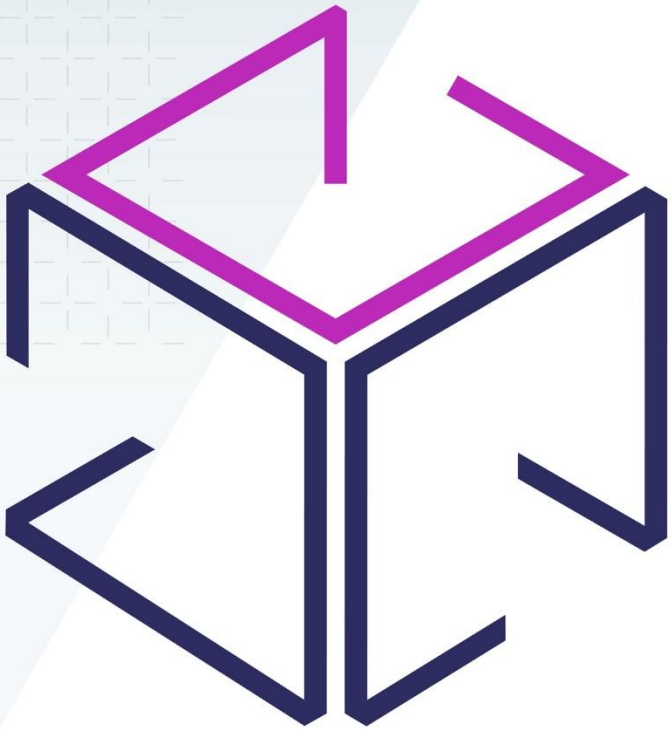

UK Manufacture of High Voltage Direct Current Cable Systems

Interim Report: Workforce Foresighting Cycle Output

Revision:	Draft 0.0	Draft 0.1	1.0	1.1	1.2	
Date:	12/05/2025	19/05/2025	23/05/2025	11/06/2025	12/06/2025	

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ACKNOWLEDGEMENTS

The Workforce Foresighting process integrates data from the following international data sets:

- IfATE – Institute for Apprenticeships and Technical Education, England
- ESCO – European Skills, Competencies, Qualifications & Occupations, EU
- ONet – Occupational Networks Online, USA

In accordance with licence and publishing requirements of these organisations for the use of their data sets, the Workforce Foresighting Hub team states that:

- The IfATE data used contains public sector information licensed under the Open Government Licence v1.0.
- The ESCO data is used in accordance with the EUROPEAN UNION PUBLIC LICENCE v. 1.2 EUPL © the European Union 2007, 2016
- The ONet data used is under CC BY 4.0 license. (O*NET® is a trademark of USDOL/ETA.) The Workforce Foresighting Hub team has modified all or some ONet information. USDOL/ETA has not approved, endorsed, or tested these modifications.

Any errors, omissions and incorrect data are the responsibility of the Workforce Foresighting Hub team, and all queries should be addressed to info@iuk.wf-hub.org

The method and process used in the Workforce Foresighting process is under development and there may be errors and omissions in the data provided.

This report was produced following workshops undertaken 2025 Q2 using the data set and tools available at that time.

EXECUTIVE SUMMARY

Workforce Foresighting is a national initiative funded by Innovate UK and deployed through the Innovate UK Catapult Network. Workforce Foresighting is a systemic approach to planning ahead and anticipating future skills and capability needs associated with new technologies and government transformation targets. It involves identifying and understanding the skills required for tomorrow's jobs, ensuring our education and training systems are prepared so that our workforce is ready to adopt new technologies and support future industrial growth.

This interim report outlines findings from the second phase - 'Carrying Out' - of a workforce foresighting study on "High Voltage Direct Current Cable Systems Manufacture". The study is sponsored by RenewableUK and conducted by the Offshore Renewable Energy Catapult in collaboration with the Workforce Foresighting Hub.

The study considers the organisational capabilities needed for HVDC cable and convertor manufacture in the UK, and integration with offshore wind generation and power transmission.

Within this report, participants and stakeholders can review the developed capability sets and Future Occupational Profiles ('FOPs') before the next phase of work. The appendices provide further information about workforce foresighting, selection of the topic, and provide links to an online visualisation tool for exploration of data generated during this study.

Participants and Stakeholders

The following organisations participated in the carrying-out phase of this foresighting cycle:

Organisation	Technologist Group	Employer Group
The Offshore Renewable Energy Catapult	o	o
Sumitomo Electric UK Power Cables	o	o
XLCC	o	o
The National HVDC Centre	o	o
Siemens Energy	o	
GE Vernova	o	
The University of Highlands and Islands (UHI)	o	o

Key stakeholders in the foresighting cycle are:

Role	Purpose	Stakeholder
Challenge Sponsor	Person or organisation requiring the outputs of the foresighting process to support decisions to act on education and training.	RenewableUK: Jane Cooper, Director of Offshore Wind
Challenge Convener	Organisation that identifies and brings together stakeholders to define the Challenge, Sponsor and take part in foresighting.	ORE Catapult: Tony Quinn, Operations Director
Foresighting Champion	Person with authority and influence to convene foresighting interest within the organisation and with its stakeholder and partner bodies.	ORE Catapult: Danielle Portsmouth, Future Skills Manager
Foresighting Coordinator	Person who will manage the acquisition of project information, facilitate topic selection, recruit and organise participants, and author reports.	Paul Hatchett Consulting Limited

Results of the "Carrying Out" Phase

The workforce foresighting workshops and surveys identified 131 capabilities relevant to the topic. Of these capabilities:

- 97 capabilities were adopted from the Workforce Foresighting Data Cube, of which -
  - *41 were from existing UK IfATE or O*Net standards.*
  - *33 were from the previous ORE Catapult Dynamic Cable Systems study.*
  - *23 were from other Workforce Foresighting cycles.*
- 12 capabilities were adapted (modified) from other Workforce Foresighting cycles.
- 22 capability statements were newly defined by the study.

The capabilities are grouped into eighteen future occupational profiles ('FOPs'). The purpose of the FOPs is to indicate coherent groups of capabilities that can be used as a basis in skills analysis, job design, and education / training curricula. The FOPs are not job descriptions, and it is possible that one job may encompass parts of several FOPs or specialise into part of only one FOP. These resulting FOPs now form the basis for ongoing discussions and the "causing action" phase of workforce foresighting.

Next Steps

In the next phase of the foresighting cycle ORE Catapult will work with stakeholders to identify and initiate actions to close the potential future skills gaps identified through foresighting. This work will include:

1. Incorporating feedback from industrial participants and other reviewers of the future occupational profiles and capability sets.
2. Developing forecasts that help to understand component volumes and the expected role numbers.

3. Consider likely career / training pathways to competency in roles aligned with the future occupational profiles and compare these with the sixteen priority roles mapped by the Offshore Wind Industries Council (OWIC) ‘Investment in Talent’ group.
4. Initiating a working group across HVDC cable system manufacturers, ancillary equipment manufacturers and their skills partners, to focus on the skills value chain for production facilities, including:
    a. Working with further and higher education partners, as well as industry training organisations, to identify potential course module content – based on foresighting and forecasting, and relevant Knowledge, Skills and Behaviours.
    b. Extending the group to include LS Cables, who in May 2025 announced an intention to establish a cable manufacturing site in the Northeast of the UK.
    c. Encouraging a champion for development of skills in HVDC in the UK renewables sector.
5. Evaluating the opportunity for further foresighting studies in high voltage electrical engineering in UK offshore wind.
6. Continuing ORE Catapult educational outreach and building awareness of ‘green jobs’ and encouraging young people into STEM skills.

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FIGURES AND TABLES

NOMENCLATURE

Term	Definition
AC	Alternating current
AI	Artificial intelligence (in the case of foresighting, the 'GPT4' large language model, used to analyse and match capability statements and standards).
Capability (Organisation)	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation
CPD	Continuing professional development.
Data Cube	The database and framework developed by the Workforce Hub to hold, compare and analyse organisational capabilities against occupational standards. For further detail, see Appendix 1 .
DC	Direct current
Delphi-style workshops	The workshop approach used in Workforce Foresighting. Delphi-style workshops are structured to gather insights and reach consensus on complex topics, using anonymous feedback and iterative rounds. The term derives from the ancient Greek oracle at Delphi, and the workshop approach is attributed the RAND Corporation.
DESNZ	The UK Government's Department for Energy Security and Net Zero.
Fit Factor (FF)	The degree to which the capability statements within an Existing Provision definition fit to a given future occupational profile (from foresighting). A higher Fit Factor indicates a closer match.
FOP	Future Occupational Profile.

Term	Definition
FOW	Floating offshore wind.
GW	Gigawatts
HVDC	High voltage direct current
IfATE	The Institute for Apprenticeships and Technical Education, see https://www.instituteforapprenticeships.org/
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
LCoE	Levelised cost of energy.
LLM	Large language model.
MI	Mass impregnation – method used in the production of HVDC cable insulation systems, first deployed by Nexans in 1977 on the Skagerrak interconnector project.
ML	Machine learning.
OEM	Original equipment manufacturer.
ORE Catapult	The Offshore Renewable Energy Catapult, part of the UK Catapults network of research and technology organisations, established and funded by Innovate UK to accelerate technology and capability in key industrial sectors, and act as a bridge between academic research and industry.
OWIC	Offshore Wind Industry Council.
OWIGP	The UK's Offshore Wind Industrial Growth Plan (RenewableUK, 2024).
RAS	Robotic and Autonomous Systems
R&D	Research and development.
RTO	Research and technology organisation (e.g. ORE Catapult).
SEUK	Sumitomo Electric UK Power Cables Ltd., a subsidiary of Japanese company Sumitomo Electric Industries, Ltd.
SF Surplus Factor	The degree to which the capability statements within an Existing IfATE course definition are not contained within a given future occupational profile (from foresighting). A lower Surplus Factor indicates a closer match.
VSC	Voltage source convertor
WFH, WF Hub	The Workforce Foresighting Hub provides the process, insight and recommendations for industry, policymakers and educators to adapt to continuing change, helping UK businesses to adopt innovation and succeed in the dynamic global marketplace. The central team is based at the Manufacturing Technology Centre (part of the High Value Manufacturing Catapult).
XLPE	Cross-linked polyethylene – a material used for HVDC cable insulation, particular in extruded cables as an alternative to MI.

1. Introduction

1 INTRODUCTION

1.1 Purpose of the Interim Report

This interim report is a summary of output from Phase 2 ('Carrying Out') of a workforce foresighting study on "UK Manufacture of High Voltage Direct Current Cable Systems for Offshore Wind". The study is part of a series sponsored by RenewableUK and conducted by the Offshore Renewable Energy Catapult, with the Workforce Foresighting Hub facilitating the foresighting process through structured workshops and detailed analysis.

The report is intended principally for participants and interested stakeholders to review and access the capability sets and prototype future occupational profiles ('FOPs') developed by the study so far. This provides an opportunity for comment, before the "causing action" phase of the study. FOPs are intended to support industry and the training / education sector in the design of roles and course content, but they are not intended as prescriptions for job descriptions or specific course modules.

The report briefly summarises the foresighting topic and its selection, presents the future occupational profiles, and provides the capability sets within the Appendices. The appendices to the report also contain further information about the workforce foresighting process, and links to an online visualisation tool, where the generated data can be viewed in various ways.

1.2 Background to Workforce Foresighting

The report "Manufacturing the Future Workforce" (Collier et al., 2020) recommended the Skills Value Chain as an approach to avoid shortfalls in workforce capabilities relating to future innovations (see Figure 1). This is the genesis of the workforce foresighting programme, which is sponsored by Innovate UK and delivered through the Innovate UK Catapult Network.

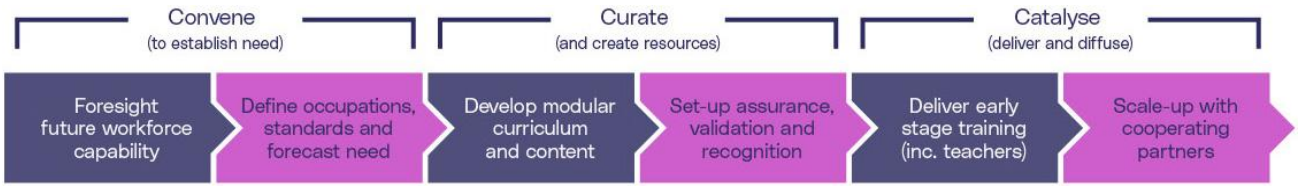

Figure 1 - The Skills Value Chain

The first step of the skills value chain is to "Foresight future workforce capability": This calls for technology, industry, education, and training partners to convene using government as a focal point, to "foresight and articulate future skills needs, standards and qualifications associated with emerging technologies" (Collier et al., 2020).

1.3 Workforce Foresighting - Process Overview

The core of workforce foresighting is convening groups of relevant specialists to conduct Delphi-style workshops to capture and discuss the set of organisational capabilities that will be required to respond to and exploit technology innovation.

Organisational capabilities are captured using a classification developed by the Workforce Foresighting Hub, which uses a structured common language to enable cross-sector collaboration and integration of data. Additionally, the classification enables data from several national and international open-source workforce datasets to be integrated through the same common language. The data is held in a cloud-based "Data Cube" that is dynamically growing as each workforce foresighting cycle adds to the shared data relating to future workforce capabilities.

Using AI and Large Language Model data tools, the Data Cube is used to undertake detailed analysis to 'map' future workforce capability requirements against the current education and training provision to identify where existing provision can be used or where new provision, CPD or qualifications are required.

As an agile development project, the Workforce Foresighting Hub team are constantly evolving and improving the detailed workshop process and workshop approach, but a study cycle always consists of the following stages:

Considering – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as foresighting topic suggestions align with strategic priorities.

Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for foresighting.

Preparing – The convening of specialists and scheduling of workshops.

Carrying out – Run foresighting workshops with experts, collate and analyse data.

Communicating – Insights, findings and recommendations gathered from all research in report.

Causing action – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of foresighting.

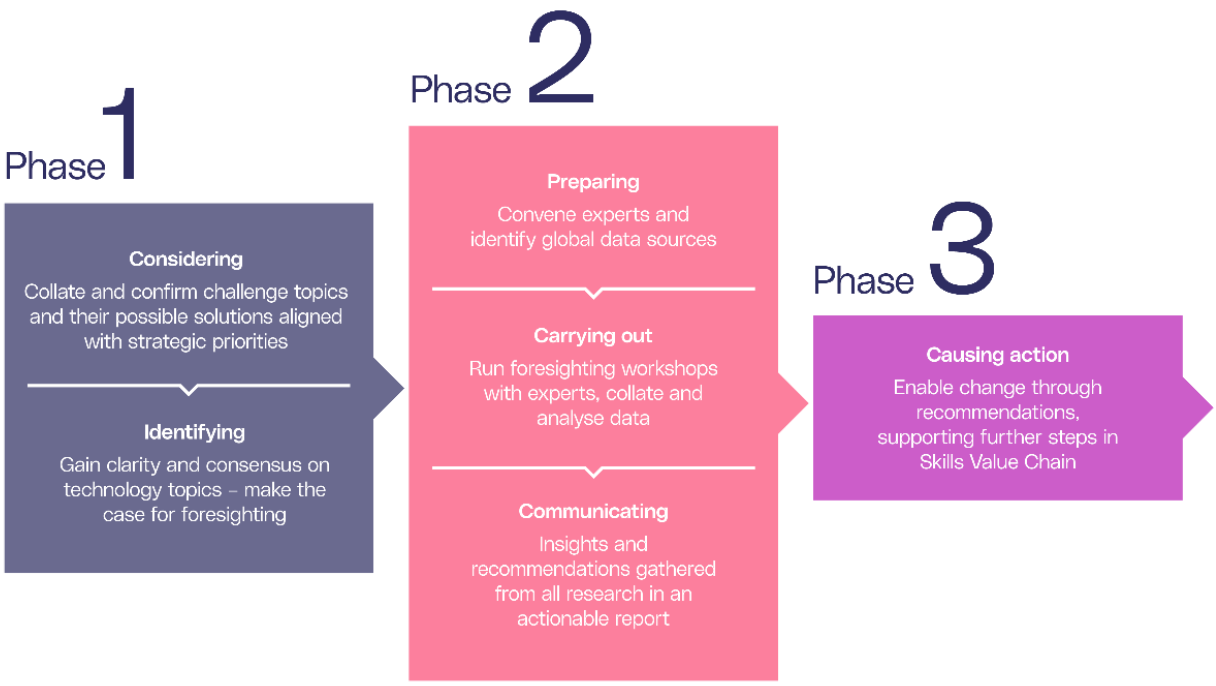

Figure 2 - The workforce foresighting process

1.4 Foresighting vs Forecasting

Although this study is focussed on workforce foresighting (capabilities required) it is important to keep in mind parallel findings from forecasting (required capacities and numbers). ORE Catapult is working with the Department for Energy Security and Net Zero ('DESNZ') and Innovate UK to make assessments and maintain thought leadership around offshore wind installation targets and the implications on educators, industry, and sector bodies. Forecasting, alongside foresighting, provides vital input to the sector, feeding into recruitment and development targets for employers, and consideration of economic class sizes and recruitment targets for educators. However, it is beyond the scope of the foresighting study to carry out independent forecasting, and as such readers should refer to other studies for detail on forecasting.

1.5 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool is a powerful, innovative system, which will enable the reader to explore and analyse foresighting data to determine the capabilities required for future roles. Some instructions on how to use the Visualisation Tool can be found in Appendix 2 .

2. Defining the Foresighting Challenge

2 DEFINING THE FORESIGHTING CHALLENGE

The foresighting challenge, technologies and topics were identified during a combined 'consider-identify-prepare' phase[1].

2.1 Positioning and National Context

According to the UK's Clean Power Action Plan 2030 (Department for Energy Security and Net Zero, 2024), power generation from offshore wind is a vital part of the UK's future energy security and achievement of CO_2 reduction targets. The UK has a target of 43-50GW of power from offshore wind by 2030. Alongside nuclear, this is seen as the backbone of a clean electricity system in the UK. The gap between current installed capacity and future targets is illustrated in Figure 2 below.

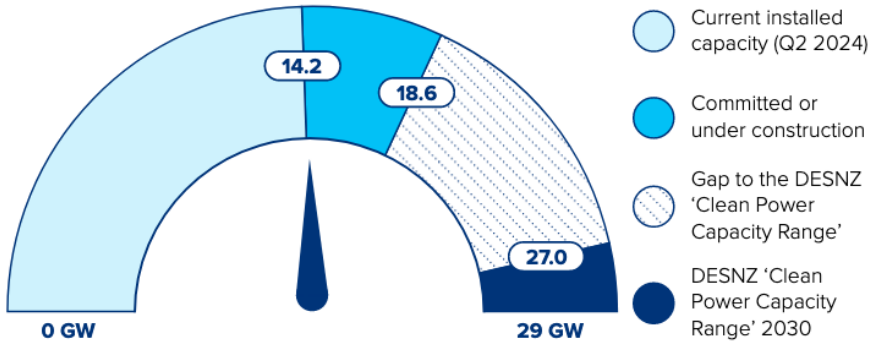

Figure 2 - Offshore Wind installed capacity vs 'Clean Power Capacity Range' in 2030 (Department for Energy Security and Net Zero, 2024)

The need for new technologies and capabilities to support this increase in the UK's installed offshore wind generating capacity, is the top-level challenge being addressed through ORE Catapult's workforce foresighting studies.

2.2 Topic Selection Approach

The foresighting topic of "Manufacture of High Voltage Dynamic Cable Systems for Offshore Wind" has been selected through the following approach:

1. A detailed review of the UK's "Offshore Wind Industrial Growth Plan" (RenewableUK, 2024) to identify focal technology areas for foresighting.
2. Review of the UK's "Clean Power 2030 Action Plan" (Department for Energy Security and Net Zero, 2024) and the Energy Skills supplement to better understand the strategic landscape.
3. Review and shortlisting workshops with lead technologists from the Offshore Renewable Energy Catapult ('ORE Catapult').

[1] A summary of the approach is provided here, but greater detail is set out in the ORE Catapult report "Future Skills Needs in UK Offshore Wind: Workforce Foresighting Cycles 3-5 Activity Zero" (Hatchett, 2025).

2.2.1 Overview of the Offshore Wind Industrial Growth Plan

The Offshore Wind Industrial Growth Plan ('OWIGP') is a recommendation by industry bodies to government, for investment in the growth of UK offshore wind and strengthening of the industrial sector. The report sets out an aim to expand the UK's offshore wind supply chain and grow its market share, domestically and internationally. The plan targets £25 billion in gross value added through a focus on key technologies, leveraging the UK's existing strengths in the sector.

The OWIGP emphasises the need for a strategic approach, with a focus on technologies vital to domestic supply and those where the UK can establish a competitive advantage through innovation. The document sets priorities, objectives, and actions for key technologies, future trends, and innovation.

According to the report, progress will be supported by a new delivery body which will own the growth plan, report against and refresh the plan at intervals, align stakeholders, and champion the UK as a leading destination for investment.

The OWIGP acknowledges that the development of a skilled workforce is a critical factor in making the UK a top employment destination within the offshore wind sector. Workforce Foresighting is referenced within the OWIGP as an approach to identify future workforce capability requirements; however, the plan itself is light on workforce planning and skills development needs.

2.2.2 Overview of the Clean Power 2030 Action Plan

The Clean Power 2030 Action Plan was published by the Department for Energy Security and Net Zero ('DESNZ') in December 2024. The Action Plan describes the UK's transition to clean energy by 2030. The goals set by the plan are shown below:

Measure	2024 Value	2030 Goal
Increase clean energy as a percentage of Great Britain's overall generating capacity	60%	95%
Increase clean energy production, compared to Great Britain's total power consumption	56%	100%
Decrease Great Britain's CO_2 emissions intensity	171g / KWh	50g / KWh

Table 1 - Clean Power 2030 Goals (Department for Energy Security and Net Zero, 2024)

The plan reiterates the UK's target of 50GW of offshore wind generating capacity by 2030, although in certain scenarios this target is reduced to 43GW of offshore wind. Batteries (both domestic, and as large-scale grid-attached storage) also play a significant role, with an increase from 4.5GW current installed capacity up to 23-27GW by 2030.

Skills are a significant consideration in the Clean Power 2030 Action Plan – the only addendum to the report is the "Assessment of the Clean Energy Skills Challenge". This notes that the offshore wind sector has reported persistent skills gaps in high-level electrical, digital, and consenting skills, including roles like Senior Authorised Persons, data analysts and scientists, and regulators. It also notes that there are workforce shortages in the areas of project management, on- and off-shore logistics, and construction resources for floating wind projects. Workforce Foresighting is

referenced as a component in resolving the skills challenge, citing ORE Catapult's study on Dynamic Cable Systems (Hatchett et al., 2023).

2.2.3 Topic Longlisting Approach

The OWIGP recommends the UK should be a global leader in five areas of offshore wind:

- Advanced Turbine Technology
- Industrialised Foundations & Substructures
- Future Electrical Systems & Cables
- Smart Environmental Services, and
- Next Generation Installation, Operations & Maintenance

For each of these areas, the plan outlines "Respond, Expand, and Disrupt" programs. The "Respond" programs are focused on addressing immediate infrastructure needs and supply constraints, the "Expand" programs aim to build capacity for emerging export markets, and the "Disrupt" programs seek to establish the UK as a leader in offshore wind advancements through innovation and commercialisation. The plan highlights the need for the UK to increase its manufacturing capabilities in key areas like blades, towers, foundations, and cables, and to enhance its skills in areas like installation, and operations & maintenance ('O&M'). In addition to the list of initiatives, the OWIGP identifies some key technology trends which further inform potential areas for skills foresighting.

Thirteen potential foresighting topics were identified through review of the OWIGP:

- Novel manufacturing processes and methods for wind turbine blade leading edge protection.
- 3D printing of wind turbine blade leading-edge parts.
- Design of composite wind turbine blades to enable production with advanced techniques.
- Automating composite manufacturing techniques for blades.
- Use of alternative materials to reduce steel weight in Floating Offshore Wind ('FOW').
- Use of alternative and synthetic materials for anchors and moorings in FOW.
- Use of synthetic ropes for mooring lines in FOW.
- Development of hybrid energy offshore wind farm solutions.
- Incorporation of power-to-x and energy storage systems in offshore wind farms.
- Development of autonomous windfarm environmental and site inspection survey.
- Survey algorithm & autonomous controls for RAS-based environmental and site inspection.
- Batteries & energy storage for autonomous survey systems.
- ML analysis of Survey Data (for species monitoring, habitat monitoring).
- Generate solutions for next-generation drive train technologies.

2.2.4 Topic Shortlisting

The shortlisting exercise involved gathering input from lead technologists and senior managers at the Offshore Renewable Energy Catapult:

- Dr. Thomas Wildsmith, Head of Commercial
- Deri Galvin, Head of Industrialisation
- Michael Smailes, Principal Development Engineer.
- Andrew Esson, Future Skills Lead

- Danielle Portsmouth, Future Skills Manager
- Paul Hatchett, Future Skills Consultant (facilitator)
- Andrew Stormonth-Darling, Principal Portfolio Manager – Floating Offshore Wind
- Jack Paterson, Team Leader – Floating Offshore Wind
- Alex Neumann, Chief Engineer – HV Electrical
- Tony Quinn, Director – Technology Development

Participants screened the longlist considering the fit with workforce foresighting methodology, ease of scoping the topic, likely skills needs, and maturity of the technology (i.e. achieving 'horizon 2' around 2030-2032). Topics were challenged and adjusted for suitable scope (neither too broad nor too niche). The group also considered potential collaborations with other Catapults and RTOs, favouring those where there might be some beneficial overlap.

After a check for omissions, including comparison to the European Technology & Innovation Platform on Wind Strategy (ETIPWind, n.d.), the group carried out a prioritisation exercise considering the level of future skills challenge, and ability to convene an effective working group. This resulted in two clusters of foresighting topics:

Cluster 1

- **Structures – automated welding**: The development and application of automated welding solutions [and assembly methods] for foundations, transition structure and tower sections.
- **Advanced production methods in WTG blades**: Design and production of WTG blades to utilise advanced techniques such as 3d printing / ceramic leading edges, automated production methods.
- **HVDC Cable Systems**: Development and production of high voltage direct current (HVDC) cables in the UK, potentially including novel polymers, and associated equipment.

Cluster 2

- **Smoothing power delivery to grid from Offshore Wind**: Power-to-x (e.g. electrolyser), hybrid and large-scale energy storage systems for offshore wind; also possibly considering system including application of grid forming control in WTG invertors.
- **Autonomous survey**: RAS application for autonomous subsea environmental, site and geotechnical survey (pre-construction).
- **Alternative materials for Floating Offshore Wind moorings / structures**: Use of synthetic ropes, alternative and synthetic materials for mooring lines in floating offshore wind /or/ Use of advanced / novel concrete materials and forming for floating offshore wind foundations, structures.

2.3 Topic Description

Deriving from the third shortlisted topic, this workforce foresighting cycle addresses "Manufacture of High Voltage Direct Current Cable Systems for Offshore Wind".

In the late 19th century, AC was championed by Nikola Tesla and George Westinghouse and ultimately won out over Thomas Edison's DC system. Alternating current (AC) has been preferred

for power transmission due to some advantages over direct current (DC). AC can be easily transformed to different voltages, which allows electricity to be transmitted at high voltages over long distances. Higher voltage means the current is reduced, which in turn reduces energy losses from the resistance in the wire conductors. After transmission, the voltage can then be stepped down for industrial and domestic consumer usage. AC allows generating systems to operate synchronously, i.e. they operate at the same electrical phase and frequency as the grid, which has benefits for maintaining grid stability.

Figure 3 and Figure 4 show the main components in an HVDC system connecting an offshore wind farm in diagrammatic and pictorial form, respectively. Figure 5 shows the two main types of HVDC submarine cable – mass impregnated (MI) and XLPE extruded, in diagrammatic and pictorial form.

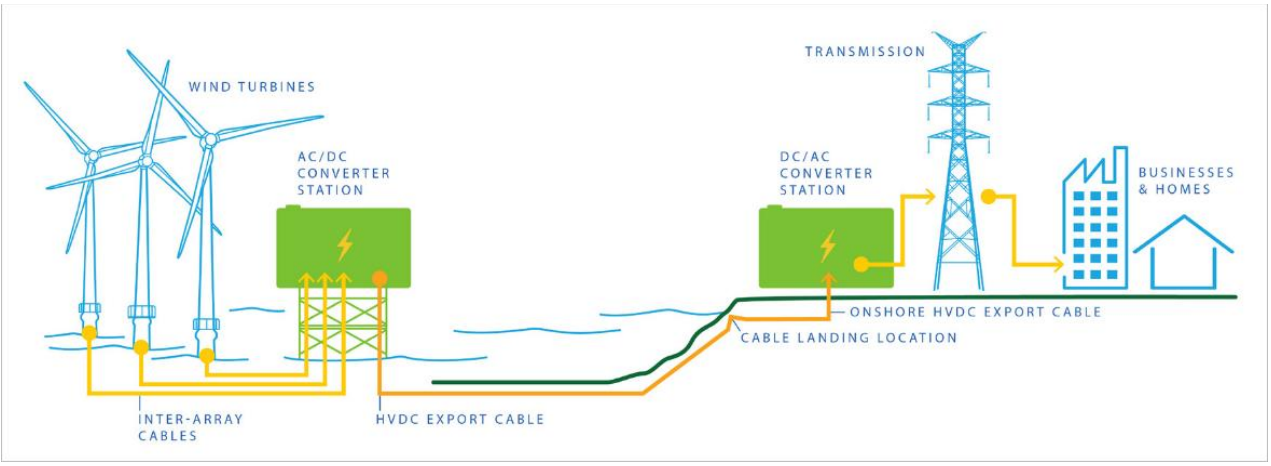

Figure 3 - Diagram of Offshore Wind HVDC Transmission Components (Baker et al., 2024)

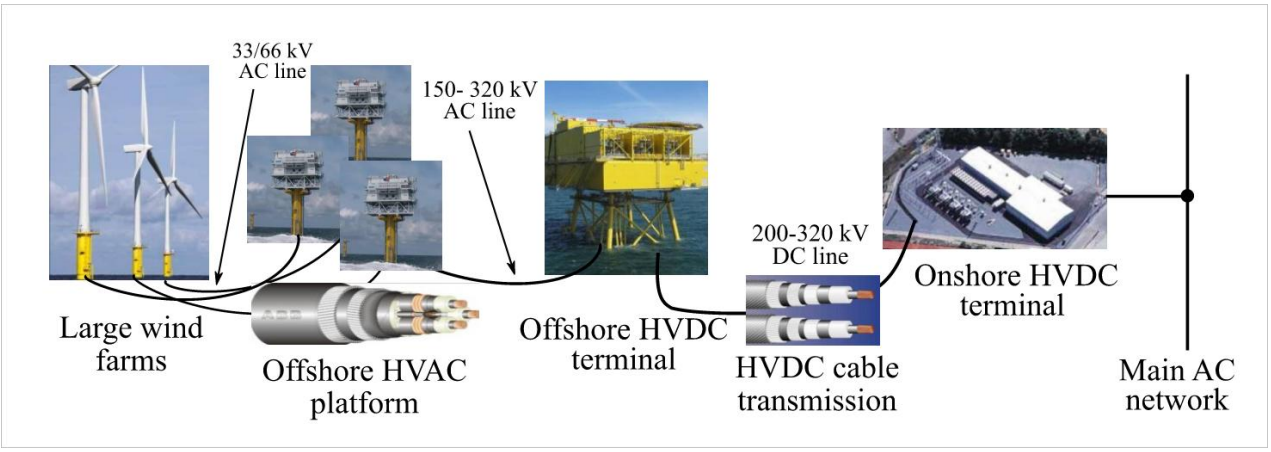

Figure 4 - Pictorial Scheme of Offshore Wind HVDC Transmission Components (Ryndzionek & Sienkiewicz, 2020)

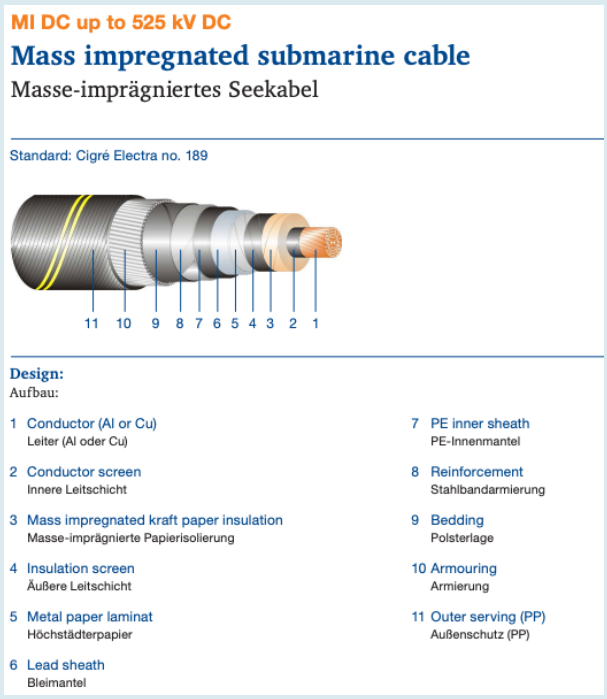

Figure 5 - HVDC MI Cable (left, NKT[2]) and HVDC Extruded Cable (right: Prysmian[3])

2.3.1 Advantages and Challenges of High Voltage Direct Current for Power Transmission

Although analysis is required for each application, there are economic and technical drivers for using HVDC in place of AC for power distribution from offshore wind, including:

- **Cost Effective over Long Distances:** Over certain distances - around 70km – subsea HVDC cables become more economic than AC cables for transmission (Chen et al., 2015). More expensive power electronics in the convertors are needed, but the cost of these becomes offset by savings in the cable itself (bipolar lines vs three phase lines), and lower transmission losses (see Figure 6 and Figure 7). Additionally, there is no need for reactive power compensation over long transmission distances, when using HVDC cables (Mazzanti, 2021).
- **Cable Properties:** Manufacture of DC cable can be cheaper and less demanding than AC cables. One reason for this is that a bipole conductor is used, rather than needing a conductor for each of the three phases of AC. HVDC cables, particularly those that are extruded using XPLE are lighter than regular AC cables, which means that cables can be transported in longer sections (Ryndzionek & Sienkiewicz, 2020). Extruded cables can withstand higher operational temperatures, which means that more power can be carried for a given conductor cross section compared to mass impregnated cables; they also avoid environmental problems caused by oil leakage, and are recyclable (Chen et al., 2015).

[2] Retrieved February 2025 via https://www.nkt.com/products-solutions/high-voltage-cable-solutions/high-voltage-offshore-solutions/high-voltage-offshore-dc-cables

[3] https://www.prysmian.com/sites/default/files/business_markets/markets/downloads/datasheets/HVDC_A4_LOW.pdf

- **Enhanced Grid Integration and Control:** Modern HVDC systems, especially those using Voltage Source Converters (VSC), provide enhanced grid control and stability features. Using VSC, the wind farm can be decoupled from the grid, which allows for grid code compliance to be taken care of within the HVDC system and wind turbine developers to focus on standardisation and cost reduction (Korompili et al., 2016). HVDC connections can act as bridges between non-synchronous generating sources (such as windfarms) and the grid and also prevent faults cascading between connected AC grids (Mazzanti, 2021). Thus, HVDC transmission systems are considered a key element of future 'Smart Grid' intelligent power grids (Ryndzionek & Sienkiewicz, 2020).

Some of the challenges for HVDC include:

- **Electrical performance:** Electric field distribution is more complex in HVDC cables compared to AC, and further research in this area is ongoing particularly for XLPE extruded cables (Chen et al., 2015). Over-voltages in VSC HVDC systems are also a challenge that is particular to these systems (Mazzanti, 2021). Thus, there is a need for advanced electrical engineering and computational modelling to solve these challenges.
- **Component design and manufacture:** The reliability of critical cable joints is considered the weakest link in HVDC cable systems, therefore creating a need for skilled cable jointers. These joints may be prone to failure due to differing mechanical, electrical and thermal stresses over different material interfaces (Chen et al., 2015; Mazzanti, 2021). There is also a need to consider system-level design and standardisation across major components to help ensure compatibility and interconnectivity (Ryndzionek & Sienkiewicz, 2020).
- **Testing and Monitoring:** There is a lack of condition monitoring solutions for HVDC systems, particularly those that are integrated across different parts of the system (e.g. cable, grid, convertor stations). In part this is due to relative newness, but also to a lack of information sharing and limited understanding of how the extruded HVDC cables age electrically (El Mountassir, 2015). As well as monitoring, new standards are needed for testing, especially at higher voltages and for more complex measurements around space charge[4]. Standards such as IEEE Std. 1732-2017 have been introduced, recommending practices for such tests up to 550kV (Chen et al., 2015; Mazzanti, 2021)

[4] The accumulation of electric charge within the insulation of long transmission cables, which can affect their performance. It can lead to increased losses and impact the overall efficiency and reliability of the power transmission.

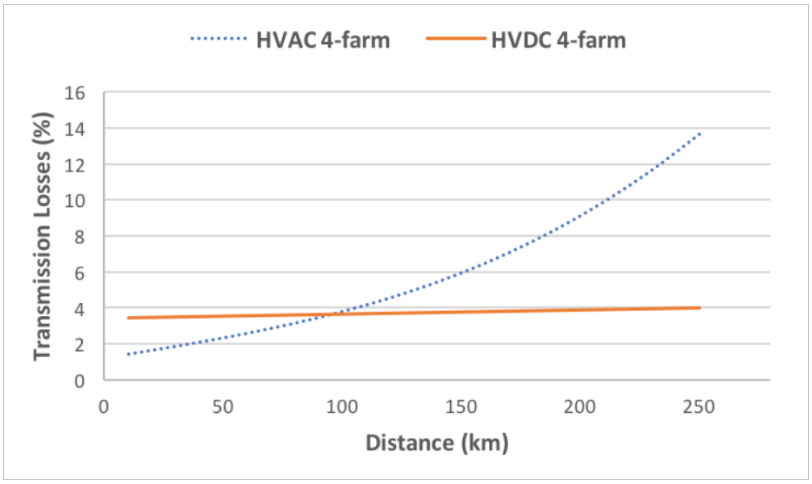

Figure 6 - HVAC and HVDC (VSC) Transmission Losses for a 1MW 4Plant Layout (Apostolaki-Iosifidou et al., 2019)

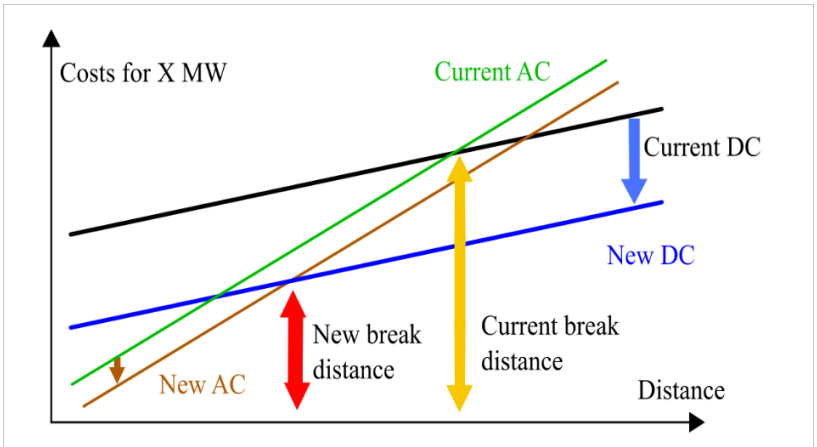

Figure 7 - HVDC vs AC Transmission: Economic Breakeven Points[5] (Ryndzionek & Sienkiewicz, 2020)

2.3.2 Drivers for establishing HVDC System Manufacture in the UK

The need for the UK to establish two production facilities for HVDC cable systems is identified as a 'Respond' program[6] in the Offshore Wind Industrial Growth Plan (RenewableUK, 2024), and in the Clean Power Action Plan 2030 (Department for Energy Security and Net Zero, 2024). Reasons given for this include:

- **Addressing supply constraints:** The global and European supply chains for offshore wind components are still developing, and supply constraints are expected to impact array and offshore export cables through to 2030. Constraints are anticipated to start in 2025 in Europe and 2026 globally. Given the demand from UK wind farms - estimated at 1700km of cable per year - this supply constraint creates a need for additional capacity, which the

[5] In this diagram, 'new DC' considers systems using transistor-based VSC where 'current DC' considers older solutions based around thyristors called line commutated convertors. The exact break-even distance will vary based on several factors, but for HVDC onshore overhead transmission this is approximately 600-800km whereas subsea this distance drops to around 50km.

[6] 'Respond' programs are defined as immediate priorities driven by market needs and focused mainly on investments in infrastructure. The view expressed in the OWIGP is that unless the UK takes action to build capacity in these areas, the opportunity will be lost to international competition.

UK has an opportunity to provide. Targeted investment is required to address these constraints and develop UK capability and capacity.

- **Economic growth and job creation:** Securing HVDC cable manufacturing capacity is seen as a way to realise the economic and social potential of growth in the offshore wind industry. Array and offshore export cable manufacturing, including HVDC cables, has the potential for job creation and economic growth. The estimated incremental 10-year Gross Value Added (GVA) from increasing HVDC manufacturing capacity is significant, ranging from £1.5Bn to £2.9Bn over ten years, from an investment of £200M to £400M. With UK production facilities proposed by Sumitomo, XLCC, and LS Cables, the direct employment should be around between 1100 and 1500 direct manufacturing jobs, with at least 1500 further jobs in the supply chain[7].
- **Leveraging existing capabilities and market share:** The UK has a strong manufacturing base for cables (but not HVDC cables) and is an export leader, with UK-based companies winning offshore wind contracts globally. Establishing HVDC manufacturing capacity builds upon this success and leverages the UK's comparative advantage to cater to a bigger share of the global market. There are already several major suppliers with expertise in both HVAC and HVDC systems; and new HVDC cable factories were announced in 2023 by XLCC and Sumitomo, with a further facility announced in 2025 by LS Cables.
- **Supporting future technology trends:** Future electrical systems and cables are identified in the OWIGP as a strategic priority area for UK leadership. As wind farms are located further from shore, HVDC is becoming an important solution for transmission. Establishing domestic capacity supports the development of related technologies, such as mutually compatible and interoperable HVDC systems, which are a key enabler for the formation of smart HVDC grids and multi-terminal configurations. Developing design competence in new wet and dry cable designs and materials is also essential for securing long-term demand.

2.3.3 UK-based Supply Chain for HVDC

The OWIGP set a target for two HVDC cable manufacturers to establish production facilities in the UK (RenewableUK, 2024). As of May 2025, it looks likely that this target will be exceeded, with three facilities to be established:

- Sumitomo Electric UK Power Cables Ltd (SEUK), the UK subsidiary Japanese company Sumitomo Electric Industries Ltd., plan to establish a facility in Nigg.
- XLCC, an independent British Company founded in 2020, plan to establish a facility in Hunterston, Scotland; and
- LS Cables of South Korea announced plans in May 2025 to set up a facility in Tyneside[8].

XLCC have received a £20M investment from the UK Infrastructure Bank, towards the establishment of a manufacturing facility in Hunterston, Scotland[9] which is targeted to create 900

[7] During the study, XLCC indicated that around 500 jobs would be created in their facility, aligning with estimates from LS Cables of 500 direct manufacturing jobs, and SEUK of 330 direct jobs in Scotland.

[8] See https://www.world-energy.org/article/51918.html

[9] See https://www.thebank.scot/xlcc

skilled jobs. XLCC also have a partnership with Ayrshire College to recruit and train apprentices in specialist welding, electrical engineering and cable jointing[10]. SEUK announced their plans for a facility in the Scottish Highlands in May 2023 and have secured up to £24.5M in UK public sector support[11].

Key stages in HVDC cable manufacture typically include (see Figure 8):

1. Smelting copper to make rods 8-9mm diameter
2. Drawing of the rods into wires
3. Stranding or twisting of the wires into bundles 10-60mm diameter
4. Further stranding of the bundles
5. Insulation of the cable, for example high temperature / high pressure extrusion of cross-linked polyethylene (XLPE), sheathing of the cable and cooling.
6. Armour layer – enclosure of the conductor in metal or lead
7. Outer sheath PVC or PE extrusion.

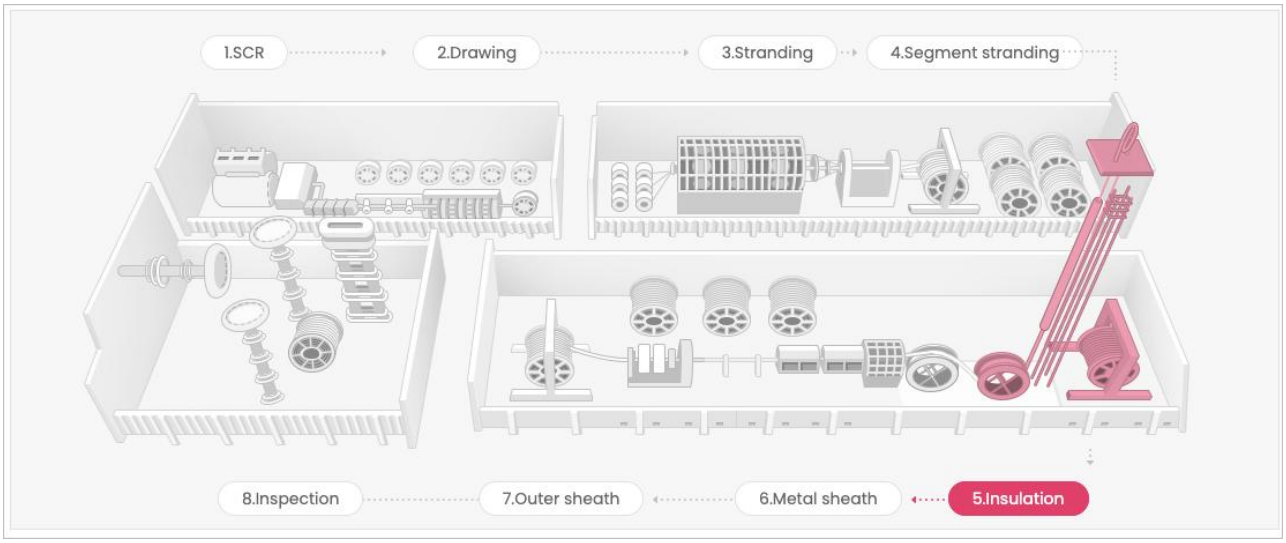

Figure 8 – Illustration of High Voltage Cable Production Facility (Image: LS Cables)

Other cable manufacturers with facilities in the UK include Prysmian and JDR, though these companies are not currently producing HVDC cable within the UK.

In addition to the cables themselves, this cycle considers the system-level design and engineering activity, and production and integration of associated equipment such as convertors. GE Vernova and Siemens Energy are two manufacturers of HVDC convertors and associated systems with bases in the UK, who participated in this study.

[10] See https://www1.ayrshire.ac.uk/news/ayrshire-college-and-xlcc-launch-recruitment-drive-for-engineering-apprentices/

[11] See https://www.sdi.co.uk/news/funding-agreed-to-secure-350-million-inward-investment-project

2.4 Cycle Scope and Boundaries

The scope of the foresighting topic was further explored during the verification workshops by mapping key tasks against supply chain and lifecycle and constrained by considering specific topics that would be outside of scope.

Agreeing the scope boundary is a process of discovery and requires some flexibility through the workshops; for example, the scope can be a function of which organisations engage and supply participants. The goal is to find a 'goldilocks' zone which is neither so broad that it is impossible to cover all the organisational capabilities needed, nor so specialist or niche such that the findings will be of very limited applicability.

Activities	Cycle 5: High Voltage DC Systems
Design	• The design of the cable itself (Cable OEMs – Sumitomo, LS Cable, XLCC) • Design of ancillary equipment such as convertors (e.g. Hitachi, Siemens Energy, GE Vernova) • Design of other components in the cable system such as connectors, flotation, protection, where this differs from designs for existing cable systems.
Make	• For 'make' the study will consider principally the production of the cable and major equipment such as convertors.
Installation & Commissioning	• Cable lay will not be included in scope: The marine cable lay operation for HVDC is unlikely to be differentiated significantly from AC. • Cable jointing may be covered, since (i) this is a scarce skill area, and (ii) possible that there are some differences due to e.g. cable extrusion or alternative material uses. • High voltage switching in general is a scarce skill (lack of Senior Authorised Persons).
Use, O&M	• The O&M phase is not in scope for the foresighting study.
Regulatory	• Regulatory aspects may be considered where there is a change to the capabilities / skills c.f. existing AC cable systems.

Table 2 - HVDC Workforce Foresighting Study Scope

3. Findings and Results

3 FINDINGS AND RESULTS

3.1 Capabilities

The technologist and employer workshops in this foresighting study identified an initial set of 131 capabilities[12] relevant to the topic. Of these capabilities:

- 97 capabilities were adopted from the Workforce Foresighting Data Cube, of which -
  - *41 were from existing UK IfATE or O*Net standards.*
  - *33 were from the previous ORE Catapult Dynamic Cable Systems study.*
  - *23 were from other Workforce Foresighting cycles.*
- 12 capabilities were adapted (modified) from other Workforce Foresighting cycles.
- 22 capability statements were newly defined by the study.

The newly created and adapted capabilities are listed in Appendix 3 on page 49.

3.1.1 Sensemaking and FOP Guiding Principles

When developing Future Occupational Profiles, it is useful to define a set of guiding principles within the framework of the Workforce Foresighting Employer workshops. These help to understand what a particular group of occupational profiles are designed to achieve. The guiding principles help participants to make sure that a profile title is descriptive of its intent and then help to determine whether a capability belongs in a profile. The guiding principles for defining the future occupational profiles within this cycle were:

- Develop and design cable systems and HVDC equipment.
- Manufacture cables and equipment.
- Carry out grid / network design and system integration.
- Support installation.

The capabilities are grouped into eighteen future occupational profiles (‘FOPs’). The purpose of the FOPs is to indicate coherent groups of capabilities that can be used as a basis in skills analysis, job design, and education / training curricula. The FOPs are not job descriptions, and it is possible that one job may encompass parts of several FOPs or specialise into part of only one FOP. These resulting FOPs now form the basis for ongoing discussions and the “causing action” phase of workforce foresighting.

3.2 Resulting Future Occupational Profiles

The Future Occupational Profiles are fully stated in Appendix 5 from page 56.

Table 3 summarises the titles of the profiles by role family, against each of the guiding principles defined. The capabilities within one FOP could be relevant to another stage of work or part of the supply chain. The table also considers which supply chain activity type the FOP fits with primarily

[12] An organisational capability is defined in workforce foresighting as a specific activity that enables or improves organisational performance. A capability is likely to be performed by or involve multiple employees and might use specific tools or methods. An example capability statement is “Design policies and procedures for robotic and autonomous systems-based operations in offshore wind.”

(P) or additionally (+). Ultimately industry will determine how and where capabilities are deployed but the FOPs and alignments should provide a basis for role design and skills development.

The role families indicate the general level of qualification or equivalent experience that might be expected for a given profile:

- Role Family 1 (RF1) profiles are at an entry grade technician or operator level.
- Role Family 2 (RF2) profiles are intended for senior technicians and operators.
- Role Family 3 (RF3) profiles are graduate / junior engineer level.
- Role Family 4 (RF4) profiles are pitched for senior engineering levels, specialist scientists or equivalent.

RF	FOP	Develop and design HVDC cables & equipment	Manufacture HVDC cables	Grid / network design and integration	Installation and field support
1	Cable Production Operator		P		
2	Cable Production Supervisor		P		
3	Development and Test Engineer	P	+	+	
	Cable Design Engineer	P		+	
	Cable System Engineer	P	+	+	+
	Cable-Lay Equipment Engineer				P
	HV Field / Offshore Engineer			+	P
	Electrical Engineer – HVDC Equipment Design	P		+	
	Electrical Engineer – Machine Learning (ML) & Automation	+	P	+	
	Electrical Engineer – Network Design	+	+	P	
	Quality Engineer		P		+
	Supply Chain & Logistics Manager		P		+
	Continuous Improvement Engineer	+	P	+	
	Factory Maintenance Engineer		P		
4	Factory Manager		P		
	Offshore Installation Manager			+	P
	HVDC System Integration Engineer	+		P	+

Table 3 - Applicability of Future Occupational Profiles to Supplier Activity Types

3.3 Future Occupational Profiles versus Existing Provision

The following table shows the closest fitting existing standards to each of the FOPs identified, according to the Workforce Foresighting methodology. The fit factor (FF) shows the percentage of capabilities assessed by the large language model (LLM) to be a 'match'[13]. The surplus factor (SF) shows the percentage of capabilities in the foundation standard, that do not match into the FOP. The delta count (Δ) shows the number of capabilities in the FOP that are not matched within the

[13] The match is based on a system threshold setting of 0.49.

foundation standard (in other words, how many capabilities a worker might need training in, if moving from a role in the foundation standard to one based on the future occupational profile).

An existing provision is considered a 'fair' or 'good candidate' for adoption if it has a fit factor above 50% - in other words, 50% or more of the capabilities in the FOP show a match with the capabilities in an existing provision. Where there is a 'fair' or 'good' candidate for adoption, the list of extra capabilities compared to the standard is given in Appendix 3 on page 49. These standards may therefore provide 'pathways' for development of the FOP roles – but as discussed in the table, the Data Cube does not alone give reliable guidance.

The pathways indicated by the Data Cube are a steer for educators and industry to develop new learning provision or CPD. They are by no means the only pathways, and the absence of an identified pathway tends to indicate that the role has a higher proportion of new or adapted capabilities. Domain-specific language within a capability naturally reduces the degree of matching. These factors mean it is difficult for the AI to match it to an existing standard. The language model cannot distinguish between capabilities that are typically trained or taught, versus those that are learned 'on the job'. Therefore, the AI matching is considered as the basis for an informed approach, and a means to highlight options that may not have been considered previously, rather than being prescriptive.

RF	FOP	Foundation standard	FF	SF	Δ	Comment
1	Cable Production Operator	Battery Manufacturing Technician	71%	38%	4	Various factory operator apprenticeships would provide a reasonable entry route into this role, but those with an electrical bias or relating to continuous vs batched production may be more appropriate. The two examples here show good fit factor with the capabilities in the FOP; Textile Manufacturing Operative also scored well (FF 64%).
		Lean Manufacturing Operative	57%	30%		
2	Cable Production Supervisor	Battery Manufacturing Technician	65%	38%	7	The repeated fit of the battery manufacturing technician is to be expected due to the similarity of the operator and supervisor role. In practice, it may be expected that a supervisor progresses from an operator role; however, at initial plant set-up this role may require a cross-sector or experienced hire.
		Machining Technician	65%	38%	7	
3	Development and Test Engineer	Electro-mechanical Engineer	33%	45%	14	This type of FOP is likely to fit an electrical or mechanical engineer, so at a certain level the AI match is logical. Like most Role Family 3 and 4 roles, candidates are more likely to be sourced from degrees rather than apprenticeships.
	Cable Design Engineer	No matches > 25%	-	-	-	No good system matches here. In practice, an electrical or mechanical engineering degree is the expected foundation for this role, with proficiency achieved through on-the-job training and practice.

RF	FOP	Foundation standard	FF	SF	Δ	Comment
	Cable System Engineer	No matches > 25%	-	-	-	NB – 'Power industry overhead linesperson' is matching with 27% FF, however while language in some capabilities is similar the practical context is quite different (e.g. "undertake fault-finding activities on power distribution networks" is matching to "Undertake design and optimisation of undersea high voltage direct current cables".) In practice, an Electrical Engineering degree is the expected foundation for this role.
	Cable-Lay Equipment Engineer	Robotics Engineer - degree	33%	82%	10	A mechanical engineering degree would also be a good entry route here. Proficiency in this role would be largely achieved through on-the-job training and practice.
	HV Field / Offshore Engineer	Electrical power protection and plant commissioning engineer	73%	10%	6	The unmatched capabilities in the FOP include those specific to cable manufacture (e.g. jointing) or offshore working.
	Electrical Engineer – HVDC Equipment Design	Electrical power protection and plant commissioning engineer	47%	30%	10	There are 2-3 moderate power system / network matches, the principle difference being the design orientation of the FOP vs use / implementation focus of the IfATE roles. An electrical engineering degree plus on-the-job training is the most likely pathway to this FOP, in practice.
	Electrical Engineer – Machine Learning & Automation	Digital manufacturing engineering leader	42%	0%	7	Fit driven by aligned digital capabilities. IfATE currently lacks other standards dealing with Industry 4.0, AI or Machine Learning – this is therefore the best fit existing standard. In practice, role occupants dealing with this FOP probably have an engineering degree, covering the ML / Automation content either as part of the degree, on-the-job training, of additional training.
	Electrical Engineer – Network Design	Electrical power networks engineer	28%	40%	18	A logical match: the low fit is driven partly by a relatively large number of capabilities in the occupational profile, and unmatched areas in the IfATE standard such as project management, using IT, and stakeholder communications.

RF	FOP	Foundation standard	FF	SF	Δ	Comment
	Electrical Engineer – Power Networks	Electrical power protection and plant commissioning engineer	48%	10%	11	The best system match is “Rail engineering technician” (FF 52%) which exhibits similarities in language but differing practical context (e.g. “Diagnose and rectify complex faults in traction and rolling stock systems” matched with “Carry out fault finding of high voltage direct current electrical systems”). In terms of the plant commissioning engineer, elements of the FOP not satisfied by the IfATE standard role include those dealing with smart analytics, virtual environments, component architecture. In practice, an electrical engineering degree with a bias towards grid networks, is a likely entry route to this type of role.
	Quality Engineer	Food industry technologist	71%	39%	5	Common language around standards, compliance, and raw materials drives several matches here. Quality engineering degrees, or progressed quality technicians from engineered equipment backgrounds, are a likely pathway into this FOP.
		Electro-mechanical engineer	53%	55%	8	
	Supply Chain & Logistics Manager	Supply Chain Practitioner, FMCG	69%	46%	4	The matched capabilities are relatively generic and not industry specific. Unmatched capabilities within the FOP include sustainability, material handling automation, and material requirement estimations.
		Supply Chain Leadership Professional (integrated degree)	62%	22%	5	
	Factory Maintenance Engineer	Mechatronics Maintenance Technician	79%	48%	3	With seven matches having FF >50% this is the best matched FOP in the set; however, the first six matches are technician rather than engineering grade roles. This FOP may be pitched at the wrong level (e.g. should be a technician / RF2 profile).
		Science Industry Maintenance Technician	71%	40%	4	
	Continuous Improvement Engineer	Digital manufacturing engineering leader	63%	0%	7	Digital and continuous improvement capabilities are well-matched here.
4	Factory Manager	Materials Process Engineer	44%	65%	9	Gaps in the IfATE standard compared to the FOP principally relate to supplier management, and to a lesser degree data / digital. While this match be indicative of useful background, it is likely that general management / operations management and (where possible) domain experience are the principal requirements in this kind of role.

RF	FOP	Foundation standard	FF	SF	Δ	Comment
	Offshore Installation Manager	No matches > 25%	-	-	-	
	HVDC System Integration Engineer	Electro-mechanical engineer	35%	55%	15	As a specialist engineering role, this profile is likely to be fulfilled by an electrical engineer with experience gained on-the-job in the HVDC field.

Table 6 - Comparison of Future Occupational Profiles with Existing Standards

4. Conclusions and Next Steps

4 CONCLUSIONS AND NEXT STEPS

4.1 Ongoing Process Improvement

Workforce Foresighting – as a process – seeks to balance development and stability across multiple cycles. This carrying-out phase included several adjustments to process and workshops, compared to earlier cycles. Some of the points for consideration identified during this cycle include:

- It has been useful to see all capabilities and occupational profiles 'in one view' through later meta-analysis. This would also be useful to participants as part of the sensemaking activity around QA4 / Workshop 2B stages. This would allow for better visual comparisons and assignment of capabilities within and between FOPs.
- Focussing participants' attention on differentiating capabilities (future state versus current state), seems to be an important part of foresighting. The 'map and gap' approach may benefit from refinement to deal with FOPs that have a high proportion of these types of capability.
- Broadening the qualification level filter helps to identify matching standards, if there are few returns within a presumed FOP qualification level.
- Replacement of AI generation of the occupational profiles with a workshop approach is beneficial and is helped by the experience and insights of participants.
- ORE Catapult have begun a 'meta' analysis of the capabilities identified across the five workforce foresighting cycles carried out around offshore wind so far, to see if this highlights any emerging patterns.

4.2 "Carrying Out" Phase Recommendations

Broadly, the existence of the energy skills assessment within the Clean Power Action Plan 2030 (Department for Energy Security and Net Zero, 2024) – and its reference to foresighting – is encouraging. Planned and current national developments including the Skills England set up, regional skills initiatives, the industry Skills Passport project, and the forthcoming Office for Clean Energy Jobs, all point towards a growing focus on getting the right talent in place – and the awareness that timing grows tight.

The principal recommendation is to continue this foresighting study into the 'causing action' phase. Validating the FOPs with industry is the first step in that journey. It is also necessary to consider foresighting alongside forecasting and current course provision, and in the context of related work such as the OWIC critical skills analysis.

Based on the FOPs identified, as well as background research, high voltage electrical engineering and power systems engineering are key to this topic, and likely to require degree-qualified engineers with professional development in these areas, as well as electrical engineers at post-graduate level in more specialist technical areas. Mechanical engineering is a key foundation to design work, manufacturing process and installation techniques. There are probable gaps around diagnostics, condition monitoring, digital and data science highlighted through the FOPs as well as background research. Core production, manufacturing and manual skills, in particular cable jointing as well as quality control, are likely to be in demand – these may be fulfilled through apprenticeship routes or well as on-the-job training. Finally, there are needs around regulatory and policy expertise,

project management, and logistics, that are likely to require some domain-specific or on-the-job training and development. Work to map out and understand these career pathways is recommended.

The Clean Power Action Plan 2030 notes that "Most of the workforce we need for 2030 is already employed, so retraining, upskilling and increasing the transferability of workers between sectors is essential." In terms of foresighting this is an interesting assertion, as it *suggests the focus should be on professional training delivery rather than apprenticeship and degree provision*. At the same time, the energy skills assessment also considers the "pressing need to train the younger generation to ensure long-term talent supply" in STEM skills. It cites findings by WorldSkills UK that 63% of 16–24-year-olds have never heard of 'green skills', and that only 27% of those who have heard of 'green jobs' could explain what the term means. Continuing educational outreach is therefore also important.

4.3 Next Steps – "Causing Action"

In the next phase of the foresighting cycle ORE Catapult will work with stakeholders to identify and initiate actions to close the potential future skills gaps identified through foresighting, considering the volume of likely roles determined by forecasting. This work will include:

1. Incorporating feedback from industrial participants and other reviewers of the future occupational profiles and capability sets.
2. Developing forecasts that help to understand component volumes and the expected role numbers.
3. Consider likely career / training pathways to competency in roles aligned with the future occupational profiles and compare these with the sixteen priority roles mapped by the Offshore Wind Industries Council (OWIC) 'Investment in Talent' group.
4. Initiating a working group across HVDC cable system manufacturers, ancillary equipment manufacturers and their skills partners, to focus on the skills value chain for production facilities, including:
    a. Working with further and higher education partners, as well as industry training organisations, to identify potential course module content – based on foresighting and forecasting, and relevant Knowledge, Skills and Behaviours.
    b. Seeking to extend the group to include LS Cables, who in May 2025 announced an intention to establish a cable manufacturing site in the Northeast of the UK.
    c. Encouraging a champion for development of skills in HVDC in the UK renewables sector.
5. Evaluating the opportunity for further foresighting studies in high voltage electrical engineering in UK offshore wind.
6. Continuing ORE Catapult educational outreach and building awareness of 'green jobs' and encouraging young people into STEM skills.

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5. Appendices

6 APPENDICES

APPENDIX 1 ABOUT WORKFORCE FORESIGHTING

A1.1 The purpose of workforce foresighting

Our Vision: To foster the organisational capabilities and workforce skills required to adapt to continuing change and enable adoption of innovative technologies to enable a prosperous UK industry.

Our Mission: To provide the process, insight and recommendations required to identify and address future skills demands to enable the UK to adopt innovation and succeed in the dynamic global marketplace.

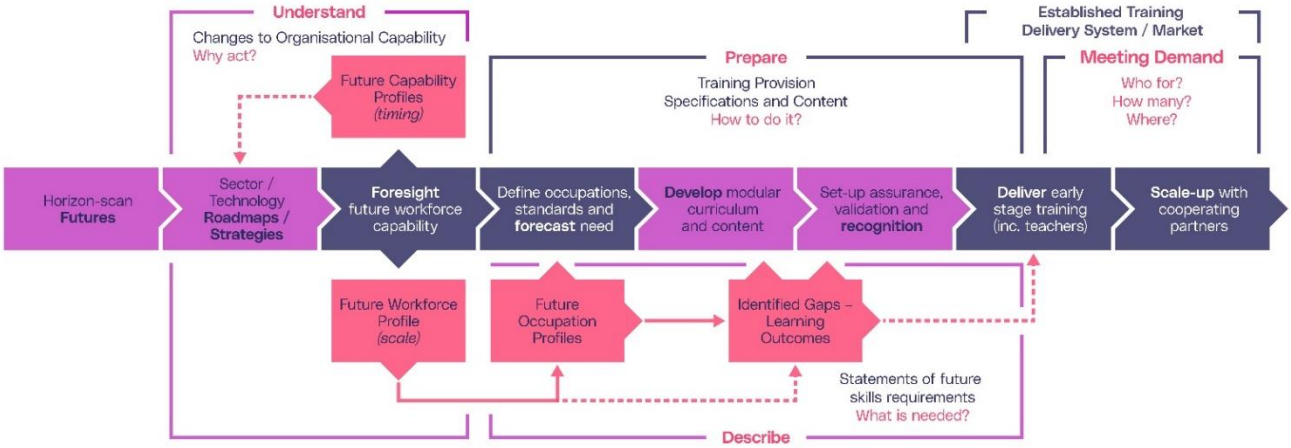
Our Goals:

- **Define** future capabilities required across a sector in response to a challenge, or technology innovation and consequently define the skill sets of the workforce of the future.
- **Understand** and explain gaps between technology adoption, organisational capability and workforce profiles that could hamper innovation.
- **Identify** and communicate insights, future requirements and the action required by industry and educators.
- **Enable** and deliver a consistent approach to workforce Foresighting.

Outcomes:

The process integrates insight from experts in three categories – domain specialists/technologists, employers, and educators. Using a structured and facilitated series of collaborative information-gathering workshops, combined with data from open-source global data sets, the workforce Foresighting process can produce a wealth of detailed quantitative data to inform action.

At the heart of the Foresighting process are working groups consisting of the industry sponsor and centre of innovation, with support from the Workforce Foresighting Hub team, who undertake detailed analysis to report and summarise key data insights and recommendations for action. This report details future supply chain capabilities, prototype future occupational profiles and identifies changes required to current training provision for the sponsor to take forward and address skills challenges relating to the specific topic.



Workforce foresighting is a data intensive approach that can provide sponsors, stakeholders and participants with detailed insight about future workforce requirements. A dynamic data set is provided for each cycle to allow all stakeholders and participants to freely access and interrogate the data. Additionally, the WFH team will support the production of a report that provides targeted recommendations that require action to address gaps in training and education provision relevant to the challenge and planned technology solution.

The dynamic data portal provides a range of standard data sets and visualisations. Additionally, users can download data to undertake their own more detailed interrogation of data to guide and inform subsequent actions.

The key aspect is to provide insight about gaps – which capabilities required in the future are NOT addressed by aspects of current provision – apprenticeship standards, qualifications or other provision. Gaps represent:

Short term CPD – topics required across the workforce to upskill members of current workforce.

Medium term – topics to be included as current provision / standards are reviewed and updated.

Longer term – new qualifications and standards that may be needed to equip new entrants.

The insight produced by a workforce foresighting cycle (project) provides:

- **Technologists** and technical leads with insight of the organisational capability sets required across future supply chain partners in response to the identified challenge.
- **Employers** with insight about possible future roles and occupations that may be required across the whole workforce, operators to researchers, to ensure they are equipped and ready.
- **Educators** with details of the gaps to be addressed by short-course training to upskill the existing workforce and insight about qualifications and provision that will be required to support new entrants in the future.

A1.2 Principles and implementation

The core of workforce Foresighting is convening three groups of relevant specialists to conduct structured, Delphi-style, facilitated workshops to capture and discuss the set of organisational capabilities that will be required to respond to and exploit technology innovation.

Organisational capabilities are captured using a bespoke classification that has been developed by the Workforce Foresighting Hub. The classification uses a structured common language to enable cross sector and cross centre collaboration and integration of data. Additionally, the classification enables data from several other national and international open-source workforce datasets to be integrated through the same common language. This data is held in a cloud based "Data Cube" that is dynamically growing as each workforce Foresighting cycle adds to the shared data relating to future workforce capabilities.

Using innovative AI and Large Language Model data tools, the Data Cube is used to undertake detailed analysis to 'map' future workforce capability requirements against the current education and training provision to identify where existing provision can be used and where new provision, CPD or qualifications are required.

As an agile development project, the Workforce Foresighting Hub team are constantly evolving and improving the detailed workshop process and workshop approach, but always consists of the following stages:

Considering – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as Foresighting topic suggestions align with strategic priorities.

Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for Foresighting.

Preparing – The convening of specialists and scheduling of workshops

Carrying out – Run Foresighting workshops with experts, collate and analyse data.

Communicating – Insights, findings and recommendations gathered from all research in report.

Causing action – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of Foresighting.

A1.3 Capability Classification and The Data Cube

During the 'carrying out' phase, capabilities are defined and articulated using a classification system developed by the Workforce Foresighting Hub. This classification builds upon Existing published and widely used national and international frameworks including the Occupational Information Network (ONet) US[14]; European Skills, Competences, Qualifications and Occupations

[14] https://www.onetcenter.org/

(ESCO)[15]; National Occupational Standards, UK[16]; and the Institute for Apprenticeships and Technical Education (IfATE)[17], England.

This classification has been used to build a data repository, referred to as the 'Data Cube' – see figure below – which underpins the workshops and related activities of the carry out phase. Data is input using a common language, which means that any centre conducting similar activities can describe capabilities in a consistent format and vocabulary. The Data Cube integrates information from ONet, ESCO, NOS, IfATE and other open-source databases, again, using the same common language. The result being a database that is exponentially growing with rich data relating to future workforce capabilities.

The Workforce Foresighting process uses an information architecture built on five functional areas which are common to any business:

Design	The function of an organisation that focuses on activities relating to product, service or solution design.
Implement	The function of an organisation that focuses on activities relating to producing / making / providing its products or services.
Logistics	The function of an organisation that focuses on activities relating to procurement, delivery, materials, or services necessary for operations – service / manufacturing, etc.
Support	The function of an organisation that focuses on activities relating to users, in-service support, repair / maintenance, recycling, end of life disposal.
Enterprise	Core functions of an organisation - e.g., strategic planning, leadership and management, human resources, digital backbone and data systems, integration of relevant statutory / regulatory requirements and compliance.

The five root functions comprise around 40 domains which are broken down to around 140 functional areas. The architecture is used to position ~ 30,000 capability statements which are the building blocks used in the workforce foresight process. Each capability statement has several attributes - some are static and reflect the position of the capability statement in the architecture, whilst others are dynamic and are assigned values through a cycle and set of workshops.

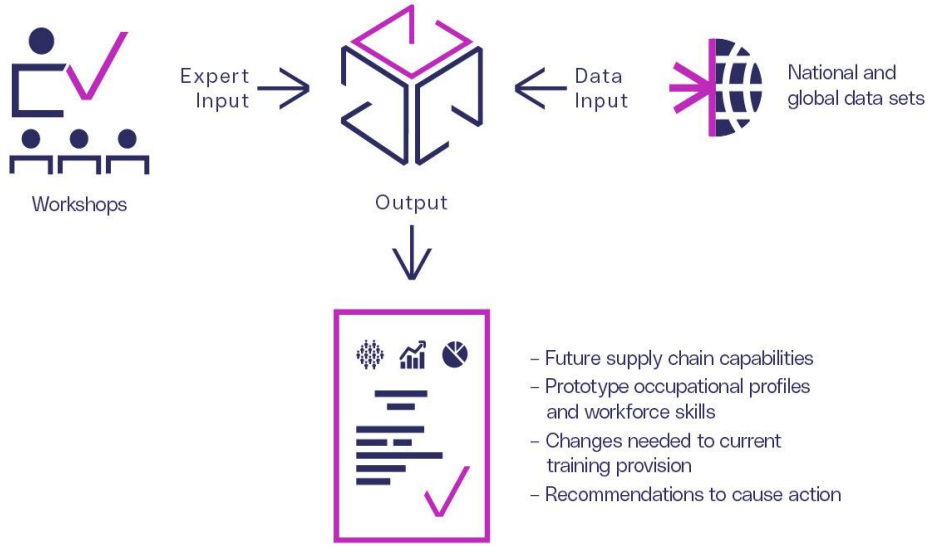
The data architecture is implemented in a bespoke 'data-cube' which underpins the foresight process, workshops, and enables extensive use of LLM and AI tools. Additionally, a key feature of

[15] https://esco.ec.europa.eu/en

[16] https://www.gov.uk/government/publications/national-occupational-standards

[17] https://www.instituteforapprenticeships.org/

the data-cube is that the data from each foresight topic cycle is added into the data set and can then be used, where relevant, in future cycles. This ensures that the capabilities of the system are dynamic and up to date.



AI large language models are used to analyse workshop input in terms of capability statements, compare these to existing capabilities in the Data Cube, and generate clusters of similar capabilities as potential future occupation profiles.

During the workshop sessions and output, the Data Cube is used to 'map' the future workforce capability requirements (FOPs) against the current education and training provision, providing a 'map and gap' analysis.

A1.4 Step-by-Step Overview of Workforce Foresighting Methodology

Summary information is provided with a narrative based on the underlying data which is also provided using bespoke visualisations to enable greater insight and access to detail. The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers.

A1.4.1 Step One – How Will the Supply Chain Change? Organisational Changes

Exploration of organisational changes provides insights into how organisations will need to adapt their current capabilities to implement the solutions that respond to the challenge addressed by the foresighting project.

Typically, organisational changes will also require the adoption of new capabilities and a change in the distribution of these capabilities across supply chain partners. The change in capabilities within an organisation as well as their supply chain partners will determine the changes knowledge and skill changes required by the role groups within the workforce of each Supply Chain partner.

A1.4.2 Step Two – How Will the Workforce Change? - Occupational Changes

A set of 'Future Occupational Profiles' (FOPs) is produced by the foresight process that demonstrates how current occupations may need to change in the future. FOPs are generated using a combination of attributes from the underlying capability classification and from data collected in the workshops. The FOP generation algorithm works to group capabilities into logical sets reflecting role levels, function, proficiency and capability similarity. As part of the foresight process the generated FOPs are reviewed, revised and distilled by the Employer group. The agreed set of FOPs are then compared with selected current education provision; the default reference is the set of Institute for Apprenticeships and Technical Education (IfATE) apprenticeship standards; to assess which current training and education provision could be used in the future. Two bespoke metrics - match and surplus - are used to evaluate the alignment of current provision with the set of FOPs proposed. Summaries are presented of the key findings related to each Supply Chain partner.

Findings are aimed at both Employers, and Education and Training Providers, and identify matches and gaps in future training needs compared with current provision to guide further detailed investigation.

A1.4.3 Step Three – Highlighting Changes for Future Educational Provision

The report identifies suggested changes to education and training provision – principally apprenticeship standards that will deliver the knowledge, skills and behaviours required by future occupations. In some cases, this will include the development of short courses and continued professional development (CPD) to upskill the current workforce to meet future needs. Additionally, foresighting outputs can be used to develop programmes, qualifications, and apprenticeship standards for new entrants to the workforce joining via apprenticeship, taught qualification, or other training programme.

The insight and data in this part of the report are primarily aimed at educators training providers, apprenticeship standards bodies and awarding organisations. Combined with insight arising from the Supply Chain capability changes, the provision insight offers an effective way for employers to identify training opportunities that align to their future needs.

The Workforce Foresighting process has developed two metrics to quantify the alignment between a FOP and a current standard or qualification:

> **Fit** – expressed as a %, it is a measure of the proportion of a FOP that is covered by an existing standard or qualification.
>
> **Surplus** – expressed as a %, it is a measure of the not relevant material in an existing standard that is not required for a FOP.

An ideal existing qualification or standard would have a high fit and low surplus – this implies good coverage of the FOP but with little material that is not relevant to the FOP. Conversely a poor candidate would have a low fit and high surplus. Using these two metrics it is possible to quantitively evaluate, rank, and compare a range of existing provisions against a set of FOPs describing future needs.

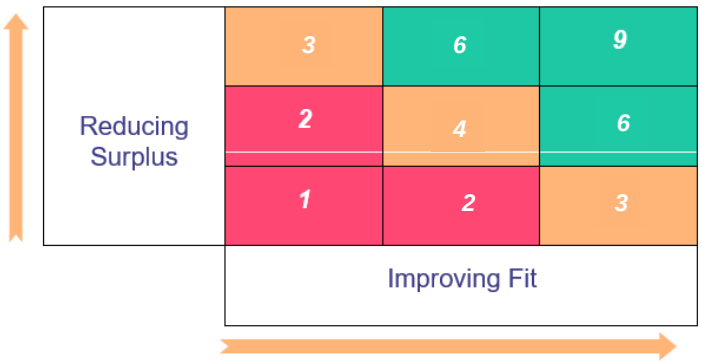
Our (Workforce Hub) interpretation is represented by a simple nine-box model to position the suitability of a given current occupational standard to a future occupational profile:

Factor scores

Fit Factor	Fit score	Surplus Factor	Surplus score
0 - 32%	1	81-100%	1
33-65%	2	51-80%	2
66-100%	3	0 - 50%	3

(Multiplying the Fit score by the Surplus score gives a Suitability Grid score of 1-9 as below)

Suitability Grid



Fit Factor scores and Suitability Grid

Using this score and indicated 'RAG status' the following interpretations can be made:

High Suitability – 6,9 – for standards that have good coverage of FOPs.

Represents good candidates from current apprenticeship standards used as the basis of development to meet FOP requirements and inform elements of short course and CPD provision.

Some Suitability – 3,4 – for standards that have only partial coverage of FOPs.

These are likely to require extended work to meet FOP requirements, further review of the data may be necessary. They are likely to contain some useful information to inform elements of short course and CPD provision.

Low Suitability – 1,2 – for standards that have poor coverage of FOPs.

These are unlikely to be adaptable to meet future needs but may contain some useful information to inform elements of short course and CPD provision, which can be assessed using the data visualisation tools.

APPENDIX 2 ONLINE DATA VISUALISATION TOOL

The interested reader may wish to access the online data visualisation tool which provides several different ways to view the cycle data. Links to relevant parts of the tool are given with brief guidance below[18]. This content is provided and maintained by the Workforce Foresighting Hub.

Visualisation Tool Section	What is it and what can it be used for?
Data Capture Overview	Provides a summary of the data captured across the foresight cycle, bringing together the work of the Technologists / Domain Specialists, Employers and Educators into one overview.
Supply Chain Capabilities	Provides an overview of the identified capabilities at a Supply Chain / Workflow Partner level. By selecting/deselecting each Supply Chain / Workflow Partner you can review the capabilities identified as required in that area of the Supply Chain / Workflow. This can be used to generate organisational capability profiles for each area of the workflow /supply chain to help prioritise and focus the acquisition of new capabilities that will be required in the future. It can also be used to generate combined organisational profiles, where an organisation may be involved in more than one area of the supply chain.
FOP Detail	This page allows you to review a specific Occupational Profile, including the capabilities contained within it and the Knowledge, Skills & Behaviour (KSB) tags associated with the capability. You can select an individual Role Family and linked FOP in the two available dropdowns. The table in the lower section of the page will then be populated with all relevant capabilities. The search control above the table allows you to filter content of any of the columns of data. A key piece of functionality in this table is the presence of the KSB tags associated with the capabilities.
FOP Matrix	Provides a detailed breakdown of future occupational profiles that could be required in the future workforce. These were generated using a combination of attributes collected through the workshops and an algorithm. These suggested profiles were then reviewed and ratified by small groups of employers who were able to add/remove capabilities and uprate/downrate proficiency levels required. You can view all the FOPs in a role family by selecting one (or more) of these from the drop down. This will then allow you to select the FOPs aligned to that role family. The populated table allows you review and compare different FOPs within or across role families. You can view the capabilities in each FOP and the assigned proficiency levels. You can also toggle 'Hide Empty Capabilities' on/off to reduce the view down to only those capabilities included in the role family you are reviewing.

[18] The URL to access the visualisation tool is https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=76e203a506f8346fae9d4ec40d981f07

Visualisation Tool Section	What is it and what can it be used for?
Future KSBs Summary	Not yet completed in this cycle. Provides a view of the complete set of capabilities within the cycle along with all of the associated KSB tags which are linked to them. It is, essentially, the superset of all details displayed on the FOP detail page. This is used to: • To review the identified Knowledge, Skill and Behaviour tags for a given capability, to support development of future education and learning material. • To review the requirements from a capability level, rather than a role family/occupational profile grouping.
FOP Distribution	This page allows provides a breakdown of the Capabilities within the selected Cycle and how they are distributed across the FOPs with the addition of a distribution chart showing the required proficiency across those FOPs. Clicking the "View FOPs" button alongside each capability will provide a list of the proficiencies (EPA) with the FOPs that fall into them. The exported version of this data will include a full breakdown of the FOP IDs which contain the capability within a specific proficiency. This is used to: • understand the levels/volumes of common/crossover Capabilities, to support prioritisation of Capability Development • identify which Occupational Profiles contain these common/crossover capabilities, and so which may be prioritised for development activity
Capabilities Matched to Current Provision	This page allows you to review and compare individual capabilities against 'Duty' statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level and the Duty Statement this is matched to. You can filter in several ways to focus your review: • By the Capability Classification Framework (left-hand panel). • By capabilities that **are** served by the reference mapping framework – the default is Institute for Apprenticeships and Technical Education (IfATE) provision. By capabilities that **are not** served by the reference mapping framework, e.g., IfATE provision – these are capabilities required in the future that may require new/bespoke training and CPD materials to be developed to upskill/re-skill the workforce. This page can be used to identify where existing provision may exist across the broad spectrum of Occupational Standards, and not just within a narrow range of sector-specific Standards. The data also allows you to identify where provision may already exist to support specific capabilities.
Fit & Surplus Factors	This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). It is possible for the 'Fit' and 'Surplus' comparison to total over 100%, as they are two separate calculations based on a two-way comparison.

Visualisation Tool Section	What is it and what can it be used for?
Fit & Surplus Matrix	This page is a visual representation of the 'Fit and Surplus Factor' insight. You can visually review 'Fit' and 'Surplus' of Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). This can help you identify which provision may align strongest, or which may require adaptation, to provide the suitable provision fit for each future role. It will help you focus in on which provision to focus your attention for analysis.
FOP Capability Matches	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (IfATE) Duty Statements. Clicking the arrow next to a number in the 'Matches' column will open a popup with more detail for each Capability. Each capability also includes Knowledge, Skill and Behaviour Tags, to support with scaffolding future education provision. You can review individual Future Occupational Profiles (FOPS) or review all FOPs under a Role Family, to give a more holistic view of Capabilities and Matches Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements. This can be used to review the capability requirements for Role Families and FOPs, from Job / Occupation level through to Knowledge, Skill and Behaviour level
FOP vs Provision	This page allows you to compare FOPs against existing IfATE Standards. The information here allows you to prioritise effort or action over the short, medium or long-term. This is displayed as a Matched/Not Matched Capability, comparing the Capability in a FOP to the Duties in a Standard. The left-hand side allows you to select the Role Family and FOP, while the right-hand modal allows you to compare against the top 10 matched IfATE Standards for that Occupational Profile. Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements.
FOP Priorities	Provides a list of all the FOPs within the selected cycle with details of their fit and surplus factors. The information here allows you to prioritise effort or action over the short, medium or long-term.

APPENDIX 3 ADAPTED AND ADDED CAPABILITIES

The following capabilities have been created or adapted from others as part of this workforce foresighting cycle:

A3.1 Newly Created [22]

ID	Capability Statement	Function
227898	Use virtual environments and digital twins to prepare or evaluate network diagrams, floor plans, or configurations for existing facilities, renovations, or new systems.	DESIGN
227909	Adapt high-voltage safety systems to enhance protection during operations with complex direct current systems.	DESIGN
227896	Evaluate system modification requests to determine feasibility and necessary actions based on critical thinking and past experience.	DESIGN
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.	DESIGN
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.	DESIGN
227915	Consider interchangeability / inter-operability when designing system components, to optimise system flexibility and lifecycle cost.	DESIGN
227527	Design and develop high voltage direct current (HVDC) systems for offshore wind using advanced simulation and modelling tools.	DESIGN
227905	Adapt cable lay vessels and methodologies to improve the economics for HVDC installations.	DESIGN
227907	Design circuit breaker systems to ensure HVDC networks function safely and consistently regardless of the equipment supplier.	DESIGN
227908	Develop insulation materials for high-voltage direct current (HVDC) cables to enhance performance and durability.	DESIGN
227916	Understand system-level electrical transmission design in the early stages of the project lifecycle, to reduce grid connection and commissioning costs.	DESIGN
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE
227904	Analyse models or simulations to predict the performance of products or systems and ensure system resilience.	ENTERPRISE
227914	Apply smart analytics and machine learning to operational data from high-voltage convertor systems to maximise performance.	IMPLEMENT
227911	Develop switches and circuit breakers suitable for use in HVDC networks to ensure safe operation.	IMPLEMENT
227913	Incorporate data and condition monitoring into the design of high-voltage convertor systems to enable smart operation.	IMPLEMENT
227906	Devise a standardised architecture for HVDC components to improve compatibility and interchangeability within and without the business.	LOGISTICS
227918	Consider product repair, operation, maintenance and disposal during the design phase, to ensure maintainability by operators and reduce lifecycle costs.	SUPPORT
229007	Undertake mechanical system design of undersea high voltage cable systems.	DESIGN
229006	Undertake electrical and power design of undersea high voltage cable systems.	DESIGN
229010	Develop a comprehensive quality management system to ensure adherence to specific manufacturing standards and continuous improvement in high voltage cable projects.	DESIGN

ID	Capability Statement	Function
229011	Inspect high voltage cables for defects using advanced non-destructive testing technology	SUPPORT

A3.2 Adapted from other Workforce Foresighting Cycles [12]

ID	Capability Statement	Function
227893	Research and develop high voltage electrical and power systems for undersea high voltage, direct current cable systems.	DESIGN
227897	Undertake high voltage design and optimisation of undersea high voltage direct current cable systems.	DESIGN
227900	Develop innovative, safe-to-fail technology qualification processes and field integration programmes	DESIGN
227901	Integrate smart grid technology for efficient energy transmission	IMPLEMENT
227899	Document technical specifications and operating standards for high voltage direct current distribution equipment.	DESIGN
227902	Perform maintenance and testing of power transmission submarine and land cable plant and apparatus.	SUPPORT
227903	Carry out fault finding of high voltage direct current electrical systems	SUPPORT
188907	Observe the operation of machinery or equipment to diagnose malfunctions	IMPLEMENT
213139	Operate within an automated, digitalized quality-controlled environment, performing technical quality checks and peer reviews in line with standard operating procedures.	SUPPORT
227031	Create system models to test support systems prior to product deployment	SUPPORT
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.	DESIGN
188979	Use integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN

A3.3 Adopted from the Dynamic Cable Systems Cycle [33]

Although not newly defined or adapted within this cycle, the following capabilities were adopted from the Dynamic Cable Systems study and might otherwise have been created here.

ID	Capability Statement	Function
227893	Research and develop high voltage electrical and power systems for undersea high voltage, direct current cable systems.	DESIGN
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE
188936	Analyse component failures to identify design improvements.	DESIGN
188948	Design solutions for in-situ repair of cable systems	DESIGN
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN
188963	Develop integrated supply chain partnerships / industry forum for exchange of best practice/collaboration	ENTERPRISE
188968	Utilise Smart Operations and Maintenance data analysis and machine learning to better understand cable health.	SUPPORT
188895	Provide statistical and computational tools for system analysis and optimisation	DESIGN
188922	Commission subsea high voltage cable systems and/or components.	LOGISTICS

ID	Capability Statement	Function
188927	Oversee workers in line with safe off-shore working practices - BOSIET and relevant offshore Health and Safety certifications.	SUPPORT
188928	Develop and implement operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems.	SUPPORT
188929	Inspect high voltage electrical instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.	SUPPORT
188955	Use tools such as Orcaflex, UFLEX and COMSOL to better understand both thermal and mechanical fatigue with different material types.	DESIGN
188967	Create a cable reliability database to identify common faults.	SUPPORT
188983	Review electromechanical equipment, materials, components, or systems to meet functional specifications	DESIGN
188894	Analyse job orders, drawings, blueprints, specifications and design data to determine manufacturing process data i.e. Production processes, tool selection, machine speeds, and feed rates.	DESIGN
188921	Install subsea high voltage cable systems and/or components.	LOGISTICS
188923	Handover to operator subsea high voltage cable systems and/or components.	LOGISTICS
188931	Develop and deploy specialised materials characterization procedures for the high voltage, subsea, marine environment.	SUPPORT
188937	Establish the appropriate routing for cables optimisation	DESIGN
188946	Design for recycling - reuse of cable materials after decommissioning etc	DESIGN
188957	Develop Digital Twin of cable system, moorings and substructure including data science / system modelling.	DESIGN
188906	Design undersea elements to minimise the impact of marine fouling.	DESIGN
188909	Undertake preparation, splicing and jointing of HV undersea cables using appropriate tools and equipment.	IMPLEMENT
188939	Design systems to meet Operations & Maintenance i.e. tow-to-port and plug & play	DESIGN
188940	Design equipment for installation of cable system (on vessel and subsea intervention)	DESIGN
188949	Design and Manufacture for de-commissioning/removal of cable systems	DESIGN
188960	Develop lifecycle models of total cost of ownership, i.e. from design, manufacture installation, shipping, handling etc.	DESIGN
188958	Develop tools to model failure costs vs the cost of quality and identify mitigating measures. e.g. location of each Wind Turbine Generator and analyse location specific conditions. cable directions relative to WTG etc	DESIGN
188961	Develop collaborative risk sharing approaches across supply chain for contracting and risk management.	ENTERPRISE
188933	Develop integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN
188942	Use an integrated approach to design of cable systems - i.e. ancillary equipment in the design of systems and early discussions on optimisation and performance	DESIGN
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors	DESIGN

APPENDIX 4 FOPS vs EXISTING STANDARDS

The following tables show the additional capabilities that would need to be added to an **existing standard** in IfATE, to approximate the capability content within the **future occupational profiles**.

A4.1 Role Family 1 - Entry Level Operator / Technician

CABLE PRODUCTION OPERATOR vs BATTERY MANUFACTURING TECHNICIAN

FF 71%
SF 38%

ID	Additional Capabilities Needed
99890	Monitor equipment to ensure proper operation.
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors
227109	Load machinery and tools for operational tasks

CABLE PRODUCTION OPERATOR vs LEAN MANUFACTURING OPERATIVE

FF 57%
SF 30%

ID	Additional Capabilities Needed
168460	Tend and observe equipment and machinery to verify efficient and safe operation.
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors
227109	Load machinery and tools for operational tasks
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.

A4.1 Role Family 2 - Supervisor / Senior Technician

CABLE PRODUCTION SUPERVISOR vs BATTERY MANUFACTURING TECHNICIAN

FF 65%
SF 38%

ID	Additional Capabilities Needed
99890	Monitor equipment to ensure proper operation.
188905	Monitor, analyse and initiate action using condition monitoring data.
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors
227109	Load machinery and tools for operational tasks
188894	Analyse job orders, drawings, blueprints, specifications and design data to determine manufacturing process data i.e. production processes, tool selection, machine speeds, and feed rates.

CABLE PRODUCTION SUPERVISOR vs MACHINING TECHNICIAN

FF 65%
SF 38%

ID	Additional Capabilities Needed
188905	Monitor, analyse and initiate action using condition monitoring data.
94960	Manage the movement of goods into and out of production facilities to ensure efficiency, effectiveness, or sustainability of operations.
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors
227109	Load machinery and tools for operational tasks
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.
227111	Implement lean manufacturing principles to streamline the production process and reduce cycle time.

A4.2 Role Family 3 – Engineer

HV FIELD / OFFSHORE ENGINEER vs ELECTRICAL POWER PROTECTION AND PLANT COMMISSSIONING ENGINEER

FF 73%
SF 10%

ID	Additional Capabilities Needed
1160	Adjust controls to generate specified electrical power or to regulate the flow of power between generating stations and substations.
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.
188927	Oversee workers in line with safe off-shore working practices - BOSIET and relevant offshore Health and Safety certifications.
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.
90620	Maintain clean working environments, according to clean room standards.
215075	Undertake conductor jointing techniques including pressure clamps, exo-thermic welding, brazing and crimping.

HV FIELD / OFFSHORE ENGINEER vs POWER INDUSTRY OVERHEAD LINESPERSON

FF 68%
SF 33%

ID	Additional Capabilities Needed
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.
2010	Adjust, repair, or replace electrical or electronic components to correct defects and to ensure conformance to specifications.
188905	Monitor, analyse and initiate action using condition monitoring data.
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.
90620	Maintain clean working environments, according to clean room standards.
215075	Undertake conductor jointing techniques including pressure clamps, exo-thermic welding, brazing and crimping.

QUALITY ENGINEER vs FOOD INDUSTRY TECHNOLOGIST

FF 71%
SF 39%

ID	Additional Capabilities Needed
181862	Leads process improvement activities associated with new and existing manufacturing processes utilising latest techniques and practices by the collection and analysis of data using standard SPC analytical techniques
196862	Conduct condition monitoring.
155740	Select, calibrate, or operate equipment used in the non-destructive testing of products or materials.
150230	Review existing manufacturing processes to identify opportunities for yield improvement or reduced process variation.
189225	*Conduct inspections using a specific non-destructive testing (NDT) method, understanding its capabilities and limitations.
229011	Inspect high voltage cables for defects using advanced non-destructive testing technology
222181	*Inspect materials using advanced NDT methods to identify faults and imperfections

SUPPLY CHAIN & LOGISTICS MANAGER vs SUPPLY CHAIN PRACTITIONER (FMCG[19])

FF 69%
SF 46%

ID	Additional Capabilities Needed
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships
63110	Estimate materials required for production and manufacturing of products.
209122	Implement advanced material handling automation for efficient sorting and preparation.

SUPPLY CHAIN & LOGISTICS MANAGER vs SUPPLY CHAIN LEADERSHIP PROFESSIONAL (Integrated Degree)

FF 62%
SF 22%

ID	Additional Capabilities Needed
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.
63110	Estimate materials required for production and manufacturing of products.
209122	Implement advanced material handling automation for efficient sorting and preparation.

FACTORY MAINTENANCE ENGINEER vs MECHATRONICS MAINTENANCE TECHNICIAN

[19] FMCG = Fast Moving Consumer Goods

FF 79%
SF 48%

ID	Additional Capabilities Needed
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.
188929	Inspect high voltage electrical instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.
201551	Define predictive maintenance systems and tools to support production and manufacturing operations

FACTORY MAINTENANCE ENGINEER vs SCIENCE INDUSTRY MAINTENANCE TECHNICIAN

FF 79%
SF 48%

ID	Additional Capabilities Needed
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.
188929	Inspect high voltage electrical instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.
201551	Define predictive maintenance systems and tools to support production and manufacturing operations

APPENDIX 5 THE FUTURE OCCUPATIONAL PROFILES

This Appendix presents the capability sets defined through the foresighting process to date. Capabilities are grouped into ‘future occupational profiles’ (FOPs) within four role families:

- Role Family 1 (RF1) roles are at an entry grade technician or operator level.
- Role Family 2 (RF2) roles are intended for senior technicians and operators.
- Role Family 3 (RF3) roles are graduate / engineer level.
- Role Family 4 (RF4) roles are pitched for senior engineering levels or equivalent.

Where a FOP has a progression within the subgroup then the two roles are tabulated together (e.g. engineer / senior engineer, or operator / supervisor).

Each capability is identified as (A) Awareness, (P) Practitioner or (E) Expert proficiency level for the FOP. In general, the Awareness level capabilities are presented only where there is a corresponding Practitioner or Expert level identified for a progression role (in other words, capabilities where only the Awareness level is present, are omitted here for brevity).

The FOPs are presented here in full. The previous section provided the ‘delta’, or additional capabilities compared to existing standards. This may be of use to educators and trainers in terms of developing modular or conversion course content.

A5.1 Role Family 1 – Entry-Level Operator / Technician

A5.1.1 Cable Production Operator

ID	Capability Statement – Cable Production Operator	Function	Functional Domain	Functional Area	Type	RF1 Level
227541	Implement production operations to assembly-based final stages with subsection components manufactured by the supply chain.	IMPLEMENT	Manage Operations	Direct Operations	Implement	P
227109	Load machinery and tools for operational tasks	IMPLEMENT	System/Equipment Operation & Monitoring	Load Equipment	Use	P
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.	LOGISTICS	Supply Chain Operations	Move Supplies	Use	P
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Use	P
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors	DESIGN	System/Equipment Design & Implementation	Design Equipment	Implement	P
168460	Tend and observe equipment and machinery to verify efficient and safe operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
100120	Monitor functioning of equipment to ensure system operates in conformance with specifications.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Use	P
99890	Monitor equipment to ensure proper operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
90620	Maintain clean working environments, according to clean room standards.	SUPPORT	System/Equipment Maintenance	Clean Tools & Equipment	Maintain	P
227111	Implement lean manufacturing principles to streamline the production process and reduce cycle time.	IMPLEMENT	Plan Operations	Plan Operations	Implement	A
213139	Operate within an automated, digitalized quality-controlled environment, performing technical quality checks and peer reviews in line with standard operating procedures.	SUPPORT	Quality Control	Manage Quality Control	Maintain	A
212764	Identify opportunities to improve manufacturing processes, products or to reduce costs using e.g. knowledge of fabrication processes, tooling and production equipment, assembly methods, quality control standards, or product design, materials and parts.	DESIGN	Prototype Design & Development	Refine Designs	Implement	A
182330	Contributing to continuous improvement in component production or assembly.	IMPLEMENT	Product Processing	Join Components	Create	A
181992	Identify ways to improve processes by monitoring production process and end product.	DESIGN	Process Design & Implementation	Develop Processes	Implement	A

A5.2 Role Family 2 – Supervisor / Senior Technician

A5.2.1 Cable Production Supervisor

ID	Capability Statement – Cable Production Supervisor	Function	Functional Domain	Functional Area	Type	RF2 Level
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.	LOGISTICS	Supply Chain Operations	Move Supplies	Use	P
213139	Operate within an automated, digitalized quality-controlled environment, performing technical quality checks and peer reviews in line with standard operating procedures.	SUPPORT	Quality Control	Manage Quality Control	Maintain	P
212764	Identify opportunities to improve manufacturing processes, products or to reduce costs using e.g. knowledge of fabrication processes, tooling and production equipment, assembly methods, quality control standards, or product design, materials and parts.	DESIGN	Prototype Design & Development	Refine Designs	Implement	P
188952	Undertake high volume manufacturing of high voltage / power connectors with inclusion of fibre optic connectors	DESIGN	System/Equipment Design & Implementation	Design Equipment	Implement	P
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN	Prototype Design & Development	Design Systems & Applications	Implement	P
168460	Tend and observe equipment and machinery to verify efficient and safe operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
100120	Monitor functioning of equipment to ensure system operates in conformance with specifications.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Use	P
99890	Monitor equipment to ensure proper operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
94960	Manage the movement of goods into and out of production facilities to ensure efficiency, effectiveness, or sustainability of operations.	IMPLEMENT	Manage Operations	Direct Operations	Use	P
227541	Implement production operations to assembly-based final stages with subsection components manufactured by the supply chain.	IMPLEMENT	Manage Operations	Direct Operations	Implement	E
227111	Implement lean manufacturing principles to streamline the production process and reduce cycle time.	IMPLEMENT	Plan Operations	Plan Operations	Implement	E
188894	Analyse job orders, drawings, blueprints, specifications and design data to determine manufacturing process data i.e. Production processes, tool selection, machine speeds, and feed rates.	DESIGN	System/Equipment Design & Implementation	Configure Equipment	Use	E
182330	Contributing to continuous improvement in component production or assembly.	IMPLEMENT	Product Processing	Join Components	Create	E
150230	Review existing manufacturing processes to identify opportunities for yield improvement or reduced process variation.	DESIGN	Technical Research	Research & Develop Technologies	Maintain	E

ID	Capability Statement – Cable Production Supervisor	Function	Functional Domain	Functional Area	Type	RF2 Level
90620	Maintain clean working environments, according to clean room standards.	SUPPORT	System/Equipment Maintenance	Clean Tools & Equipment	Maintain	E
227109	Load machinery and tools for operational tasks	IMPLEMENT	System/Equipment Operation & Monitoring	Load Equipment	Use	A
227055	Operate robotic equipment to perform green production applications, including testing and maintaining specific components.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Use	A

A5.3 Role Family 3 – Engineer

A5.3.1 Development & Test Engineer

ID	Capability Statement – Development & Test Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE	Regulatory Compliance	Monitor Regulation Changes	Implement	P
215772	Research and develop sustainable production techniques, processes and the use of recycled and sustainable materials	ENTERPRISE	Leadership & Strategy	Promote Sustainable Practices	Create	P
202804	*Conduct functionality testing and inject currents and voltages into high voltage equipment to simulate fault conditions and scenarios.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Maintain	P
201562	Support the maintenance and revision of testing procedures for high-voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
188968	Utilise Smart Operations and Maintenance data analysis and machine learning to better understand cable health.	SUPPORT	Operator Support	Operate support systems	Implement	P
188955	Use tools such as Orcaflex, UFLEX and COMSOL to better understand both thermal and mechanical fatigue with different material types.	DESIGN	Product Evaluation	Evaluate Technical Performance	Use	P
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	P
188946	Design for recycling - reuse of cable materials after decommissioning etc	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P

ID	Capability Statement – Development & Test Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
181527	Create and utilise technical analyses models or simulations to predict the performance of products or systems. This includes modelling and analysis of electrical circuit behaviour and of mechanical behaviour (for example structural strength, kinematics, dynamic response).	ENTERPRISE	Data Management	Perform Data Analysis	Create	P
229007	Undertake mechanical system design of undersea high voltage cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
229006	Undertake electrical and power design of undersea high voltage cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
227908	Develop insulation materials for high-voltage direct current (HVDC) cables to enhance performance and durability.	DESIGN	Prototype Design & Development	Design Materials & Devices	Create	E
227893	Research and develop high voltage electrical and power systems for undersea high voltage, direct current cable systems.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
222006	*Develop test plans for products that have been developed	ENTERPRISE	Product Management	Develop Specifications	Create	E
201487	Conduct thorough risk assessments using Simulation Software	ENTERPRISE	Risk Management	Analyse Business Risks	Use	E
188967	Create a cable reliability database to identify common faults.	SUPPORT	Quality Control	Evaluate Product Characteristics & Quality	Create	E
188957	Develop Digital Twin of cable system, moorings and substructure including data science / system modelling.	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	E
188948	Design solutions for in-situ repair of cable systems	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188936	Analyse component failures to identify design improvements.	DESIGN	Prototype Design & Development	Refine Designs	Create	E
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Create	A
188960	Develop lifecycle models of total cost of ownership, i.e. from design, manufacture installation, shipping, handling etc.	DESIGN	Supply Chain Design & Implementation	Develop Supply Chain Models & Systems	Create	A

A5.3.2 Cable Design Engineer

ID	Capability Statement – Cable Design Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
227918	Consider product repair, operation, maintenance and disposal during the design phase, to ensure maintainability by operators and reduce lifecycle costs.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Create	P
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE	Regulatory Compliance	Monitor Regulation Changes	Implement	P
227915	Consider interchangeability / inter-operability when designing system components, to optimise system flexibility and lifecycle cost.	DESIGN	Prototype Design & Development	Design Materials & Devices	Create	P
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.	DESIGN	Prototype Design & Development	Refine Designs	Create	P
227527	Design and develop high voltage direct current (HVDC) systems for offshore wind using advanced simulation and modelling tools.	DESIGN	Technical Research	Research & Develop Technologies	Create	P
215772	Research and develop sustainable production techniques, processes and the use of recycled and sustainable materials	ENTERPRISE	Leadership & Strategy	Promote Sustainable Practices	Create	P
188979	Use integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	P
188957	Develop Digital Twin of cable system, moorings and substructure including data science / system modelling.	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	P
188955	Use tools such as Orcaflex, UFLEX and COMSOL to better understand both thermal and mechanical fatigue with different material types.	DESIGN	Product Evaluation	Evaluate Technical Performance	Use	P
188949	Design and manufacture for de-commissioning/removal of cable systems	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P
188946	Design for recycling - reuse of cable materials after decommissioning etc	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P
188942	Use an integrated approach to design of cable systems - i.e. ancillary equipment in the design of systems and early discussions on optimisation and performance	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P
188939	Design systems to meet Operations & Maintenance i.e. tow-to-port and plug & play	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P
188906	Design undersea elements to minimise the impact of marine fouling.	DESIGN	Prototype Design & Development	Refine Designs	Create	P
154880	Select electromechanical equipment, materials, components, or systems to meet functional specifications.	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	P

ID	Capability Statement – Cable Design Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
32430	Confer with engineers, customers, or others to discuss existing or potential engineering projects or products.	ENTERPRISE	Product Management	Develop Specifications	Use	P
229007	Undertake mechanical system design of undersea high voltage cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
227897	Undertake high voltage design and optimisation of undersea high voltage direct current cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
188983	Review electromechanical equipment, materials, components, or systems to meet functional specifications	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	E
225558	*Work with other engineers and specialists to provide engineering solutions for complex electricity network scenarios	DESIGN	Product Engineering	Create Engineering Designs	Maintain	A
188933	Develop integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	A

A5.3.3 Supply Chain & Logistics Manager

ID	Capability Statement – Supply Chain & Logistics Manager	Function	Functional Domain	Functional Area	Type	RF3 Level
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.	DESIGN	Prototype Design & Development	Refine Designs	Create	P
227070	Utilise automated factory logistic systems to move material to production lines within specified timeframes.	LOGISTICS	Supply Chain Operations	Move Supplies	Use	P
209122	Implement advanced material handling automation for efficient sorting and preparation.	IMPLEMENT	Input Processing & Preparation	Sort Materials	Use	P
188963	Develop integrated supply chain partnerships / industry forum for exchange of best practice/collaboration	ENTERPRISE	Leadership & Strategy	Manage Change & Transformation Programmes	Create	P
188961	Develop collaborative risk sharing approaches across supply chain for contracting and risk management.	ENTERPRISE	Risk Management	Analyse Business Risks	Create	P
63110	Estimate materials required for production and manufacturing of products.	IMPLEMENT	Plan Operations	Plan Operations	Use	P
227057	Verify the capabilities of new supply chain companies to ensure compliance with operational standards.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Use	E

ID	Capability Statement – Supply Chain & Logistics Manager	Function	Functional Domain	Functional Area	Type	RF3 Level
220418	Support end to end supply chain planning.	DESIGN	Supply Chain Design & Implementation	Develop Supply Chain Models & Systems	Create	E
211086	Implement strategies for robust and resilient supply chains.	LOGISTICS	Inventory Management	Plan Supply Contingencies	Implement	E
205780	Manage supply chain logistics using established best practices	DESIGN	Supply Chain Design & Implementation	Develop Supply Chain Models & Systems	Use	E
94960	Manage the movement of goods into and out of production facilities to ensure efficiency, effectiveness, or sustainability of operations.	IMPLEMENT	Manage Operations	Direct Operations	Use	E
43230	Design comprehensive supply chains that minimise environmental impacts or costs.	DESIGN	Supply Chain Design & Implementation	Analyse Logistics	Create	E
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	A

A5.3.4 Quality Engineer

ID	Capability Statement – Cable Production Operator	Function	Functional Domain	Functional Area	Type	RF3 Level
229011	Inspect high voltage cables for defects using advanced non-destructive testing technology	SUPPORT	System/Equipment Maintenance	Inspect Facilities & Equipment	Use	P
229010	Develop a comprehensive quality management system to ensure adherence to specific manufacturing standards and continuous improvement in high voltage cable projects.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	P
222181	*Inspect materials using advanced NDT methods to identify faults and imperfections	SUPPORT	System/Equipment Maintenance	Inspect Facilities & Equipment	Maintain	P
222006	*Develop test plans for products that have been developed	ENTERPRISE	Product Management	Develop Specifications	Create	P
220039	Quality assure raw materials.	SUPPORT	Quality Control	Manage Quality Control	Create	P
196862	Conduct condition monitoring.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Maintain	P

ID	**Capability Statement** – Cable Production Operator	Function	Functional Domain	Functional Area	Type	RF3 Level
188936	Analyse component failures to identify design improvements.	DESIGN	Prototype Design & Development	Refine Designs	Create	P
188928	Develop and implement operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Implement	P
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN	Prototype Design & Development	Design Systems & Applications	Implement	P
181992	Identify ways to improve processes by monitoring production process and end product.	DESIGN	Process Design & Implementation	Develop Processes	Implement	P
181862	Leads process improvement activities associated with new and existing manufacturing processes utilising latest techniques and practices by the collection and analysis of data using standard SPC analytical techniques	DESIGN	Process Design & Implementation	Develop Processes	Implement	P
155740	Select, calibrate, or operate equipment used in the non-destructive testing of products or materials.	DESIGN	System/Equipment Design & Implementation	Select Equipment	Use	P
150230	Review existing manufacturing processes to identify opportunities for yield improvement or reduced process variation.	DESIGN	Technical Research	Research & Develop Technologies	Maintain	P
104930	Observe machines on trial runs or conduct computer simulations to ensure that programs and machinery will function properly and produce items that meet specifications.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Use	P
39160	Create and implement inspection and testing criteria or procedures.	DESIGN	Process Design & Implementation	Develop Processes	Create	P
227106	Monitor compliance of operational activities with specific industry standards to ensure they meet quality and safety requirements.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Maintain	E
189225	*Conduct inspections using a specific non-destructive testing (NDT) method, understanding its capabilities and limitations.	IMPLEMENT	Service Delivery	Monitor & Evaluate Individual Capabilities	Maintain	E

A5.3.5 Electrical Engineer – HVDC Equipment Design

ID	Capability Statement – HVDC Equipment Design	Function	Functional Domain	Functional Area	Type	RF3 Level
227918	Consider product repair, operation, maintenance and disposal during the design phase, to ensure maintainability by operators and reduce lifecycle costs.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Create	P

ID	Capability Statement – HVDC Equipment Design	Function	Functional Domain	Functional Area	Type	RF3 Level
227901	Integrate smart grid technology for efficient energy transmission	IMPLEMENT	Energy Supply	Generate Energy	Use	P
225558	*Work with other engineers and specialists to provide engineering solutions for complex electricity network scenarios	DESIGN	Product Engineering	Create Engineering Designs	Maintain	P
215772	Research and develop sustainable production techniques, processes and the use of recycled and sustainable materials	ENTERPRISE	Leadership & Strategy	Promote Sustainable Practices	Create	P
154880	Select electromechanical equipment, materials, components, or systems to meet functional specifications.	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	P
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE	Regulatory Compliance	Monitor Regulation Changes	Implement	E
227915	Consider interchangeability / inter-operability when designing system components, to optimise system flexibility and lifecycle cost.	DESIGN	Prototype Design & Development	Design Materials & Devices	Create	E
227913	Incorporate data and condition monitoring into the design of high-voltage convertor systems to enable smart operation.	IMPLEMENT	Manage Operations	Manage Operation Control Systems	Implement	E
227912	Consider sustainability and circularity at all points of the product lifecycle, to reduce environmental impact.	DESIGN	Prototype Design & Development	Refine Designs	Create	E
227911	Develop switches and circuit breakers suitable for use in HVDC networks to ensure safe operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Implement	E
227909	Adapt high-voltage safety systems to enhance protection during operations with complex direct current systems.	DESIGN	System/Equipment Design & Implementation	Install Equipment	Implement	E
227907	Design circuit breaker systems to ensure HVDC networks function safely and consistently regardless of the equipment supplier.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227527	Design and develop high voltage direct current (HVDC) systems for offshore wind using advanced simulation and modelling tools.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227031	Create system models to test support systems prior to product deployment	SUPPORT	Operator Support	Design and configure support systems	Create	E
202805	*Ensuring that protection systems interface correctly with associated high voltage equipment and coordinate effectively with the wider high voltage system.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Maintain	E
202804	*Conduct functionality testing and inject currents and voltages into high voltage equipment to simulate fault conditions and scenarios.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Maintain	E
188983	Review electromechanical equipment, materials, components, or systems to meet functional specifications	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	E
188936	Analyse component failures to identify design improvements.	DESIGN	Prototype Design & Development	Refine Designs	Create	E

A5.3.6 Electrical Engineer – Machine Learning & Automation

ID	Capability Statement – Machine Learning & Automation	Function	Functional Domain	Functional Area	Type	RF3 Level
227914	Apply smart analytics and machine learning to operational data from high-voltage convertor systems to maximise performance.	IMPLEMENT	Manage Operations	Analyse Operations Data	Use	P
227904	Analyse models or simulations to predict the performance of products or systems and ensure system resilience.	ENTERPRISE	Data Management	Perform Data Analysis	Use	P
227898	Use virtual environments and digital twins to prepare or evaluate network diagrams, floor plans, or configurations for existing facilities, renovations, or new systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
209665	Develop remote monitoring and control systems for real-time energy generation and distribution management.	IMPLEMENT	Manage Operations	Manage Operation Control Systems	Maintain	P
188968	Utilise Smart Operations and Maintenance data analysis and machine learning to better understand cable health.	SUPPORT	Operator Support	Operate support systems	Implement	P
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.	DESIGN	System/Equipment Design & Implementation	Configure Equipment	Use	E
205630	*Evaluate and select digital manufacturing tools and software for implementation	IMPLEMENT	Service Delivery	Create & Process Digital Media	Create	E
205623	*Lead and oversee the implementation of digital manufacturing technologies	IMPLEMENT	Service Delivery	Create & Process Digital Media	Maintain	E
194437	Implement digital twin technology to simulate and optimize manufacturing processes	IMPLEMENT	Service Delivery	Create & Process Digital Media	Create	E
188895	Provide statistical and computational tools for system analysis and optimisation	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
181527	Create and utilise technical analyses models or simulations to predict the performance of products or systems. This includes modelling and analysis of electrical circuit behaviour and of mechanical behaviour (for example structural strength, kinematics, dynamic response).	ENTERPRISE	Data Management	Perform Data Analysis	Create	E
227913	Incorporate data and condition monitoring into the design of high-voltage convertor systems to enable smart operation.	IMPLEMENT	Manage Operations	Manage Operation Control Systems	Implement	A

A5.3.7 Electrical Engineer – Network Design

ID	Capability Statement – Electrical Engineer, Network Design	Function	Functional Domain	Functional Area	Type	RF3 Level
227914	Apply smart analytics and machine learning to operational data from high-voltage convertor systems to maximise performance.	IMPLEMENT	Manage Operations	Analyse Operations Data	Use	P
227904	Analyse models or simulations to predict the performance of products or systems and ensure system resilience.	ENTERPRISE	Data Management	Perform Data Analysis	Use	P
227901	Integrate smart grid technology for efficient energy transmission	IMPLEMENT	Energy Supply	Generate Energy	Use	P
227899	Document technical specifications and operating standards for high voltage direct current distribution equipment.	DESIGN	Prototype Design & Development	Develop Prototypes	Implement	P
201487	Conduct thorough risk assessments using Simulation Software	ENTERPRISE	Risk Management	Analyse Business Risks	Use	P
188979	Use integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	P
188968	Utilise Smart Operations and Maintenance data analysis and machine learning to better understand cable health.	SUPPORT	Operator Support	Operate support systems	Implement	P
104930	Observe machines on trial runs or conduct computer simulations to ensure that programs and machinery will function properly and produce items that meet specifications.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Use	P
32430	Confer with engineers, customers, or others to discuss existing or potential engineering projects or products.	ENTERPRISE	Product Management	Develop Specifications	Use	P
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE	Regulatory Compliance	Monitor Regulation Changes	Implement	E
227916	Understand system-level electrical transmission design in the early stages of the project lifecycle, to reduce grid connection and commissioning costs.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
227915	Consider interchangeability / inter-operability when designing system components, to optimise system flexibility and lifecycle cost.	DESIGN	Prototype Design & Development	Design Materials & Devices	Create	E
227911	Develop switches and circuit breakers suitable for use in HVDC networks to ensure safe operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Implement	E
227909	Adapt high-voltage safety systems to enhance protection during operations with complex direct current systems.	DESIGN	System/Equipment Design & Implementation	Install Equipment	Implement	E
227906	Devise a standardised architecture for HVDC components to improve compatibility and interchangeability within and without the business.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	E

ID	Capability Statement – Electrical Engineer, Network Design	Function	Functional Domain	Functional Area	Type	RF3 Level
227900	Develop innovative, safe-to-fail technology qualification processes and field integration programmes	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	E
227893	Research and develop high voltage electrical and power systems for undersea high voltage, direct current cable systems.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227527	Design and develop high voltage direct current (HVDC) systems for offshore wind using advanced simulation and modelling tools.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
209665	Develop remote monitoring and control systems for real-time energy generation and distribution management.	IMPLEMENT	Manage Operations	Manage Operation Control Systems	Maintain	E
202805	*Ensuring that protection systems interface correctly with associated high voltage equipment and coordinate effectively with the wider high voltage system.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Maintain	E
188939	Design systems to meet Operations & Maintenance i.e. tow-to-port and plug & play	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188895	Provide statistical and computational tools for system analysis and optimisation	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	E
225558	*Work with other engineers and specialists to provide engineering solutions for complex electricity network scenarios	DESIGN	Product Engineering	Create Engineering Designs	Maintain	A
188963	Develop integrated supply chain partnerships / industry forum for exchange of best practice/collaboration	ENTERPRISE	Leadership & Strategy	Manage Change & Transformation Programmes	Create	A
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	A

A5.3.8 Cable System Engineer

ID	Capability Statement – Cable System Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
227918	Consider product repair, operation, maintenance and disposal during the design phase, to ensure maintainability by operators and reduce lifecycle costs.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Create	P
227899	Document technical specifications and operating standards for high voltage direct current distribution equipment.	DESIGN	Prototype Design & Development	Develop Prototypes	Implement	P

ID	Capability Statement – Cable System Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
227898	Use virtual environments and digital twins to prepare or evaluate network diagrams, floor plans, or configurations for existing facilities, renovations, or new systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
227897	Undertake high voltage design and optimisation of undersea high voltage direct current cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	P
224940	*Construct and maintain electrical infrastructure using tools and equipment across a range of voltages	SUPPORT	System/Equipment Maintenance	Maintain Tools & Equipment	Maintain	P
205664	Undertake operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
188968	Utilise Smart Operations and Maintenance data analysis and machine learning to better understand cable health.	SUPPORT	Operator Support	Operate support systems	Implement	P
188937	Establish the appropriate routing for cables optimisation	DESIGN	System/Equipment Design & Implementation	Design Equipment	Implement	P
188922	Commission subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	P
154880	Select electromechanical equipment, materials, components, or systems to meet functional specifications.	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	P
227907	Design circuit breaker systems to ensure HVDC networks function safely and consistently regardless of the equipment supplier.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227905	Adapt cable lay vessels and methodologies to improve the economics for HVDC installations.	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188983	Review electromechanical equipment, materials, components, or systems to meet functional specifications	DESIGN	System/Equipment Design & Implementation	Select Equipment	Implement	E
188957	Develop Digital Twin of cable system, moorings and substructure including data science / system modelling.	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	E
188948	Design solutions for in-situ repair of cable systems	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188942	Use an integrated approach to design of cable systems - i.e. ancillary equipment in the design of systems and early discussions on optimisation and performance	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188940	Design equipment for installation of cable system (on vessel and subsea intervention)	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188933	Develop integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	E
188931	Develop and deploy specialised materials characterization procedures for the high voltage, subsea, marine environment.	SUPPORT	System/Equipment Maintenance	Inspect Facilities & Equipment	Use	E

ID	Capability Statement – Cable System Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
181527	Create and utilise technical analyses models or simulations to predict the performance of products or systems. This includes modelling and analysis of electrical circuit behaviour and of mechanical behaviour (for example structural strength, kinematics, dynamic response).	ENTERPRISE	Data Management	Perform Data Analysis	Create	E
188967	Create a cable reliability database to identify common faults.	SUPPORT	Quality Control	Evaluate Product Characteristics & Quality	Create	A
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	A

A5.3.9 Continuous Improvement Engineer

ID	Capability Statement – Continuous Improvement Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
188331	Review engineering and maintenance procedures identifying potential improvements to processes, materials, resources or planning. For example, improvements on costs, efficiencies and quality.	SUPPORT	Quality Control	Manage Quality Control	Maintain	P
227898	Use virtual environments and digital twins to prepare or evaluate network diagrams, floor plans, or configurations for existing facilities, renovations, or new systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
194437	Implement digital twin technology to simulate and optimize manufacturing processes	IMPLEMENT	Service Delivery	Create & Process Digital Media	Create	P
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Create	P
188895	Provide statistical and computational tools for system analysis and optimisation	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	P
212889	Develop and apply Lean Manufacturing principles to streamline manufacturing processes and reduce waste generation.	LOGISTICS	Waste Management	Manage Waste	Implement	E
227540	Implement data sharing and benchmarking initiatives to compare manufacturing capabilities and enhance overall performance.	ENTERPRISE	Leadership & Strategy	Evaluate Business Performance	Implement	E
227062	Improve factory layout to support automation and ensure more efficient movement	LOGISTICS	Supply Chain Operations	Move Supplies	Implement	E

ID	Capability Statement – Continuous Improvement Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
212764	Identify opportunities to improve manufacturing processes, products or to reduce costs using e.g. knowledge of fabrication processes, tooling and production equipment, assembly methods, quality control standards, or product design, materials and parts.	DESIGN	Prototype Design & Development	Refine Designs	Implement	E
209939	Optimise process development using Modelling and Simulation (M&S) and Digital Twin Technologies	DESIGN	Process Design & Implementation	Model Processes	Implement	E
205626	*Utilize advanced data analytics tools to analyse manufacturing data and identify areas for improvement	ENTERPRISE	Data Management	Perform Data Analysis	Create	E
181992	Identify ways to improve processes by monitoring production process and end product.	DESIGN	Process Design & Implementation	Develop Processes	Implement	E
182330	Contributing to continuous improvement in component production or assembly.	IMPLEMENT	Product Processing	Join Components	Create	E
181862	Leads process improvement activities associated with new and existing manufacturing processes utilising latest techniques and practices by the collection and analysis of data using standard SPC analytical techniques	DESIGN	Process Design & Implementation	Develop Processes	Implement	E
150230	Review existing manufacturing processes to identify opportunities for yield improvement or reduced process variation.	DESIGN	Technical Research	Research & Develop Technologies	Maintain	E
227111	Implement lean manufacturing principles to streamline the production process and reduce cycle time.	IMPLEMENT	Plan Operations	Plan Operations	Implement	A
227060	Develop roadmaps for potential suppliers to outline specific technical requirements and expected production volumes.	LOGISTICS	Supply Chain Management	Work with Suppliers	Implement	A
205623	*Lead and oversee the implementation of digital manufacturing technologies	IMPLEMENT	Service Delivery	Create & Process Digital Media	Maintain	A
205630	*Evaluate and select digital manufacturing tools and software for implementation	IMPLEMENT	Service Delivery	Create & Process Digital Media	Create	A

A5.3.10 Factory Maintenance Engineer

ID	Capability Statement – Factory Maintenance Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
201562	Support the maintenance and revision of testing procedures for high-voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
2010	Adjust, repair, or replace electrical or electronic components to correct defects and to ensure conformance to specifications.	DESIGN	System/Equipment Design & Implementation	Install Equipment	Use	P
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN	Prototype Design & Development	Design Systems & Applications	Implement	P
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.	DESIGN	System/Equipment Design & Implementation	Configure Equipment	Use	P
188331	Review engineering and maintenance procedures identifying potential improvements to processes, materials, resources or planning. For example, improvements on costs, efficiencies and quality.	SUPPORT	Quality Control	Manage Quality Control	Maintain	P
100120	Monitor functioning of equipment to ensure system operates in conformance with specifications.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Use	P
168460	Tend and observe equipment and machinery to verify efficient and safe operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
188907	Observe the operation of machinery or equipment to diagnose malfunctions	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	P
188929	Inspect high voltage electrical instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.	SUPPORT	Quality Control	Evaluate Product Characteristics & Quality	Use	E
227090	Conduct predictive maintenance of processing and equipment using condition-based monitoring	SUPPORT	System/Equipment Maintenance	Manage Facility Maintenance	Maintain	E
201551	Define predictive maintenance systems and tools to support production and manufacturing operations	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Create	E
99890	Monitor equipment to ensure proper operation.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Equipment	Use	E
92540	Maintain production equipment and machinery.	SUPPORT	System/Equipment Maintenance	Maintain Tools & Equipment	Maintain	E
196862	Conduct condition monitoring.	IMPLEMENT	System/Equipment Operation & Monitoring	Monitor Operations	Maintain	A

A5.3.11 HV Field / Offshore Engineer

ID	Capability Statement – HV Field / Offshore Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
201562	Support the maintenance and revision of testing procedures for high-voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
205664	Undertake operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
202804	*Conduct functionality testing and inject currents and voltages into high voltage equipment to simulate fault conditions and scenarios.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Maintain	P
222227	*Install and connect electrical transformers, switchgear, and circuit breakers	DESIGN	System/Equipment Design & Implementation	Install Equipment	Maintain	P
224940	*Construct and maintain electrical infrastructure using tools and equipment across a range of voltages	SUPPORT	System/Equipment Maintenance	Maintain Tools & Equipment	Maintain	P
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
2010	Adjust, repair, or replace electrical or electronic components to correct defects and to ensure conformance to specifications.	DESIGN	System/Equipment Design & Implementation	Install Equipment	Use	P
90620	Maintain clean working environments, according to clean room standards.	SUPPORT	System/Equipment Maintenance	Clean Tools & Equipment	Maintain	P
1160	Adjust controls to generate specified electrical power or to regulate the flow of power between generating stations and substations.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Use	P
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN	Prototype Design & Development	Design Systems & Applications	Implement	P
188927	Oversee workers in line with safe off-shore working practices - BOSIET and relevant offshore Health and Safety certifications.	SUPPORT	Operator Support	Supervise Others	Use	P
188929	Inspect high voltage electrical instruments, products, or systems to ensure conformance to specifications, safety standards, or applicable codes or regulations.	SUPPORT	Quality Control	Evaluate Product Characteristics & Quality	Use	P
188921	Install subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Coordinate Logistics	Use	P

ID	Capability Statement – HV Field / Offshore Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
227902	Perform maintenance and testing of power transmission submarine and land cable plant and apparatus.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Maintain	P
227910	Perform control tuning of multiple PLCs to maintain system resilience and security.	DESIGN	System/Equipment Design & Implementation	Configure Equipment	Use	E
202805	*Ensuring that protection systems interface correctly with associated high voltage equipment and coordinate effectively with the wider high voltage system.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Maintain	E
215075	Undertake conductor jointing techniques including pressure clamps, exo-thermic welding, brazing and crimping.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Maintain	E
219397	Conduct electrical switching procedures on networks (high or low).	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Maintain	E
188922	Commission subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	E
188923	Handover to operator subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	E
188909	Undertake preparation, splicing and jointing of HV undersea cables using appropriate tools and equipment.	IMPLEMENT	System/Equipment Operation & Monitoring	Operate Equipment	Use	E
227903	Carry out fault finding of high voltage direct current electrical systems	SUPPORT	System/Equipment Maintenance	Maintain Systems	Maintain	E

A5.3.12 Cable Lay Equipment Engineer

ID	Capability Statement – Cable Lay Equipment Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Create	P
188895	Provide statistical and computational tools for system analysis and optimisation	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	P
227904	Analyse models or simulations to predict the performance of products or systems and ensure system resilience.	ENTERPRISE	Data Management	Perform Data Analysis	Use	P

ID	Capability Statement – Cable Lay Equipment Engineer	Function	Functional Domain	Functional Area	Type	RF3 Level
181527	Create and utilise technical analyses models or simulations to predict the performance of products or systems. This includes modelling and analysis of electrical circuit behaviour and of mechanical behaviour (for example structural strength, kinematics, dynamic response).	ENTERPRISE	Data Management	Perform Data Analysis	Create	P
155740	Select, calibrate, or operate equipment used in the non-destructive testing of products or materials.	DESIGN	System/Equipment Design & Implementation	Select Equipment	Use	P
188936	Analyse component failures to identify design improvements.	DESIGN	Prototype Design & Development	Refine Designs	Create	P
188948	Design solutions for in-situ repair of cable systems	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	P
188955	Use tools such as Orcaflex, UFLEX and COMSOL to better understand both thermal and mechanical fatigue with different material types.	DESIGN	Product Evaluation	Evaluate Technical Performance	Use	P
227896	Evaluate system modification requests to determine feasibility and necessary actions based on critical thinking and past experience.	DESIGN	Prototype Design & Development	Select Technologies	Use	E
227905	Adapt cable lay vessels and methodologies to improve the economics for HVDC installations.	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
201487	Conduct thorough risk assessments using Simulation Software	ENTERPRISE	Risk Management	Analyse Business Risks	Use	E
32430	Confer with engineers, customers, or others to discuss existing or potential engineering projects or products.	ENTERPRISE	Product Management	Develop Specifications	Use	E
188940	Design equipment for installation of cable system (on vessel and subsea intervention)	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188960	Develop lifecycle models of total cost of ownership, i.e. from design, manufacture installation, shipping, handling etc.	DESIGN	Supply Chain Design & Implementation	Develop Supply Chain Models & Systems	Create	E
188927	Oversee workers in line with safe off-shore working practices - BOSIET and relevant offshore Health and Safety certifications.	SUPPORT	Operator Support	Supervise Others	Use	A

A5.4 RF4 – Senior Engineer / Line Manager

A5.4.1 Factory Manager

ID	Capability Statement – Factory Manager	Function	Function	Domain	Area	RF4 Level
227111	Implement lean manufacturing principles to streamline the production process and reduce cycle time.	IMPLEMENT	Plan Operations	Plan Operations	Implement	P
213139	Operate within an automated, digitalized quality-controlled environment, performing technical quality checks and peer reviews in line with standard operating procedures.	SUPPORT	Quality Control	Manage Quality Control	Maintain	P
211086	Implement strategies for robust and resilient supply chains.	LOGISTICS	Inventory Management	Plan Supply Contingencies	Implement	P
201350	Design and implement statutory/regulatory health and safety compliance systems and ways of working.	SUPPORT	Health, Safety & Environment	Maintain Safety & Security	Implement	P
188963	Develop integrated supply chain partnerships / industry forum for exchange of best practice/collaboration	ENTERPRISE	Leadership & Strategy	Manage Change & Transformation Programmes	Create	P
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Create	P
188961	Develop collaborative risk sharing approaches across supply chain for contracting and risk management.	ENTERPRISE	Risk Management	Analyse Business Risks	Create	P
188954	Develop innovative Technology qualification processes and field integration programmes such as Risk & Revenue Sharing Partnerships or Joint Innovation Partnerships	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	P
188331	Review engineering and maintenance procedures identifying potential improvements to processes, materials, resources or planning. For example, improvements on costs, efficiencies and quality.	SUPPORT	Quality Control	Manage Quality Control	Maintain	P
227898	Use virtual environments and digital twins to prepare or evaluate network diagrams, floor plans, or configurations for existing facilities, renovations, or new systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	E
227540	Implement data sharing and benchmarking initiatives to compare manufacturing capabilities and enhance overall performance.	ENTERPRISE	Leadership & Strategy	Evaluate Business Performance	Implement	E
212764	Identify opportunities to improve manufacturing processes, products or to reduce costs using e.g. knowledge of fabrication processes, tooling and production equipment, assembly methods, quality control standards, or product design, materials and parts.	DESIGN	Prototype Design & Development	Refine Designs	Implement	E

ID	Capability Statement – Factory Manager	Function	Function	Domain	Area	RF4 Level
205630	*Evaluate and select digital manufacturing tools and software for implementation	IMPLEMENT	Service Delivery	Create & Process Digital Media	Create	E
205623	*Lead and oversee the implementation of digital manufacturing technologies	IMPLEMENT	Service Delivery	Create & Process Digital Media	Maintain	E
188894	Analyse job orders, drawings, blueprints, specifications and design data to determine manufacturing process data i.e. production processes, tool selection, machine speeds, and feed rates.	DESIGN	System/Equipment Design & Implementation	Configure Equipment	Use	A
94960	Manage the movement of goods into and out of production facilities to ensure efficiency, effectiveness, or sustainability of operations.	IMPLEMENT	Manage Operations	Direct Operations	Use	A

A5.4.2 Offshore Installation Manager

ID	Capability Statement – Offshore Installation Manager	Function	Function	Domain	Area	RF4 Level
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	P
188962	Establish a collaborative approach for open sharing of lessons learnt, failure reviews and Root Cause Analysis so the industry benefits and all move forward similar to the aerospace industry.	ENTERPRISE	Leadership & Strategy	Identify New Business Partnerships	Create	P
32430	Confer with engineers, customers, or others to discuss existing or potential engineering projects or products.	ENTERPRISE	Product Management	Develop Specifications	Use	P
188960	Develop lifecycle models of total cost of ownership, i.e. from design, manufacture installation, shipping, handling etc.	DESIGN	Supply Chain Design & Implementation	Develop Supply Chain Models & Systems	Create	P
188905	Monitor, analyse and initiate action using condition monitoring data.	DESIGN	Prototype Design & Development	Design Systems & Applications	Implement	P
75960	Implement or perform preventive maintenance, backup, or recovery procedures.	ENTERPRISE	Data Management	Manage Data Security	Use	P
39160	Create and implement inspection and testing criteria or procedures.	DESIGN	Process Design & Implementation	Develop Processes	Create	E
227896	Evaluate system modification requests to determine feasibility and necessary actions based on critical thinking and past experience.	DESIGN	Prototype Design & Development	Select Technologies	Use	E

ID	Capability Statement – Offshore Installation Manager	Function	Function	Domain	Area	RF4 Level
227900	Develop innovative, safe-to-fail technology qualification processes and field integration programmes	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	E
222227	*Install and connect electrical transformers, switchgear, and circuit breakers	DESIGN	System/Equipment Design & Implementation	Install Equipment	Maintain	E
188948	Design solutions for in-situ repair of cable systems	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188927	Oversee workers in line with safe off-shore working practices - BOSIET and relevant offshore Health and Safety certifications.	SUPPORT	Operator Support	Supervise Others	Use	E
188921	Install subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Coordinate Logistics	Use	E
188923	Handover to operator subsea high voltage cable systems and/or components.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	E
188928	Develop and implement operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Implement	E
188937	Establish the appropriate routing for cables optimisation	DESIGN	System/Equipment Design & Implementation	Design Equipment	Implement	E
211086	Implement strategies for robust and resilient supply chains.	LOGISTICS	Inventory Management	Plan Supply Contingencies	Implement	A

A5.4.3 HVDC System Integration Engineer

ID	Capability Statement – HVDC System Integration Engineer	Function	Function	Domain	Area	RF4 Level
205664	Undertake operational, maintenance, or testing procedures for high voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	P
227918	Consider product repair, operation, maintenance and disposal during the design phase, to ensure maintainability by operators and reduce lifecycle costs.	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Create	P
39160	Create and implement inspection and testing criteria or procedures.	DESIGN	Process Design & Implementation	Develop Processes	Create	P

ID	Capability Statement – HVDC System Integration Engineer	Function	Function	Domain	Area	RF4 Level
188931	Develop and deploy specialised materials characterization procedures for the high voltage, subsea, marine environment.	SUPPORT	System/Equipment Maintenance	Inspect Facilities & Equipment	Use	P
227897	Undertake high voltage design and optimisation of undersea high voltage direct current cable systems.	DESIGN	Prototype Design & Development	Design Systems & Applications	Create	P
188979	Use integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	P
227904	Analyse models or simulations to predict the performance of products or systems and ensure system resilience.	ENTERPRISE	Data Management	Perform Data Analysis	Use	E
227896	Evaluate system modification requests to determine feasibility and necessary actions based on critical thinking and past experience.	DESIGN	Prototype Design & Development	Select Technologies	Use	E
201562	Support the maintenance and revision of testing procedures for high-voltage electrical components, equipment, or systems	SUPPORT	System/Equipment Maintenance	Maintain Facilities & Equipment	Use	E
202804	*Conduct functionality testing and inject currents and voltages into high voltage equipment to simulate fault conditions and scenarios.	DESIGN	System/Equipment Design & Implementation	Test Equipment & Systems	Maintain	E
83220	Integrate electrical systems with renewable energy systems to improve overall efficiency.	DESIGN	Prototype Design & Development	Design Systems & Applications	Use	E
227909	Adapt high-voltage safety systems to enhance protection during operations with complex direct current systems.	DESIGN	System/Equipment Design & Implementation	Install Equipment	Implement	E
227917	Agree industry standards and regulatory frameworks for system interchangeability and inter-operability, to optimise system flexibility and lifecycle cost.	ENTERPRISE	Regulatory Compliance	Monitor Regulation Changes	Implement	E
227906	Devise a standardised architecture for HVDC components to improve compatibility and interchangeability within and without the business.	LOGISTICS	Supply Chain Management	Work with Suppliers	Use	E
168750	Test and evaluate hardware and software to determine efficiency, reliability, or compatibility with existing systems.	ENTERPRISE	Leadership & Strategy	Manage Change & Transformation Programmes	Implement	E
188939	Design systems to meet Operations & Maintenance i.e. tow-to-port and plug & play	DESIGN	System/Equipment Design & Implementation	Design Equipment	Create	E
188958	Develop tools to model failure costs vs the cost of quality and identify mitigating measures. e.g. location of each Wind Turbine Generator and analyse location specific conditions. cable directions relative to WTG etc	DESIGN	Process Design & Implementation	Model Processes	Create	E

ID	Capability Statement – HVDC System Integration Engineer	Function	Function	Domain	Area	RF4 Level
188933	Develop integrated lifecycle tools for the modelling of electrical/mechanical characteristics of cables and interconnectors	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227893	Research and develop high voltage electrical and power systems for undersea high voltage, direct current cable systems.	DESIGN	Technical Research	Research & Develop Technologies	Create	E
227900	Develop innovative, safe-to-fail technology qualification processes and field integration programmes	DESIGN	Product Evaluation	Evaluate Technical Performance	Create	E
227901	Integrate smart grid technology for efficient energy transmission	IMPLEMENT	Energy Supply	Generate Energy	Use	E
227031	Create system models to test support systems prior to product deployment	SUPPORT	Operator Support	Design and configure support systems	Create	E
222227	*Install and connect electrical transformers, switchgear, and circuit breakers	DESIGN	System/Equipment Design & Implementation	Install Equipment	Maintain	A