve immediate impact (short-term) and transformational (long-term) objectives. GUH sees the UK Subsea Cable System Forum and the steering group as being integral to the creation of a roadmap that initially drives changes - "impact" - on the current challenges and issues, while supporting the formulation of practical and achievable plans - "transformation".

Immediate: During 2024 GUH has consulted with key parts of the cable systems supply chain to identify the critical challenges and issues where a supplier-driven approach could benefit the entire industry. This was confirmed by the enthusiastic engagement and feedback at the Cables Conference and Insurance Workshop, cementing the drive to develop this whitepaper, initiate the forum and develop a strategic roadmap to deliver industry improvement.

The broader forum and identified sub-groups will drive the adoption of **systems-based design** methodology, through **industry collaboration**, across the entire cable system supply chain. This will present solutions to common problems and promote **data sharing**, to drive long-term improvements in **Quality Control**, focusing resources on critical-to-quality parameters aimed at control and improvement. By presenting a clear and concise view of these challenges, the forum will seek to respond to and steer the development of guidance and **standards**.

Impact (1-3 years): The Industrial Growth Plan has identified ***Future Electrical Systems and Cables*** as an area in which the UK should be a technology leader. By creating the forum as a safe place for cross-discipline interface, 'no blame' knowledge and data sharing, GUH can reduce supply chain risk and support development of capability and capacity.

The UK will be a hub of excellence in subsea cable systems and a world leader in dynamic cables, building on its capability in engineering, innovation and technology developed over decades in oil and gas, as well as other offshore sectors.

As a leader in installed offshore wind capacity, the UK has the know-how to develop leading O&M strategies for reliability and to utilise this data to produce revised guidance and develop improved standards - a "by industry / for industry" approach to standards

Transform (3+ years): The Industrial Growth Plan and Invest 2035 offer a long-term strategic direction for the offshore wind industry. By establishing the UK Subsea Cable System Forum, GUH can ensure that a clear conduit exists to align suppliers with the broader industry and to ensure support is targeted to the underwater supply chain in identified areas of strategic economic interest.

Areas of focus:

Quality

As a sector, a significant amount of time is expended monitoring quality, often with several different organisations present, leading to the production of record books extending into thousands of pages.

This approach has the tendency to treat all elements, steps, and parameters (quantitative or qualitative) as having the same criticality. Employing a systems-based approach, where the supply chain is focused on the Critical to Quality (CTQ) outputs and Critical to Process (CTP) inputs, will allow for the alignment of requirements at all levels of system design. Proven techniques can therefore be employed to support all level of the supply chain to align the quality requirements at design, manufacture, installation, and operational phases.

It will be the aim of GUH and the Subsea Cable System Forum to not only define these CTQ and CTP characteristics but to strengthen the industry by making awareness and application of these techniques commonplace through the provision of easily accessed knowledge and tools.

The broader wind industry has seen the launch of APQP4WIND (apqp4wind.org), with representation from developers and turbine manufacturers and their supply chain, which aims to employ standardised techniques developed and employed in the automotive and aerospace industries.

The vision of APQP4WIND is to “align and mature the global wind industry value chain by lowering the cost of quality”. Involvement in APQP4WIND requires membership and commitment to training and assessment which pushes it financially outside the reach of the lower tiers of the supply chain in many cases.

As an industry, there is a need to take hold of the development of the supply chain’s approach to quality and direct resources to the critical areas that impact reliability. GUH has identified accessible education on quality as a key enabler in improving reliability and will push that the development of the supply chain is embedded within each area of the supply chain.

Standards

The offshore wind industry is subject to a wide range of applicable standards and guidance from IEC and Cigre, amongst others, alongside customer specific requirements. Some of these standards are submarine specific (e.g. IEC63026) and some adapted land cable standards (IEC60840).

As floating offshore wind develops, a number oil and gas standards from API, DNV & ISO become part of this complex scene, although they may require revisiting to focus on power cables specifically.

The forum would aim to adequately represent the cable system supply chain, helping to develop new standards through the collation of input and dialogue with the supply chain.

Qualification, Verification and Additional Testing

With cable demand predicted to grow more than ten-fold by 2030, according to the Industrial Growth Plan, the development of new manufacturing sites and the acceleration of offshore wind deployment, demand for testing facility capacity will inevitably surge.

Expansion of dynamic cable testing is an immediate potential bottleneck with each test taking months, potential multiple tests per project and the time to setup the test and analyse the data. The investment in a test rig at FOWCOE (ORE Catapult’s “Floating Offshore Wind Centre of Excellence”) is a step in the right direction, but given targets, further investment will be required across industry, academia, and government.

Testing can be complex, and the forum would look to ensure there is simplified guidance available through the supply chain to ensure clear compliance with the requirements.

Monitoring

Advanced monitoring will become a key part of the specification of offshore wind farms, alongside the adoption of condition-based maintenance philosophies and a data-driven approach to mitigate the risk of failure.

While the forum will be technology and vendor agnostic, the discussion will be around how the industry utilises this opportunity to reduce failure rates and uses the data to identify the true root causes and drive improvements.

The benefits of condition-based maintenance philosophies include:

Early Fault Detection - the early identification of potential faults such as insulation degradation or mechanical damage before they lead to catastrophic failures.

Reduced Downtime - by detecting issues early, condition-based monitoring will help in planning to minimise unexpected outages, planned interventions and improving overall system reliability.

Cost Savings - proactive maintenance based on actual cable conditions could significantly reduce repair costs.

Combining these and other benefits would enhance reliability and reduce risk, which in turn could lead to improved “insurability” and a **reduction in insurance costs**. The data and documentation on health and performance of the cable system will provide transparent evidence of diligent practices to improve cable performance and potentially lower insurance costs.

The additional complexity and potential for damage will make the incorporation of monitoring into “dynamic” cable systems on floating offshore wind a priority. To support the rapid deployment, industry needs to find a way to share and deploy the data in the supply chain to drive improvements in overall system reliability.

Installation & Handling

Given the relative lack of integrated EPC contractors within the subsea cable space, the “handover” of a manufactured cable towards handling and ultimate installation creates potential gaps and grey areas in guidelines. As such, additional risks of fatigue through overbending, spooling and handling can arise, together with a lack of clear responsibility. As such, appropriate guidelines which cover all instances of reliability should be introduced.

GUH has a close relationship with IMCA, enabling it to connect both memberships together to build upon and develop the best practice guidelines published in 2024, ensuring design, testing, equipment manufacture, and vessel design and operation are included and that lessons learned both onshore and offshore are shared and implemented.



Conclusion

The reliability of subsea cable systems is critical to the success of offshore wind projects and progress towards the broader goal of achieving net zero emissions and energy security.

Subsea cable system reliability not only makes offshore wind projects more economically viable but also ensures that the energy supply remains uninterrupted and reduces the impact of insurance costs on project financials.

As the voice of the underwater sector, GUH is uniquely positioned to establish and lead the UK Subsea Cable System Forum, ensuring that the entire supply chain can effectively influence standards and policy to drive reliability, cost effectiveness and quality into cable systems supplied in the UK, enabling the country to become a world-leader in subsea cable systems for offshore wind.

The forum, through the development of an agreed roadmap led by an industry steering committee and working with partners across the sector, would drive innovation and improvements in systems-based design, data sharing and quality control. As a result of this increased collaboration, the forum will influence the development of the standards needed to reduce risk and increase performance.

This, in turn, will ensure that the UK becomes well-positioned as an authoritative centre of excellence for reliable subsea cable systems and solutions that enhance the economic viability of offshore wind projects and accelerate the development of floating offshore wind. Ultimately, the holistic approach by the UK Subsea Cable System Forum will help deliver the standards required for a new generation of products and services to the global floating offshore wind market estimated to be worth £1trillion.



Image courtesy of JDR Cable Systems



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