Workforce Foresighting Hub

Future Skills for Integrating Hybrid Energy Technologies with Offshore Wind to Enable Dispatchable Clean Energy.

A Workforce Foresighting Study

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Acknowledgements

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

Skills England (formerly 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 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 2026 Q1 using the data set and tools available at that time.

Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on Future Skills for Integrating Hybrid Energy Technologies with Offshore Wind to Enable Dispatchable Clean Energy. This study was conducted by Offshore Renewable Energy (ORE) Catapult in collaboration with the Workforce Foresighting Hub, an Innovate UK initiative.

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 report sets out the findings of the workforce foresighting study and suggests the next recommended actions required by various Stakeholders to ensure a workforce is created that is prepared to effectively implement these new technologies in the sector.

Strategic context and purpose for Workforce Foresighting

The UK's Clean Power Action Plan 2030 targets 43-50GW of offshore wind capacity by 2030, a significant increase from 2024 levels of 15GW. A fundamental challenge is that wind energy is non-dispatchable - supply depends on the weather, not on demand. This mismatch creates two costly problems: Energy shortfalls during low wind periods and curtailment when generation exceeds grid capacity. Curtailment charges alone reached £1.46 billion in 2025. Rather than reducing renewable generation, emerging technological solutions enable grid balancing through hybrid energy systems.

Three primary technology approaches are scaling up from pilot testing towards broad-front deployment in 2030-2035: Battery energy storage systems (BESS) offering rapid response; hydrogen and Power-to-X solutions (green hydrogen, synthetic fuels) enabling long-duration storage and energy conversion; and grid-forming technologies providing synthetic inertia to stabilise grid frequency.

These hybrid systems represent a fundamental shift from discrete generation, storage, and production activities to the need to manage all these activities synchronously and in real-time. This requires greater cross-disciplinary and cross-domain expertise. Skills implications reach through market optimisation, forecasting, systems integration, and technical domains including electrochemistry, materials science, hydrogen handling, and power electronics.

Participants and Stakeholders

Thank you to all those organisations for their time and commitment to providing insights and data for this study, in the hope that this process will have a significant impact on the sector.

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Summary of Findings

The workforce foresighting workshops and surveys identified 113 capabilities relevant to the topic. Of these capabilities:

- 6 capabilities were adapted (modified) from the Workforce Foresighting Data Cube[1]; and
- 107 capability statements were newly defined by the study and added to the Data Cube.

The capabilities are grouped into Future Occupational Profiles (FOPs) in the following areas of practice:

1. Grid-Forming Power Electronics & Advanced Control Systems.
2. Hybrid Grid Integration, Stability & Compliance.
3. Power-to-X, Hydrogen & Multi-Vector Energy Systems.
4. Digital Systems Modelling.
5. Manufacturing, Installation & Supply Chain Integration.
6. Markets, Regulation & System Governance.
7. Collaboration, Innovation & Advocacy.

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

ORE Catapult will build on its workforce foresighting approach by expanding the use of "role archetypes" to simplify and scale the application of the future occupational profiles and new capabilities identified. This approach enables agile skills development, by layering specialist capabilities onto foundational roles, rather than creating entirely new qualifications (with the exception if identified skills course opportunities to support upskilling).

The approach will support education providers in aligning curricula to emerging industry needs, focusing on new and differentiating skills while enabling clearer progression and reskilling pathways.

ORE Catapult are currently piloting the adaptation and use of a software skills platform (skillsminer.ai) under an Innovate UK funded project, looking at how workforce foresighting data can be operationalised and taken into effective action by employers and educators. Subject to the success of the pilot (and future funding), data from this study will be incorporated within the next stages of the 'cause action' project. Digital enablement through this platform will help to scale the impact of workforce foresighting by embedding insights into a platform that supports workforce planning, skills matching, and reskilling across the sector.

Other recommended actions include:

- Governance and working groups will be established to ensure industry validation, accountability, and the translation of insights into tangible training and workforce interventions.
- To maintain momentum and coordination, a national industry champion is recommended to provide leadership and drive sector-wide alignment.
- Cross-sector collaboration will be enhanced to support workforce mobility and shared capability development, improving resilience and reducing investment risk.

[1] These are from capabilities within the WfHub Data Cube which includes Skills England standards

Glossary

Term	Definition
BESS	Battery energy storage system
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
Capability Statements	Description of the organisational capability, normally consisting of a verb-noun pair.
CfD	Contracts for Difference
Competencies (Workforce / Individual)	'Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
CPD	Continued Professional Development
Catapult	Part of the UK's network of nine research and technology organisations under Innovate UK. See https://catapult.org.uk/.
Curtailment	The need to disconnect renewable energy sources like wind or solar, when generation exceeds demand.
Dispatchable energy sources	Sources like coal and gas-fired steam turbines, where the generation can be turned off or on, as opposed to non-dispatchable energy sources like wind power.
Foresighting Cycle / Study	Set of workshops, analysis and reporting that implements Workforce Foresighting for a particular topic.
Future Competency Set	The KSB output from the Educator workshop for each Role Group
'KSBs' (Knowledge, Skills and Behaviours)	Knowledge, Skills, and Behaviours are used to provide additional detail to an organisational Capability Statement and act as a common language with other skills frameworks.
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary.
NESO	National Energy Systems Operator – see https://www.neso.energy/
ORE Catapult	The Offshore Renewable Energy Catapult
OWIGP	The Offshore Wind Industrial Growth Plan (RenewableUK, 2024)
Power-to-X / PtX	Conversion of power / electrical energy into other stored or chemical energy forms like hydrogen or sustainable aviation fuel.
Proficiencies	Proficiencies differentiate the degree of competency required in a capability when it appears in a particular future occupational profile: Expert, Practitioner or Awareness.
Project Sponsor	Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act.
Role Family	Role families are a collective of roles that exist in a typical manufacturing business / industrial sector, at a particular range in the relevant qualification framework.

Table 1: Glossary

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Figures and Tables

Introduction & Challenge Definition

1 Introduction

1.1 Purpose of this Report

This report is a summary of output from Phase 2 (‘Carrying Out’) of a workforce foresighting study on “Future Skills for Integrating Hybrid Energy Technologies with Offshore Wind to Enable Dispatchable Clean Energy”. The study is 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 or 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[10], where the generated data can be viewed in various ways.

1.2 Introduction to Workforce foresighting

Workforce foresighting is essential in addressing the skills challenge, by aligning the skills value chain—from early education through to advanced training—with the demands of emerging technologies. By identifying future occupational profiles and the capabilities required for new roles, foresighting enables educators, employers, and policymakers to proactively adapt curricula, qualifications, and training pathways. This ensures the workforce is not only prepared for technological change but also equipped to drive innovation and productivity. In doing so, it transforms the skills gap from a reactive challenge into a strategic opportunity for national growth and resilience. See Appendix A (**Table 9: A1. Visualisation Tool Links)**

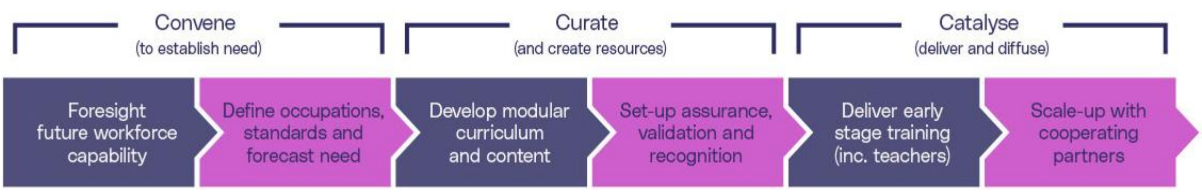


Figure 1: The Skills Value Chain (SVC)

1.3 Defining the Foresighting Challenge

1.3.1 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 CO2 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.

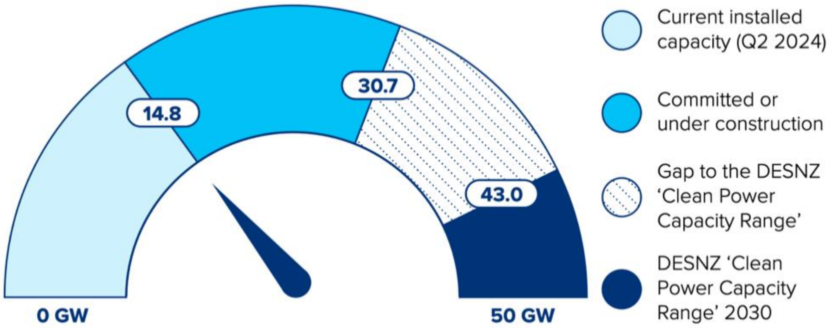


Figure 2: Offshore Wind installed capacity vs 'Clean Power Capacity Range' in 2030 (Department for Energy Security and Net Zero, 2024)

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.

1.3.2 Topic Selection Approach

The foresighting topic has been selected through review of the UK's "Offshore Wind Industrial Growth Plan" (RenewableUK, 2024), the UK's "Clean Power 2030 Action Plan" (Department for Energy Security and Net Zero, 2024), and shortlisting workshops within the Offshore Renewable Energy Catapult ('ORE Catapult')

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 through a focus on five areas:

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

The Clean Power 2030 Action Plan was published by the Department for Energy Security and Net Zero ('DESNZ') in December 2024 and describes the UK's transition to clean energy by 2030, such that clean energy should comprise 95% of Great Britain's overall generating capacity (currently 60%) and produce as much power as Great Britain consumes (currently 56%). Great Britain's CO_2 emissions intensity should also reduce below 50g per KWh by 2030 (currently 171g CO_2 / KWh).

Skills are referenced in both the OWIGP and the Clean Power 2030 plan (the only addendum to the report focusses on skills and notes that the offshore wind sector has reported persistent skills gaps in high-level electrical, digital, and consenting skills; and for roles like Senior Authorised Persons, data analysts and scientists, and regulators). Workforce Foresighting is referenced as a component in resolving the skills challenge in both the OWIGP and the Clean Power 2030 plan, citing ORE Catapult's study on Dynamic Cable Systems (Hatchett et al., 2023).

From these three sources and analyses, two clusters of foresighting topics resulted:

Cluster 1 (studies completed in 2025 H1):

- **Structures – automated welding:** The development and application of automated welding solutions for foundations, transition structures and tower sections.
- **Advanced production methods in wind turbine blades**: Design and production utilising advanced and automated production methods.
- **HVDC Cable Systems:** Development and production of high voltage direct current (HVDC) cables and associated equipment in the UK.

Cluster 2:

- **Smoothing power delivery to grid from Offshore Wind: The** topic described in this report.
- **Autonomous survey:** Robotic & autonomous systems 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 / Use of novel concrete materials and forming; in floating offshore wind.

1.3.3 Topic Selection and Description

The Strategic Challenge

This study addresses the topic of smoothing power delivery from offshore wind to the grid. The expansion of offshore wind contributes to reducing the UK's carbon footprint, energy independence and security. However, wind energy is "non-dispatchable" – it cannot be switched on or off at will. Unlike legacy energy generation like coal- or gas-fired steam turbines, wind generation is determined by unpredictable weather patterns.

The mismatch between supply and demand creates two main problems, and costs: Firstly, shortfall in energy generation when demand is high, and wind speeds are low; and secondly and perhaps more frustrating is curtailment, when the wind is blowing and windfarms generate more electricity than the power grid can absorb or transport. In the present market, windfarm operators may be instructed by the National Energy System Operator ('NESO') when supply exceeds demand or the capacity of the grid to transmit electricity from where it is generated to where it is required. At the same time, the windfarm operators may be paid curtailment charges to offset "losses" from not selling the electricity[2]. In effect, curtailment describes 'wasted wind' – and charges for this reached £1.46Bn in 2025 (Hawkes, n.d.).

To fix this problem there are mitigation approaches which do not involve reducing the amount of green energy:

[2] In fact, they are paid if the wholesale energy price – which varies due to demand – is lower than the "strike price" which is often fixed in the Contract for Difference ('CfD') set in place when the windfarm was developed and contracted for the sale of electricity. The operators may also receive Constraint Payments if NESO asks a wind farm to reduce output. At the same time, NESO may then need to instruct gas plants and other dispatchable energy sources to ramp up supply closer to the demand (e.g., in South-East England); these gas plants are paid well for this flexibility. Ultimately, the energy consumers bear these costs and thus it can be argued they are paying twice for the same amount of electricity.

- Alter regulatory and market / pricing models, for example making energy cheaper where renewable energy supply is strong (zonal pricing).
- Store excess energy when it cannot be consumed or transported so that it can be released back to the grid when it is needed (time-shifting).
- Use the excess energy to do something else useful.
- Remove bottlenecks in the transmission grid – like the B6 transmission boundary between Scotland (where there is more wind generating capacity) and England (where there is higher demand for electricity).
- The net system benefits each year increase significantly each year, based on the presumed growth in renewable energy. For example, net annual benefits from energy storage increase from £0.12Bn to £2Bn-5Bn up to £10Bn-£15Bn in 2020, 2030 and 2050, respectively (Brandon et al., 2016).

This study set out to address the approaches that involve deployment and scaling of new technologies – although it also inevitably touched on the regulatory and market aspects too.

1.3.4 Future Technology

The future technology solutions are developing and scaling quickly. These include battery energy storage systems (BESS)[3], generating green hydrogen by electrolysis, which in turn can be used for other things (Power-to-X) such as synthetic aviation fuels (SAF) or ammonia, or stored; and lastly, grid-forming and power shaping.

Battery Energy Storage Systems

Battery technologies and chemistries are reasonably well understood, although there is a shift from lithium-ion batteries towards sodium-ion and redox flow batteries, which may offer improvements in safety and cost effectiveness for long-term storage (Rho Motion, 2023). Batteries also offer near-instantaneous response times which makes them useful for ancillary services such as Enhanced Frequency Response (EFR) – a service introduced in 2016 by the National Grid – and dynamic containment (Beckford et al., 2023). Battery technologies and chemistries are reasonably well understood, although there is a shift from lithium-ion batteries towards sodium-ion and redox flow batteries, which may offer improvements in safety and cost effectiveness for long-term storage.

However, there is a significant pipeline of BESS projects in the UK, and only a small fraction of the planned capacity is currently in operation. In 2022, only 5% of projects were in operation while the remaining 95% were under construction, in development or awaiting planning approval (Rho Motion, 2023). Grid connection delays are one of the most significant barriers to deployment, though there have been regulatory issues (storage was treated as generation until recently, leading to double taxation) and planning issues too.

Hydrogen, Power-to-X and Direct Air Carbon Capture

Excess energy can be used to electrolyse water as a source of green hydrogen[4] or to capture carbon from the air. Hydrogen can be stored for long durations (days, weeks or months), for example in salt caverns or depleted undersea reservoirs. Then, when demand exceeds supply, in place of burning natural gas, the green hydrogen can be converted back

[3] Technology is also not the only factor here: Battery capacity needs to be used when available, and the current energy bids and dispatch rules weren't designed for large fleets of batteries. Furthermore, there is a large queue of battery storage awaiting connection to the grid (Harper, 2025).

[4] 'Green hydrogen' refers to hydrogen produced using renewable energy sources, as opposed to 'grey hydrogen' (produced from natural gas via steam methane reformation), 'blue hydrogen' (produced in the same way as grey hydrogen with the addition of carbon capture and storage), and various other 'colours' reflecting differing production methods.

into electricity[5] (Power Generation Working Group, 2025). Power-to-X (PtX) takes this concept further with hydrogen being converted into other ('x') forms like green ammonia for use in fertilisers or shipping, or synthetic aviation fuels (Danish Ministry of Climate, Energy and Utilities, 2021).

Expected developments in this field include advancements in electrolysis technology like alkaline water electrolysers using lower-cost materials, proton exchange membranes that offer faster responses and higher power density compared to alkaline units, and solid oxide electrolysers which but have lower electrical energy requirements. (Beckford et al., 2023; Brandon et al., 2016; Henry et al., 2022).

Direct air capture is currently expensive and energy intensive, but it is viewed as an (essentially) unlimited resource for carbon. When reacted with green hydrogen, captured carbon can be used to create carbon-neutral fuels such as e-methanol, e-kerosene and synthetic methane. These are all ways to turn excess electrical energy into transportable chemical energy, though much of this technology is currently in early commercial stages (Danish Ministry of Climate, Energy and Utilities, 2021; Norton et al., 2024).

Grid Forming

Historically the UK power grid (and those in most countries) has relied on the inertia of large physical turbines to resist grid frequency due to sudden changes in demand[6]. As older physical plants retire and more renewable energy sources come online, the grid needs to find other ways to deal with these changes. Grid forming technologies provide synthetic inertia – mimicking the response of synchronous machines - so that renewable energy sources can maintain grid stability and resist frequency deviations. This capability is fundamentally different from grid-following convertors standard in most offshore wind farms, which require a stable grid signal to operate. Additionally, grid-forming offshore wind turbines can undergo "black start" – re-energising parts of the national grid after a total failure, without needing external power (Pagnani et al., 2023). Power converters in such wind farms must be able to operate in 'island mode', i.e. maintain a local power network independently of the national grid, for example using localised BESS. Grid-forming control is often implemented using architectures like virtual synchronous machines (VSM) or power synchronisation control (PSC).

1.3.5 Implications for Skills

The UK energy mix is transitioning from a small number of large power plants to a more complex mix of decentralised, distributed and hybrid assets. This means that cross-disciplinary expertise is important. Compared to current scenarios where generation, storage and production are distinct activities, more advanced hybrid energy systems mean these activities need to be managed and synchronised in real time.

The main implications for skills in scaling up hybrid energy systems are around optimising and integrating these new systems, including commercial understanding, forecasting capabilities and scheduling, as well as technical skills in network planning and systems integration (P. Papadopoulos et al., 2016). Much work in Power-to-X is likely to rely on the combination of transferable skills from existing sectors but also the development of new skill

[5] There are several methods to do this, including open or combined cycle hydrogen turbines that use specially designed fuel delivery and combustion systems, reciprocating engines, combined heat and power systems, and hydrogen fuel cells such as the 40MW HyPower project (Power Generation Working Group, 2025).

[6] One analogy is a large header tank in a building's water supply system. When taps are turned on and off unpredictably throughout a building the tank acts as a buffer, absorbing sudden changes in demand without causing pressure to spike or collapse. Without the tank, every tap opening would cause a drop in pressure across in the building. Similarly, the massive rotating mass of conventional turbines acts as a buffer for the electricity grid, absorbing fluctuations in demand and giving operators crucial seconds to adjust generation without destabilising the grid frequency.

and role pathways. The hydrogen-to-power field shares many commonalities with the natural gas industry.

Other areas likely to demand new skills include areas like electrochemistry and next-generation materials for electrolytes and electrodes, and skills for dealing with hydrogen and high-pressure systems. (Beckford et al., 2023; Brandon et al., 2016; Danish Ministry of Climate, Energy and Utilities, 2021).

2. Findings & Insights

2 Findings

2.1 Findings and Results

This report outlines a three-step foresighting process to understand how emerging technologies will reshape supply chain capabilities and workforce needs.

- **Industry -** First, it explores how organisational capabilities must evolve to enable the adoption/deployment of new and emerging technology, identifying which supply chain partner and functions will be most impacted.
- **Workforce -** Next, these capabilities are grouped into Future Occupational Profiles (FOPs), which show the occupations that will need to change.
- **Provision -** Finally, the FOPs are compared against current education and training provision, using Skills England occupational standards as a benchmark, to identify where existing programmes align and where gaps exist.

The report summarises priority capabilities, FOPs, and knowledge, skills, and behaviours (KSBs). Full details of the data and findings are available in See Appendix A (**Table 9: A1. Visualisation Tool Links)** and Visualisation Tool.

2.1.1 Introduction to 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. Links throughout this report make it easy to identify existing standards which meet the needs of these future roles and pinpoint where new standards are necessary to develop a skilled workforce equipped to adopt new technologies.

The data is generated by the foresighting cycles, integrating the expertise of technologists/domain specialists, employers, and educators. The data can be used to inform the development of future curricula and course content as determined by the action plan. Using AI tools validated by human oversight, and by linking to external data sources, the tool identifies differences at the level of occupation/role as well as detailed changes required to help update/refresh knowledge, skills and behaviours thus delivering insights for learners, providers, creators, and assurers of skills.

Links: Link to **Visualisation Tool**[7]

Detailed instructions on how to use the Visualisation Tool[7] can be found in the Appendix A (**Table 9: A1. Visualisation Tool Links**) in this report.

[7] https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=861a0b88abb2bfeb81d681322b44756e

2.2 Industry Identified Organisational Capabilities

2.2.1 Capabilities Identified

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.

2.2.2 Future Supply Chain

To understand how supply chains must evolve in response to emerging technologies, we create a forward-looking view of what future supply chain operations will look like, compared to how they function today. This comparison helps highlight the areas where change is needed to meet new demands and opportunities.

Throughout the process, we work closely with participants to identify **which supply chain partners** will be affected by the technology in question. This ensures that the analysis is grounded in real-world contexts and considers the full ecosystem of organisations involved.

These are the supply chain partners in this study:

Grid and Network Operators

Responsible for adapting governance and planning frameworks to mandate storage as part of offshore windfarm design. They establish technical rules and guidance for grid-connected storage, Power-to-X systems, and related technologies, ensuring compliance and interoperability. Their role includes designing smart grid control and management systems, inspecting and certifying schemes during commissioning, and setting requirements for end-of-life processes to ensure safe and sustainable decommissioning

Wind Farm Developers and Operators

Focus on designing and developing offshore windfarm integrations that incorporate power storage and conversion solutions. They play a key role in implementing black start capabilities within windfarm infrastructure and determining which hybrid solutions are most suitable. Their responsibilities span constructing windfarms, ensuring circularity of storage and conversion systems, and managing safe decommissioning practices to minimise environmental impact.

Wind Turbine Generator and Electrical Infrastructure OEMs

Tasked with advancing turbine and electrical infrastructure technologies to support hybrid grid integration. This includes developing black start capabilities within wind turbine generators (WTGs), adapting power electronics and control systems, and building smart grid systems and controls that enable seamless interaction between offshore wind assets and energy storage or conversion technologies.

Hybrid Energy Systems OEMs

Specialise in designing and manufacturing large-scale hybrid energy systems for offshore wind integration. Their remit includes developing integrated, grid-connected solutions combining energy storage, Power-to-X, hydrogen, and carbon management technologies to enable multi-vector energy conversion and system flexibility. They oversee the full lifecycle from system design through manufacturing and integration, ensuring robust, scalable solutions that support decarbonisation and whole-system optimisation.

2.2.3 Prioritised Capability Themes

Across the various supply chain partners, a total of **113** future capabilities were identified for this CPI cycle. These capabilities were subsequently prioritised by participants through Survey B, which captured their assessment of the most essential capabilities required for successful technology adoption. All 113 capabilities were then assessed through a map-and-gap analysis against current Skills England provision. This analysis identified 39 high-priority capabilities that are not currently well matched to any existing provision.

These **39** unmatched, high-priority capabilities were then clustered into the following seven themes, which form the basis of the analysis in Education and Training provision insights

1. Grid-Forming Power Electronics & Advanced Control Systems.
2. Hybrid Grid Integration, Stability & Compliance.
3. Power-to-X, Hydrogen & Multi-Vector Energy Systems.
4. Digital Systems Modelling.
5. Manufacturing, Installation & Supply Chain Integration.
6. Markets, Regulation & System Governance.
7. Collaboration, Innovation & Advocacy.

2.3 Workforce Insight

2.3.1 Future Occupational Profiles (FOPs)

Future Occupational Profiles (FOPs) indicate how roles in the industry will need to evolve as the sector becomes more productised, systemised, and technology driven. They define the key responsibilities and the knowledge, skills, and behaviours required for each role, ensuring alignment with the industry's transformation.

The FOPs defined for this cycle do not capture the full extent of a current or future job role. Workforce Foresighting identifies new capabilities and changes required in an occupation required in the future to allow technology adoption.

Links Link **to FOP Matrix**[8]

Role Families

Organisations rely on structured role families to manage talent, drive performance, and support sustainable growth. A clear hierarchy from entry level to executive leadership ensures responsibilities are well defined and expectations aligned. Each family builds on the last in terms of complexity, autonomy and impact enabling effective collaboration and accountability.

The Role families used in ORE Catapult workforce foresighting cycles are:

- Role Family #1 Technician/Operator (no FOPs assigned in this cycle)
- Role Family #2 Senior Technician (no FOPs assigned in this cycle)
- Role Family #3 Engineers
- Role Family #4 Senior Engineers

[8] https://hvmcatapultforesighting.retool.com/embedded/public/f99a913f-8827-4730-8893-d618d489bc84?token=861a0b88abb2bfeb81d681322b44756e

Future Occupational Profiles results

For this cycle, Future Occupational Profiles (FOPs) were generated solely at the higher technical and professional levels. Throughout the analysis, all profiles aligned with Role Level 3 (Engineer) and Role Level 4 (Senior Engineer), with no FOPs assigned to Role Levels 1 or 2. This reflects the advanced technical, regulatory, and systems-integration demands associated with hybrid offshore energy technologies.

The full set of identified FOPs is presented below, grouped by Role Level and mapped across the relevant supply chain partners.

RF	FOP	Grid and Network Operators	Wind Farm Developers and Operators	Wind Turbine Generator and Electrical Infrastructure OEMs	Hybrid Energy Systems OEMs
3	Energy Management Systems (EMS) [Controls & Automation] Engineer			●	✓
	Installation, Commissioning & Operations Engineer – Hybrid Energy Systems		●	●	✓
	Production Operations Manager (Hybrid Energy Systems)		✓		
	Wind Turbine & Electrical Systems Engineer		●	✓	●
4	Grid Code & Standards Specialist	✓			
	Hybrid / Multi-Vector System Architect		✓	●	●
	Power Systems & Grid Integration Engineer	●	✓		
	Regulatory & Policy Advisor (Hybrid Systems)	✓	●		
	Senior R&D Engineer – Hybrid Energy Systems		●	●	✓
	Stakeholder & Cross-Sector Integration Manager	●	✓		
✓ Primary Supply Chain Partner, ● other relevant supply chain partners					

Figure 3: Future Occupational Profiles and Supply Chain Partner Alignment

2.3.2 Prioritising Future Occupational Profiles

A **Priority FOP** is a profile that is seen as critical to future success. They are areas where workforce foresighting suggests that attention should be first to meet evolving sector needs. The Priority Future Occupational Profiles (FOPs) were identified based a view of the criticality of those capabilities to delivering the cycle objectives, including technology adoption, regulatory readiness and operational impact. The prioritised profiles suggested are:

- **Grid Code & Standards Specialist**
  Required for the adaptation of codes and standards to better incentivise, regulate and accommodate the incorporation of hybrid energy assets.
- **Hybrid / Multi-Vector System Architect**
  The need for a systems-level approach to solving the challenges and opportunities of hybrid energy systems is reflected in this profile.
- **Senior R&D Engineer – Hybrid Energy Systems**
  Roles aligned with this profile are central in developing, advancing and scaling the hybrid energy technologies and systems.
- **Stakeholder & Cross-Sector Integration Manager**
  Again, this profile reflects the requirements highlighted through workshops for systems-level thinking and driving coordination and integration between multiple partners and suppliers.

See Appendix B (**Appendix B. List of full Future Occupational Profiles**) for full details of all Future Occupational Profiles. You can also access the Future Occupational Profile Detail[9] page of the Visualisation Tool for further information.

[9] https://hvmcatapultforesighting.retool.com/embedded/public/81d272f0-ad80-421c-8926-86655913acdf?token=861a0b88abb2bfeb81d681322b44756e

2.4 Education and Training provision insights

2.4.1 Provision Analysis of FOPs and Capabilities

Below is a comparison of each priority FOP against highest scoring existing education provision. The tables highlight the highest-scoring standard for each and identify capabilities that are not currently addressed by the selected standard. These unmet capabilities could inform the development of future education and training provision, either by adapting existing programmes or through the creation of short continuing professional development (CPD) courses aimed at upskilling the current workforce.

A detailed comparison of current apprenticeship provision against the capability requirements of the identified FOPs is available in the visualisation tool on the **FOP vs Provision**[10] page.

Grid Code & Standards Specialist

Key Tasks: Technical (electrical engineering) role responsible for developing and advising on grid codes and standards applicable to hybrid energy solutions.

Aligned to supply chain partners: Grid and Network Operators

In FOP vs Provision there was an 20% Fit with Skills England Standard Marine Technical Superintendent (Degree). The unmatched FOP capabilities are shown in the table below:

Capability Statement
Develop advocacy strategies to accelerate adoption of hybrid technologies in global energy markets.
Establish compliance pathways for new grid standards to ensure safe and reliable integration of hybrid energy systems.
Establish certification processes for hybrid assets to meet international and local regulatory requirements.
Conduct scenario modelling of hybrid energy systems to strengthen resilience and ensure regulatory compliance.
Implement coordinated planning frameworks for hybrid grid systems across multiple offshore wind projects to optimise network reinforcement and reduce curtailment.
Define circularity standards specific to BESS/PtX: battery recycling pathways, electrolyte/by-product handling, offshore waste compliance.
Develop testing requirements for grid-forming offshore wind power plants to ensure black start readiness.
Lead working groups to update and validate grid codes supporting safe, compliant hybrid energy operation.

Table 2: Grid Code & Standards Specialist capabilites unmatched.

[10] https://hvmcatapultforesighting.retool.com/embedded/public/d9f485a2-6d23-45dd-ab48-4c4c87ced0c7?token=861a0b88abb2bfeb81d681322b44756e.

Hybrid / Multi-Vector System Architect

Key Tasks: Designs the overall architecture of hybrid and multi-vector energy systems; considers system integration but does not physically build or operate the systems.

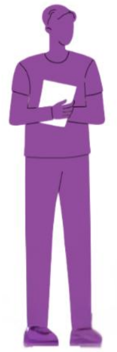
Aligned to supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs, Hybrid Energy Systems OEMs

In FOP vs Provision there was an 11.5% Fit with Skills England Standard Materials Science Technologist (Degree). The unmatched FOP capabilities are shown in the table below:

Capability Statement
Develop feasibility assessments and identify opportunities to advance hybrid offshore wind solutions integrating storage and power-to-x technologies.
Develop hybrid-mode offshore wind turbines capable of grid-following and grid-forming operations.
Establish control co-design frameworks to optimize grid integration and market participation of offshore wind farms.
Assess offshore wind farm infrastructure to integrate hybrid grid technologies effectively.
Develop integrated grid-system plans to accommodate hybrid offshore energy assets and minimise network congestion.
Develop modular hybrid systems combining wind turbines, energy storage, and hydrogen production to optimise renewable energy utilisation.
Design hybrid offshore energy parks combining wind, wave, and solar technologies to optimise energy production.
Integrate energy storage solutions with offshore wind farms to provide dispatchable clean energy and enhance grid stability.
Create interoperability standards for electron-molecule energy flows across offshore and onshore networks.
Conduct emergency drills with network operators to ensure readiness for black-start and system restoration events.
Conduct feasibility and planning assessments to validate design options and support early-stage development of hybrid offshore energy solutions.
assure the integration of new storage and smoothing equipment to enable safe, reliable connection to the electricity grid.
Develop interoperability standards for hybrid components to streamline logistics and reduce operational risk.
Implement coordinated planning frameworks for hybrid grid systems across multiple offshore wind projects to optimise network reinforcement and reduce curtailment.
Implement interoperability standards to ensure seamless integration of hybrid grid technologies in offshore wind farms.
Develop integrated infrastructure linking offshore wind, hydrogen production, and storage to enable multi-vector energy systems.
Plan the integration of hybrid offshore assets to ensure future compatibility between power-storage, power-to-x, and wind-farm systems.
Ensure hybrid energy-asset control systems can be integrated seamlessly into the overall system architecture.
Evaluate the potential impact of grid-forming inverters and opportunities this provides.
Conduct technical, regulatory, and planning feasibility assessments to identify constraints and approval risks for hybrid grid developments.
Implement multi-vector energy management systems to optimise electricity, hydrogen, and heat flows, integrating flexible demand to minimise curtailment.
Incorporate flexible-demand capabilities into system operations to improve balancing performance and support hybrid grid stability.
Integrate Power-to-X systems with offshore wind to convert excess energy into hydrogen or other fuels.

Table 3: Hybrid / Multi-Vector System Architect capabilities unmatched.

Senior R&D Engineer – Hybrid Energy



Key Tasks: Leads technology development for hybrid and multi-vector energy systems, typically within an OEM context.

Aligned to supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs, Hybrid Energy Systems OEMs

In FOP vs Provision there was an 18.8% Fit with Skills England Standard Materials Science Technologist (Degree). The unmatched FOP capabilities are shown in the table below:

Capability Statement
Design holistic grid-forming control for HVDC-connected offshore wind power plants to provide frequency response.
Create joint innovation frameworks for co-developing hybrid offshore energy technologies.
Develop feasibility assessments and identify opportunities to advance hybrid offshore wind solutions integrating storage and power-to-x technologies.
Design fire-safety and environmental-protection measures to ensure safe operation of power-storage and power-to-x equipment.
Establish hydrogen safety management systems to ensure offshore power-to-x compliance and safe operation.
Develop next-generation battery chemistries to enable cost-effective offshore energy storage.
Design power-to-hydrogen equipment informed by electro-chemical studies to assess performance, degradation, and long-term system reliability.
Develop digital twin platforms to simulate and optimize hybrid grid technologies for improved energy dispatchability.
Create interoperability standards for electron-molecule energy flows across offshore and onshore networks.
Conduct hybrid-specific environmental impact assessments for BESS/PtX (noise, spill risk, marine ecology) and implement mitigation plans.
Develop grid-forming inverter control strategies to enhance offshore wind farm stability and grid compliance.
Develop testing requirements for grid-forming offshore wind power plants to ensure black start readiness.
Engage with policymakers to influence regulations that support hybrid integration and revenue optimisation.

Table 4: Senior R&D Engineer – Hybrid Energy capabilities unmatched.

Stakeholder & Cross-Sector Integration Manager

Key Tasks: Operates from a developer/operator perspective to drive technology adoption and work across sectors to enable implementation.

Aligned to supply chain partners: Grid and Network Operators, Wind Farm Developers and Operators

In FOP vs Provision there was an 25% Fit with Skills England Standard apprenticeship Systems Thinking Practitioner. The unmatched FOP capabilities are shown in the table below:

Capability Statement
Produce investment models for hybrid energy projects to support sound financial decision-making.
Conduct emergency drills with network operators to ensure readiness for black-start and system restoration events.
Create joint innovation frameworks for co-developing hybrid offshore energy technologies.
Develop cross-project governance models to ensure interoperability and shared infrastructure for hybrid solutions.
Build resilient supply chain networks capable of supporting large-scale hybrid deployments, including offshore and onshore integration.
Develop grid-forming inverter control strategies to enhance offshore wind farm stability and grid compliance.
Develop frameworks for incentivising hybrid grid solutions through regulatory and financial mechanisms.
Contribute to developing planning frameworks for hybrid offshore grid systems to coordinate network reinforcement and minimise renewable energy curtailment.
Feed into cross-sector workshops to shape integrated grid-system plans that accommodate hybrid offshore assets and reduce network congestion
Engage regulators to influence policy that enables energy-storage integration in offshore windfarm design.
Establish collaborative development models between wind asset owners, OEMs, and storage technology providers to accelerate hybrid solution deployment.
Engage with policymakers to influence regulations that support hybrid integration and revenue optimisation.

Table 5: Stakeholder & Cross-Sector Integration Manager capabilities unmatched.

2.4.2 FOPs with the biggest Education provision gaps

By definition, Workforce Foresighting is designed to identify capabilities and occupational profiles that aren't well served by existing education provision. Therefore, we do not expect to see high fit when comparing the outputs of foresighting (the FOPs) to current apprenticeships or standards. However, the best fit current standard against each FOP is shown below.

Table key – Supply Chain Partners:

1. Grid and Network Operators
2. Wind Farm Developers and Operators
3. Wind Turbine Generator and Electrical Infrastructure OEMs
4. Hybrid Energy Systems OEMs

Role Family	FOP Title	Supply Chain Partners	Best Fit Standard/s	Closest Fit Factor (%)[11]
4) Senior Engineer	Hybrid / Multi-Vector System Architect	2,3,4	Materials science technologist (degree)	11.5
4) Senior Engineer	Senior R&D Engineer - Hybrid Energy Systems	2,3,4	Materials science technologist (degree)	18.8
4) Senior Engineers	Grid Code & Standards Specialist	1,2,3,4	Resilience and emergencies professional	20
4) Senior Engineer	Stakeholder & Cross-Sector Integration Manager	1	Systems thinking practitioner	25
4) Senior Engineer	Power Systems & Grid Integration Engineer	1,2	Light water reactor scientist and engineer	26.3
3) Engineer	Wind Turbine & Electrical Systems Engineer	2,3,4	Power and propulsion gas turbine engineer	31.3
4) Senior Engineer	Regulatory & Policy Advisor (Hybrid Systems)	1,2	Senior compliance and risk specialist	27.3
3) Engineer	Energy Management Systems (EMS) [Controls & Automation] Engineer	3,4	Electrical power networks engineer	47.1
3) Engineer	Installation, Commissioning & Operations Engineer - Hybrid Energy Systems	2,3,4	Electrical power networks engineer	52
3) Engineer	Production Operations Manager (Hybrid Energy Systems)	2	Electrical power networks engineer	50

Table 6: FOPs vs Closest Existing Apprenticeship Provision

For a deeper exploration of these FOPs within the Visualisation Tool, see the FOP Distribution[12] page.

[11] Fit Factor is determined based on semantic matching between the capability statements within a profile and the duty statements within an apprenticeship profile. 100% would indicate a match above the threshold for linguistic matching, for all capabilities within a FOP.

[12] hvmcatapultforesighting.retool.com/embedded/public/ce67cca1-5beb-4557-8482-8a0b6e174933?token=861a0b88abb2bfeb81d681322b44756e%29.

2.4.3 Knowledge, Skills, and Behaviour tags and its observations.

For each capability, the workforce foresighting approach aligns knowledge, skills and behaviours. This is intended to support:

1. **Informing / Guiding understanding of the alignment between future-state capability requirements and current educational provision**.

2. **Driving action by equipping educators to embed these capabilities into their curriculum.**

While capabilities define what organisations need to thrive in the future, KSBs provide a practical framework for how education can evolve to support development of those capabilities. New capabilities introduced during the cycle will also have the relevant tags that will support educators to integrate those capabilities into curriculum effectively.

Application

The complete list of KSBs associated with each capability is available within the Visualisation Tool, alongside all other relevant contextual information.

The application of this data can be broadly divided into two key areas:

- **Macro Trend Analysis**
  By examining KSB tags at an aggregate level across all capabilities, educators can identify major shifts in demand. This high-level view helps narrow the focus to areas where change is most significant or emerging.
- **Detailed Research**
  Once priority areas are identified through the macro lens, educators can drill down into specific capabilities or explore the detailed KSBs linked to a particular tag. This supports more targeted curriculum development and informed decision-making.

This report presents a selection of aggregated insights intended to illustrate potential use cases. Readers are encouraged to explore the Visualisation Tool for a more detailed and interactive engagement with the data. The tool offers deeper context, flexible filtering, and access to the full range of capabilities and KSB tags, enabling users to tailor their exploration to specific interests or needs.

2.4.4 Most frequent tags

The following graphic highlights the most frequently used tags across all capabilities in the foresighting cycle. These tags reveal macro trends that can guide the focus of training provisions.

Most frequent Knowledge Tags

Tag	Tag Frequency
Offshore Wind Power	40
Renewable Energy Systems	37
Electrical Power Generation	20
Power to X	20
Wind Farms	19
battery energy storage systems	18
Offshore Engineering	17
Wind Turbines	15
Energy Storage	14
Electricity Market	11
System Integration	11
Electrical Power Distribution	10
Renewable Energy	10
Hydrogen Storage	8
Energy Management System	7
Integrated Design	7
Regulatory Compliance	7
Energy Economics	6
Offshore Constructions And Facilities	6
Electrical Engineering	5
hydrogen	5

Table 7: Frequency of Knowledge Tags

Most frequent Skills Tags

Tag	Tag Frequency
Design smart grids	31
Design wind energy systems	30
Coordinate electricity generation	22
Apply planning principles to electrical grids	21
Monitor green energy systems	18
Research new renewable energy technologies	17
Optimise wind farm layout	13
Design power station systems	7
Inspect battery storage systems	6
Direct renewable energy production operations	5
Integrate systems and software	5
Perform energy simulations	5

Table 8: Frequency of Skills Tags

This data serves as a starting point to identify emerging knowledge and skill areas that may not be traditional within the industry but are gaining traction due to the adoption of new technologies. It also highlights expected tags that rank lower than anticipated, potentially indicating a decline in demand.

Using this insight, readers can explore the Visualisation Tool to examine the knowledge, skills, and behaviours (KSBs) unique to a specific capability or Future Occupational Profile (FOP), enabling more informed decision-making.

3.Conclusion & Next Steps

3 Conclusions and Next Steps

3.1 Key Findings & Conclusions

As always, the scope and depth of the insights generated through workforce foresighting is a function of the number and contributions of attendees. In previous cycles ORE Catapult have carried out a detailed prior background review and preparation stage, including supply chain mapping, triage of potential participating organisations, identification of and outreach to individual workshop participants, and giving longer notice to a wider net of cycle contributors. In this cycle, attendance varied considerably across sessions, with only a handful achieving robust participation numbers. The lower participation in this cycle has been a direct result of not including a preparation phase in the study, as well as the late "cold start" to the cycle. Nevertheless, this study has yielded valuable insights from a small number of experienced and engaged participants.

From the Workforce Foresighting Cycle the following data points were identified and focus areas were developed.

3.1.1 Key Findings

Future Capabilities & Roles:

113 future capabilities were identified, leading to 10 Future Occupational Profiles (FOPs) across 4 supply chain partners.

Priority Capabilities Themes:

These capability themes have been prioritised because they directly address the most pressing challenges and opportunities in the process of **Future Skills for Integrating Hybrid Energy Technologies with Offshore Wind to Enable Dispatchable Clean Energy**:

- Grid-Forming Power Electronics & Advanced Control Systems
- Hybrid Grid Integration, Stability & Compliance
- Power-to-X, Hydrogen & Multi-Vector Energy Systems
- Digital Systems Modelling
- Manufacturing, Installation & Supply Chain Integration
- Markets, Regulation & System Governance
- Collaboration, Innovation & Advocacy

High-Priority Roles:

The following roles will be instrumental in driving industry-wide change by facilitating informed decision-making and ensuring the compliance and economic viability of new technologies:

1. Grid Code & Standards Specialist
2. Hybrid / Multi-Vector System Architect
3. Senior R&D Engineer – Hybrid Energy Systems
4. Stakeholder & Cross-Sector Integration Manager

3.1.2 Next Steps

The uneven distribution of participants in this cycle may have limited the breadth of industry perspectives captured and could affect the applicability of findings across the wider sector. To strengthen confidence in the findings, future validation activities are recommended, involving structured engagement with both industry practitioners and educational institutions not represented in these initial workshops. Such follow-up work would help confirm whether identified needs are consistent across wider audiences and sectors, thereby enhancing the robustness and applicability of the research conclusions.

To build on the findings from this workforce foresighting cycle, the following next steps are proposed to support the operationalisation of insights and acceleration of skills development in **Integrating Hybrid Energy Technologies.**

1. **Expand and Apply the Role Archetype Approach**
   Continue the established coding and analysis approach used across previous ORE Catapult cycles to identify common emerging themes and core role archetypes. This will simplify the application of the growing library of Future Occupational Profiles and capability sets by focusing on foundational roles, onto which specialist capabilities, such as those linked to autonomous systems and AI, can be layered. This provides a more agile and scalable solution for both industry and education, enabling targeted development of new skills without requiring entirely new qualifications for each emerging role.
2. **Enable Education Alignment and Curriculum Development**
   Use role archetypes to support educators in designing provision that focuses on new and differentiating capabilities, rather than duplicating existing standards. ORE Catapult will continue to validate and map skills across role families and levels, enabling clearer progression pathways, reskilling opportunities, and alignment with industry demand.
3. **Strengthen Working Groups and Governance**
   Existing and future working groups will incorporate insights from this cycle to ensure cross-sector alignment and consistency. These groups will establish clear governance structures to drive accountability, validate findings with industry, and build a robust evidence base. Their role will be to prioritise and initiate training and course delivery, ensuring that foresighting insights translate into tangible education and workforce interventions with national strategic impact.
4. **Appoint a National Industry Champion**
   To accelerate progress and maintain sector-wide focus, it is recommended that a senior, respected industry champion is appointed, potentially through organisations such as the Offshore Wind Growth Partnership. This role would provide leadership, coordinate stakeholders, and ensure momentum in developing skills aligned to emerging technologies.
5. **Enable Cross-Sector Collaboration and Workforce Mobility**
   Establish structured engagement with adjacent sectors (e.g. automotive, advanced manufacturing) to identify shared and emerging capabilities. This will support the development of flexible career pathways, enabling individuals to enter, progress, and transition across sectors—thereby reducing investment risk and strengthening workforce resilience.
6. **Scale Digital Enablement through SkillsMiner**
   Working in partnership with skillsminer.ai (subject to funding), ORE Catapult will support the further development and extension of the platform to embed these further Workforce Foresighting outputs, including capabilities, FOPs, and role archetypes. This will enable the tool to act as a dynamic intelligence layer, supporting workforce planning, skills matching, and reskilling at scale across the sector.

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4. Appendix

Appendices

Appendix A. 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[13]. 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/e869283b-4b8a-437c-973e-64ab292e5b87?token=861a0b88abb2bfeb81d681322b44756e
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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/3573002a-ab48-4fad-9765-bee00876a42e?token=861a0b88abb2bfeb81d681322b44756e
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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/81d272f0-ad80-421c-8926-86655913acdf?token=861a0b88abb2bfeb81d681322b44756e

Visualisation Tool Section	What is it and what can it be used for?
Future Occupational Profile (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 compares 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/f99a913f-8827-4730-8893-d618d489bc84?token=861a0b88abb2bfeb81d681322b44756e
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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/8634650f-9700-4627-8431-068b4b764222?token=861a0b88abb2bfeb81d681322b44756e

Visualisation Tool Section	What is it and what can it be used for?
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: 1. understand the levels/volumes of common/crossover Capabilities, to support prioritisation of Capability Development 2. identify which Occupational Profiles contain these common/crossover capabilities, and so which may be prioritised for development activity Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/ce67cca1-5beb-4557-8482-8a0b6e174933?token=861a0b88abb2bfeb81d681322b44756e
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 (Skills England Occupational Standards) provision. By capabilities that **are not** served by the reference mapping framework, e.g., Skills England Occupational Standards 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/219ff6af-36ea-4b5e-bda1-b0b989c0e3f0?token=861a0b88abb2bfeb81d681322b44756e

Visualisation Tool Section	What is it and what can it be used for?
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 (Skills England Occupational Standards). 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/c699e504-3f64-45a0-b52e-ad44a95f9aa4?token=861a0b88abb2bfeb81d681322b44756e
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 (Skills England Occupational Standards). 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/1c4e204b-3927-4226-9f8e-2f62ce0643c5?token=861a0b88abb2bfeb81d681322b44756e
FOP Capability Matches	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (Skills England Occupational Standards) 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, Skills England Occupational 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 Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/6a205e7e-8f33-4765-b39b-82f1f549217a?token=861a0b88abb2bfeb81d681322b44756e

Visualisation Tool Section	What is it and what can it be used for?
FOP vs Provision	This page allows you to compare FOPs against existing Skills England Occupational 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 Skills England Occupational Standards for that Occupational Profile. Where a future capability has been matched to existing provision (currently, by default, Skills England Occupational 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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/d9f485a2-6d23-45dd-ab48-4c4c87ced0c7?token=861a0b88abb2bfeb81d681322b44756e
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. Full URL: https://hvmcatapultforesighting.retool.com/embedded/public/ad0f6dcb-9535-4239-96a7-c8d0e005477a?token=861a0b88abb2bfeb81d681322b44756e

Table 9: A1. Visualisation Tool Links

Appendix B. List of full Future Occupational Profiles

FOP Title: Senior Engineer – Grid Code & Standards Specialist
Role Level: 4 – Senior Engineer
Required for supply chain partners: Grid and Network Operators

ID	Capability Statement	Proficiency
322562	Develop testing requirements for grid-forming offshore wind power plants to ensure black start readiness.	Expert
322710	Establish compliance pathways for new grid standards to ensure safe and reliable integration of hybrid energy systems.	Expert
322878	Establish certification processes for hybrid assets to meet international and local regulatory requirements.	Expert
322890	Implement coordinated planning frameworks for hybrid grid systems across multiple offshore wind projects to optimise network reinforcement and reduce curtailment.	Expert
323253	Lead working groups to update and validate grid codes supporting safe, compliant hybrid energy operation.	Expert
323309	Maintain governance frameworks to ensure compliance with emerging hybrid-system regulations.	Expert
322583	Define circularity standards specific to BESS/PtX: battery recycling pathways, electrolyte/by-product handling, offshore waste compliance.	Practitioner
322883	Develop advocacy strategies to accelerate adoption of hybrid technologies in global energy markets.	Practitioner
323252	Provide technical advice to government and regulators to shape frameworks enabling hybrid offshore energy integration.	Practitioner
331302	Conduct scenario modelling of hybrid energy systems to strengthen resilience and ensure regulatory compliance.	Practitioner

Table 10: B1. Grid Code & Standards Specialist FOP

FOP Title: Senior Engineer – Regulatory & Policy Advisor (Hybrid Systems)
Role Level: 4 – Senior Engineer
Required for supply chain partners: Grid and Network Operators & Wind Farm Developers and Operators

ID	Capability Statement	Proficiency
322580	Establish control co-design frameworks to optimize grid integration and market participation of offshore wind farms.	Expert
322583	Define circularity standards specific to BESS/PtX: battery recycling pathways, electrolyte/by-product handling, offshore waste compliance.	Expert
322880	Model policy changes to anticipate regulatory developments for hybrid technologies.	Expert
322881	Shape market structures to enable hybrid system participation in flexibility and ancillary service markets.	Expert
322883	Develop advocacy strategies to accelerate adoption of hybrid technologies in global energy markets.	Expert
322889	Develop frameworks for incentivising hybrid grid solutions through regulatory and financial mechanisms.	Expert
322891	Develop cross-project governance models to ensure interoperability and shared infrastructure for hybrid solutions.	Expert
323252	Provide technical advice to government and regulators to shape frameworks enabling hybrid offshore energy integration.	Expert
331301	Engage regulators to influence policy that enables energy-storage integration in offshore windfarm design.	Expert
322882	Engage with policymakers to influence regulations that support hybrid integration and revenue optimisation.	Practitioner
323309	Maintain governance frameworks to ensure compliance with emerging hybrid-system regulations.	Practitioner

Table 11: B2. Regulatory & Policy Advisor (Hybrid Systems) FOP

FOP Title: Senior Engineer – Hybrid / Multi-Vector System Architect
Role Level: 4 – Senior Engineer
Required for supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs & Hybrid Energy Systems OEMs

ID	Capability Statement	Proficiency
322458	Develop modular hybrid systems combining wind turbines, energy storage, and hydrogen production to optimise renewable energy utilisation.	Expert
322479	Integrate Power-to-X systems with offshore wind to convert excess energy into hydrogen or other fuels.	Expert
322533	Assess offshore wind farm infrastructure to integrate hybrid grid technologies effectively.	Expert
322613	Implement multi-vector energy management systems to optimise electricity, hydrogen, and heat flows, integrating flexible demand to minimise curtailment.	Expert
322694	Integrate energy storage solutions with offshore wind farms to provide dispatchable clean energy and enhance grid stability.	Expert
322716	Conduct emergency drills with network operators to ensure readiness for black-start and system restoration events.	Expert
322886	Develop interoperability standards for hybrid components to streamline logistics and reduce operational risk.	Expert
322894	Develop integrated infrastructure linking offshore wind, hydrogen production, and storage to enable multi-vector energy systems.	Expert
322895	Create interoperability standards for electron-molecule energy flows across offshore and onshore networks.	Expert
323255	Conduct technical, regulatory, and planning feasibility assessments to identify constraints and approval risks for hybrid grid developments.	Expert
323256	Develop integrated grid-system plans to accommodate hybrid offshore energy assets and minimise network congestion.	Expert
323262	assure the integration of new storage and smoothing equipment to enable safe, reliable connection to the electricity grid.	Expert
323265	Incorporate flexible-demand capabilities into system operations to improve balancing performance and support hybrid grid stability.	Expert
323296	Plan the integration of hybrid offshore assets to ensure future compatibility between power-storage, power-to-x, and wind-farm systems.	Expert
323297	Conduct feasibility and planning assessments to validate design options and support early-stage development of hybrid offshore energy solutions.	Expert
323300	Implement interoperability standards to ensure seamless integration of hybrid grid technologies in offshore wind farms.	Expert
323305	Design hybrid offshore energy parks combining wind, wave, and solar technologies to optimise energy production.	Expert
331305	Evaluate the potential impact of grid-forming inverters and opportunities this provides.	Expert
331313	Ensure hybrid energy-asset control systems can be integrated seamlessly into the overall system architecture.	Expert
323288	Coordinate stakeholders to align design decisions for wind-turbine and electrical-infrastructure systems with wider offshore project needs.	Expert
323294	Design fire-safety and environmental-protection measures to ensure safe operation of power-storage and power-to-x equipment.	Expert

Table 12: B3. Hybrid / Multi Vector System Architect FOP

FOP Title: Senior Engineer – Stakeholder & Cross-Sector Integration Manager
Role Level: 4 – Senior Engineer
Required for supply chain partners: Grid and Network Operators & Wind Farm Developers and Operators

ID	Capability Statement	Proficiency
322716	Conduct emergency drills with network operators to ensure readiness for black-start and system restoration events.	Expert
323274	Engage stakeholders to align hybrid offshore development plans and resolve early-stage design challenges.	Expert
323298	Engage stakeholders to align design decisions for storage and power-to-x systems with regulatory, environmental, and operational expectations.	Expert
323288	Coordinate stakeholders to align design decisions for wind-turbine and electrical-infrastructure systems with wider offshore project needs.	Expert
323257	Coordinate stakeholders across the energy system to align hybrid-grid development pathways and resolve interface challenges.	Expert
331307	Feed into cross-sector workshops to shape integrated grid-system plans that accommodate hybrid offshore assets and reduce network congestion.	Expert
323281	Provide flexibility services by adjusting hybrid offshore energy output to support balancing, congestion management, and whole-system optimisation.	Expert
322708	Integrate offshore wind farms with flexible load assets to maintain grid code compliance and enhance system flexibility.	Practitioner
322682	Coordinate offshore wind generation with grid requirements to provide ancillary services like FCR and FRR.	Awareness
322462	Coordinate with grid operators to facilitate the integration of hybrid offshore wind systems into national energy grids.	Practitioner
323281	Provide flexibility services by adjusting hybrid offshore energy output to support balancing, congestion management, and whole-system optimisation.	Expert
322708	Integrate offshore wind farms with flexible load assets to maintain grid code compliance and enhance system flexibility.	Practitioner
322682	Coordinate offshore wind generation with grid requirements to provide ancillary services like FCR and FRR.	Awareness
322462	Coordinate with grid operators to facilitate the integration of hybrid offshore wind systems into national energy grids.	Practitioner

Table 13: B4. Stakeholder & Cross Sector Integration Manager FOP

FOP Title: Senior Engineer – Power Systems & Grid Integration Engineer
Role Level: 4 – Senior Engineer
Required for supply chain partners: Grid and Network Operators & Wind Farm Developers and Operators

ID	Capability Statement	Proficiency
322431	Develop hybrid-mode offshore wind turbines capable of grid-following and grid-forming operations.	Expert
322447	Develop grid-forming inverter control strategies to enhance offshore wind farm stability and grid compliance.	Expert
323263	Apply advanced electromagnetic transient simulation to analyse system behaviour and enhance operational stability of hybrid grid environments.	Expert
323300	Implement interoperability standards to ensure seamless integration of hybrid grid technologies in offshore wind farms.	Expert
322591	Integrate advanced control systems to enhance grid stability and provide ancillary services from hybrid offshore wind farms.	Expert
322517	Install hybrid grid components to integrate renewable energy sources with existing offshore wind infrastructure.	Expert
323279	Operate smart maintenance systems to optimise hybrid offshore asset performance and reduce operational risk across wind, storage, and PtX technologies.	Practitioner
322569	Integrate battery energy storage systems with offshore wind to enhance dispatchability and grid reliability.	Expert
322700	Integrate offshore wind and Power-to-X technologies to enhance grid responsiveness and energy dispatchability.	Expert
323282	Operate power-to-x facilities to convert surplus offshore wind energy into hydrogen or other carriers for system-wide optimisation.	Practitioner
331308	Integrate hybrid energy assets to stabilise offshore wind generation through grid frequency response and voltage control services.	Expert
323279	Operate smart maintenance systems to optimise hybrid offshore asset performance and reduce operational risk across wind, storage, and PtX technologies.	Practitioner
322569	Integrate battery energy storage systems with offshore wind to enhance dispatchability and grid reliability.	Expert
322700	Integrate offshore wind and Power-to-X technologies to enhance grid responsiveness and energy dispatchability.	Expert
323282	Operate power-to-x facilities to convert surplus offshore wind energy into hydrogen or other carriers for system-wide optimisation.	Practitioner
331308	Integrate hybrid energy assets to stabilise offshore wind generation through grid frequency response and voltage control services.	Expert

Table 14: B5. Power Systems & Grid Integration Engineer FOP

FOP Title: Senior Engineer – Senior R&D Engineer (Hybrid Energy Systems)
Role Level: 4 – Senior Engineer
Required for supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs & Hybrid Energy Systems OEMs

ID	Capability Statement	Proficiency
323267	Develop feasibility assessments and identify opportunities to advance hybrid offshore wind solutions integrating storage and power-to-x technologies.	Expert
322466	Collaborate with research institutions to innovate and improve technologies for hybrid offshore wind energy systems.	Expert
323259	Conduct structured innovation trials to derisk early-stage hybrid technologies and generate evidence for design decisions.	Expert
322436	Implement technology-enabled circular business models for hybridising wind farms with integrated wind/solar, PtG, PtL systems.	Practitioner
323262	Assure the integration of new storage and smoothing equipment to enable reliable grid connection.	Expert
322894	Develop integrated infrastructure linking offshore wind, hydrogen production, and storage to enable multi-vector energy systems.	Expert
323293	Develop accurate system models to predict performance and optimise interactions of wind, storage, and power-to-x technologies.	Expert
323295	Design power-to-hydrogen equipment informed by electro-chemical studies for performance, degradation, and long-term reliability.	Expert
323301	Develop next-generation battery chemistries to enable cost-effective offshore energy storage.	Expert
323283	Evaluate repowering options for ageing offshore assets to inform long-term system performance and lifecycle decisions.	Practitioner
323286	Conduct feasibility assessments to evaluate technical, commercial, and regulatory viability of wind-turbine and electrical-infrastructure design options.	Practitioner
323287	Develop design-stage plans to guide wind-turbine and electrical-infrastructure development aligned with project requirements and regulatory expectations.	Practitioner

Table 15:B6. Senior R&D Engineer (Hybrid Energy Systems) FOP

FOP Title: Engineer – Energy Management Systems (EMS) [Controls & Automation] Engineer
Role Level: 3 – Engineer
Required for supply chain partners: Wind Turbine Generator and Electrical Infrastructure OEMs & Hybrid Energy Systems OEMs

ID	Capability Statement	Proficiency
322437	Develop EMS algorithms to optimise energy dispatch and enhance grid stability.	Practitioner
322711	Implement open data standards for energy systems to enable seamless integration and data sharing across hybrid technologies.	Practitioner
322438	Implement automated grid tools to monitor and control offshore wind energy integration.	Expert
323264	Integrate artificial-intelligence tools into control-room operations to enhance real-time decision-making and system reliability.	Practitioner
323280	Deliver system-support services such as frequency response and voltage control to maintain grid stability from hybrid offshore energy assets.	Practitioner
322872	Apply predictive analysis to optimise performance and reduce failure risk across hybrid assets.	Practitioner
331303	Manage hybrid offshore systems to ensure safe integration, functional performance, and grid readiness.	Practitioner
322591	Integrate advanced control systems to enhance grid stability and provide ancillary services from hybrid offshore wind farms.	Expert
323299	Support developers during commissioning by diagnosing and resolving issues to ensure safe, reliable integration of storage and power-to-x systems.	Practitioner
323282	Operate power-to-x facilities to convert surplus offshore wind energy into hydrogen or other carriers for system-wide optimisation.	Practitioner

Table 16: B7. Energy Management Systems (EMS) [Controls & Automation] Engineer FOP

FOP Title: Engineer – Wind Turbine & Electrical Systems Engineer
Role Level: 3 – Engineer
Required for supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs & Hybrid Energy Systems OEMs

ID	Capability Statement	Proficiency
331305	Evaluate the potential impact of grid-forming inverters and opportunities this provides.	Expert
331313	Ensure hybrid energy-asset control systems can be integrated seamlessly into the overall system architecture.	Expert
323288	Coordinate stakeholders to align design decisions for wind-turbine and electrical-infrastructure systems with wider offshore project needs.	Expert
323268	Improve wind-farm control solutions to incorporate storage and power-to-x systems and enhance hybrid operational performance.	Expert
323287	Develop design-stage plans to guide wind-turbine and electrical-infrastructure development.	Practitioner
323286	Conduct feasibility assessments to evaluate viability of wind-turbine and electrical-infrastructure design options.	Practitioner
323283	Evaluate repowering options for ageing offshore assets to support lifecycle decisions.	Practitioner
323262	Assure integration of new storage and smoothing equipment to enable safe grid connection.	Expert

Table 17: B8. Wind Turbine & Electrical Systems Engineer FOP

FOP Title: Engineer – Installation, Commissioning & Operations Engineer (Hybrid Energy Systems)
Role Level: 3 – Engineer
Required for supply chain partners: Wind Farm Developers and Operators, Wind Turbine Generator and Electrical Infrastructure OEMs & Hybrid Energy Systems OEMs

ID	Capability Statement	Proficiency
323262	Assure integration of new storage and smoothing equipment to enable safe, reliable grid connection.	Expert
322479	Integrate Power-to-X systems with offshore wind to convert excess power into hydrogen or other fuels.	Expert
323298	Engage stakeholders to align design decisions for storage and PtX with regulatory, environmental and operational expectations.	Expert
322613	Implement multi-vector energy management systems to optimise energy flows and reduce curtailment.	Expert
322694	Integrate energy storage solutions with offshore wind farms to provide dispatchable power and enhance grid stability.	Expert
322458	Develop modular hybrid systems combining wind, storage, and hydrogen production.	Expert
323255	Conduct technical, regulatory and planning feasibility assessments to identify constraints for hybrid grid developments.	Expert
322886	Develop interoperability standards for hybrid components to streamline logistics and reduce risk.	Expert
322533	Assess offshore wind farm infrastructure to integrate hybrid grid technologies.	Expert
322716	Conduct emergency drills with network operators to ensure readiness for black-start and system restoration.	Expert
323299	Support commissioning by diagnosing and resolving issues to safely integrate storage and PtX systems.	Practitioner
323281	Provide flexibility services by adjusting hybrid offshore energy output to support balancing and whole-system optimisation.	Expert
323276	Procure wind turbines, foundations, and major components required to support hybrid offshore construction and assembly.	Practitioner
323277	Procure electrical infrastructure equipment (substations, cables, switchgear, transformers, reactive-power assets).	Practitioner
323272	Plan site and grid access by securing seabed leases and negotiating connection agreements.	Practitioner
331303	Manage hybrid offshore systems to ensure safe integration, functional performance, and grid readiness.	Practitioner
322517	Install hybrid grid components to integrate renewable energy sources with existing offshore wind infrastructure.	Expert
331308	Integrate hybrid energy assets for frequency response and voltage-control services in offshore wind generation.	Expert

Table 18: B9. Installation, Commissioning & Operations Engineer (Hybrid Energy Systems) FOP

FOP Title: Engineer – Production Operations Manager (Hybrid Energy Systems)
Role Level: 3 – Engineer
Required for supply chain partners: Wind Farm Developers and Operators

ID	Capability Statement	Proficiency
322614	Operate hybrid trading desks to manage market operations, including ancillary services, capacity market bids, hedging, and optimisation.	Practitioner
322718	Operate trading and market analysis functions to maximise revenue from hybrid energy assets.	Practitioner
331309	Develop smart, automated O&M tools that monitor assets and estimate remaining useful life across the plant.	Practitioner
323269	Design smart O&M approaches that optimise hybrid offshore system performance and reduce lifecycle risks.	Practitioner
322461	Establish maintenance protocols for integrated wind-battery-hydrogen systems to ensure long-term reliability and performance.	Expert
322874	Advance recycling technologies beyond batteries and PtX to cover all major hybrid components.	Expert
323307	Establish hydrogen safety management systems to ensure offshore PtX compliance and safe operation.	Expert
323294	Design fire-safety and environmental-protection measures for safe operation of storage and PtX systems.	Expert
322584	Conduct hybrid-specific environmental impact assessments for BESS/PtX and implement mitigation plans.	Expert
331311	Develop an integrated hybrid plant control system that coordinates operation, maintenance and trading tools to optimise performance.	Practitioner
331314	Provide software and energy-management tools that optimise system operation and support market participation.	Practitioner
322713	Apply circular-economy principles to manage battery/hydrogen system waste in offshore operations.	Practitioner
322484	Manufacture wind turbines, batteries, and electrolyzers to support hybrid system deployment.	Awareness

Table 19: B10. Production Operations Manager (Hybrid Energy Systems) FOP

Appendix C. List of Cycle Capabilities Currently Not Served by Skills England Provision

Table Key:

1. **Grid and Network Operators**
2. **Wind Farm Developers and Operators**
3. **Wind Turbine Generator and Electrical Infrastructure OEMs**
4. **Hybrid Energy Systems OEMs**

Capability statement	1	2	3	4
Design holistic grid-forming control for HVDC-connected offshore wind power plants to provide frequency response.	✓		✓	✓
Integrate Power-to-X systems with offshore wind to convert excess energy into hydrogen or other fuels.		✓	✓	✓
Evaluate the impact of grid-forming inverter penetration on frequency transients in high-renewable systems.	✓		✓	✓
Integrate offshore wind and Power-to-X technologies to enhance grid responsiveness and energy dispatchability.	✓	✓	✓	✓
Integrate battery energy storage systems with offshore wind to enhance dispatchability and grid reliability.		✓	✓	✓
Develop hybrid-mode offshore wind turbines capable of grid-following and grid-forming operations.			✓	
Develop integrated infrastructure linking offshore wind, hydrogen production, and storage to enable multi-vector energy systems.	✓	✓	✓	✓
Shape market structures to enable hybrid system participation in flexibility and ancillary service markets.	✓	✓		
Integrate hybrid energy assets to stabilise offshore wind generation through grid frequency response and voltage control services.		✓		
Manufacture wind turbines, batteries, and electrolyzers to support the deployment of offshore hybrid energy systems.			✓	✓
Install hybrid grid components to integrate renewable energy sources with existing offshore wind infrastructure.		✓	✓	✓
Procure wind turbines, foundations, and other major components required to support hybrid offshore wind construction and assembly.		✓		
Operate power-to-x facilities to convert surplus offshore wind energy into hydrogen or other energy carriers for system-wide optimisation.		✓		✓
Implement interoperability standards to ensure seamless integration of hybrid grid technologies in offshore wind farms.	✓	✓	✓	✓
Develop frameworks for incentivising hybrid grid solutions through regulatory and financial mechanisms.	✓			
Create interoperability standards for electron-molecule energy flows across offshore and onshore networks.	✓	✓	✓	✓
Develop advocacy strategies to accelerate adoption of hybrid technologies in global energy markets.		✓	✓	
assure the integration of new storage and smoothing equipment to enable safe, reliable connection to the electricity grid.	✓	✓	✓	✓

Coordinate offshore wind generation with grid requirements to provide ancillary services like Frequency Containment Reserve (FCR) and Frequency Restoration Reserve (FRR).	✓	✓	✓	✓
Create joint innovation frameworks for co-developing hybrid offshore energy technologies.	✓	✓	✓	✓
Develop modular hybrid systems combining wind turbines, energy storage, and hydrogen production to optimise renewable energy utilisation.			✓	✓
Design hybrid offshore energy parks combining wind, wave, and solar technologies to optimise energy production.		✓	✓	
Establish control co-design frameworks to optimize grid integration and market participation of offshore wind farms.	✓	✓	✓	✓
Develop next-generation battery chemistries to enable cost-effective offshore energy storage.				✓
Provide flexibility services by adjusting hybrid offshore energy output to support balancing, congestion management, and whole-system optimisation.	✓	✓	✓	✓
Implement coordinated planning frameworks for hybrid grid systems across multiple offshore wind projects to optimise network reinforcement and reduce curtailment.	✓	✓		
Improve wind-farm control solutions to incorporate storage and power-to-x systems and enhance hybrid operational performance.	✓	✓	✓	✓
Develop grid-forming inverter control strategies to enhance offshore wind farm stability and grid compliance.	✓		✓	✓
Integrate energy storage solutions with offshore wind farms to provide dispatchable clean energy and enhance grid stability.	✓	✓	✓	✓
Develop digital twin platforms to simulate and optimize hybrid grid technologies for improved energy dispatchability.	✓	✓	✓	✓
Implement multi-vector energy management systems to optimise electricity, hydrogen, and heat flows, integrating flexible demand to minimise curtailment.	✓	✓	✓	✓
Establish certification processes for hybrid assets to meet international and local regulatory requirements.	✓	✓		✓
Integrate offshore wind farms with flexible load assets to maintain grid code compliance and enhance system flexibility.	✓	✓	✓	✓
Establish collaborative development models between wind asset owners, OEMs, and storage technology providers to accelerate hybrid solution deployment.	✓	✓	✓	✓
Develop testing requirements for grid-forming offshore wind power plants to ensure black start readiness.	✓	✓	✓	✓
Conduct static grid connectivity studies to ensure hybrid grid technologies meet classic grid codes.	✓	✓	✓	✓
Feed into cross-sector workshops to shape integrated grid-system plans that accommodate hybrid offshore assets and reduce network congestion	✓		✓	✓
Implement multi-vector energy management systems to optimise electricity, hydrogen, and heat flows, integrating flexible demand to minimise curtailment.		✓	✓	✓
Define circularity standards specific to BESS/PtX: battery recycling pathways, electrolyte/by-product handling, offshore waste compliance.	✓		✓	✓

Establish certification processes for hybrid assets to meet international and local regulatory requirements.	✓	✓	✓	✓
Integrate offshore wind farms with flexible load assets to maintain grid code compliance and enhance system flexibility.		✓	✓	✓
Establish collaborative development models between wind asset owners, OEMs, and storage technology providers to accelerate hybrid solution deployment.			✓	
Evaluate the potential impact of grid-forming inverters and opportunities this provides.			✓	
Define circularity standards specific to BESS/PtX: battery recycling pathways, electrolyte/by-product handling, offshore waste compliance.				✓
Conduct static grid connectivity studies to ensure hybrid grid technologies meet classic grid codes.	✓	✓		

Table 20: C1. List of Cycle Capabilities Currently Not Served by Skills England Provision

Appendix D. Background to Workforce Foresighting Hub

Addressing future workforce challenges

The global marketplace is changing at a rapid pace, and the continued development of innovative technologies is creating opportunities for growth in all sectors.

Whilst we are well placed to take advantage in the UK, the Government and industry have identified that we need a workforce able to adapt to new capabilities that require different and often higher skill sets. The 'Manufacturing the Future Workforce' report, published in 2020, states: "Failure to address the workforce development challenge will mean missing out on opportunities to build the UK's manufacturing base and to take market leading positions."

Developing this workforce and preventing a skills shortfall will provide future-thinking organisations with the capabilities to successfully adopt innovation and enable the UK to build a prosperous economy.

The Skills Value Chain

A Skills Value Chain (SVC) approach promotes connectivity between upstream UK innovation and downstream skills systems, as well as enabling better co-operation within education and training provider eco-systems. It aligns and integrates innovation and skills strategies with a common purpose.

The SVC approach was proposed in the 'Manufacturing the Future Workforce' report, which examined global best practice and convened UK pioneers to explore how the UK can develop skills to exploit innovative technologies.
And it starts with workforce foresighting.

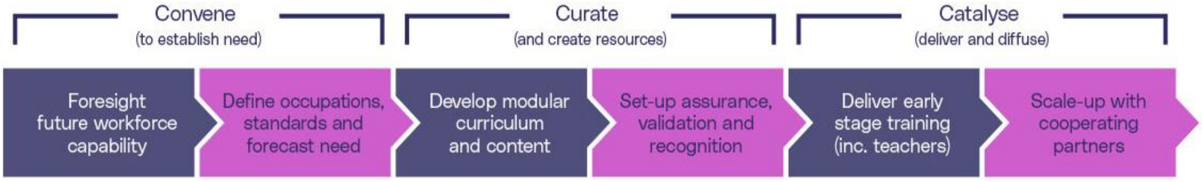


Figure 1: The Skills Value Chain (SVC)

Workforce foresighting

Using the Skills Value Chain approach, the UK will start building the skilled workforce required by tomorrow's industries and employers, and understanding what these future needs will be is where workforce Foresighting comes in.

Workforce Foresighting is a systemic approach to identifying the organisational capabilities and workforce skills necessary to enable industry to adopt and exploit innovative technologies which respond to global, national and sector challenges.

The Workforce Foresighting Hub, initiated and funded by Innovate UK, and built in collaboration with the Catapult Network, provides the processes and data that inform insight and support the recommendations required for industry, policymakers and educators to respond to continuing change.

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.

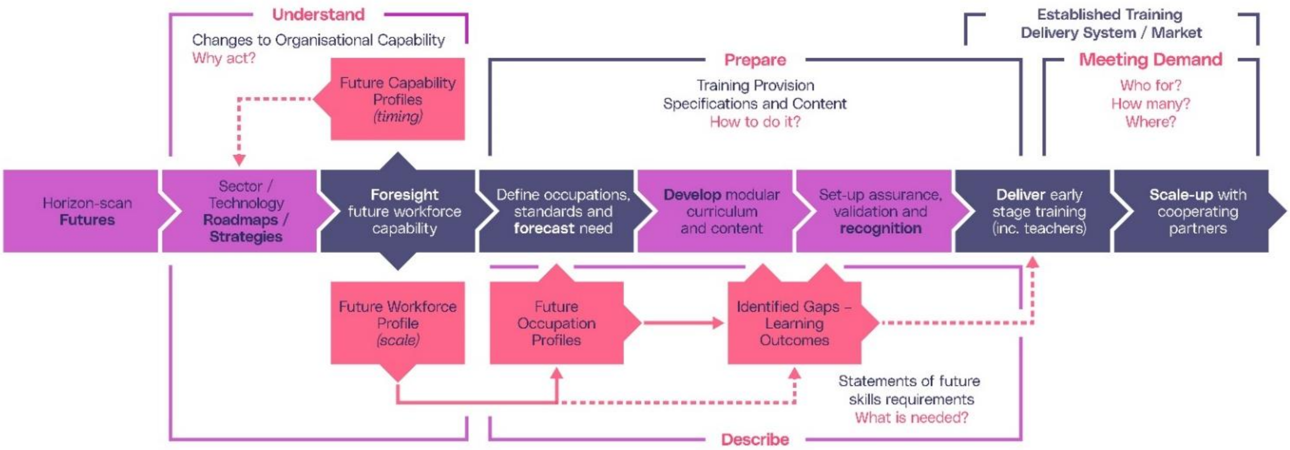
Our Goals:

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

Figure 4: C1. Workforce Foresighting & Skills Value Chain

forward and address

Approach used - 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. Lists of workshop participants are provided in Section 5.1

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 a number of 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 cutting edge 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 WFH team are constantly evolving and improving the detailed workshop process and workshop approach, but essentially 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 an actionable 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

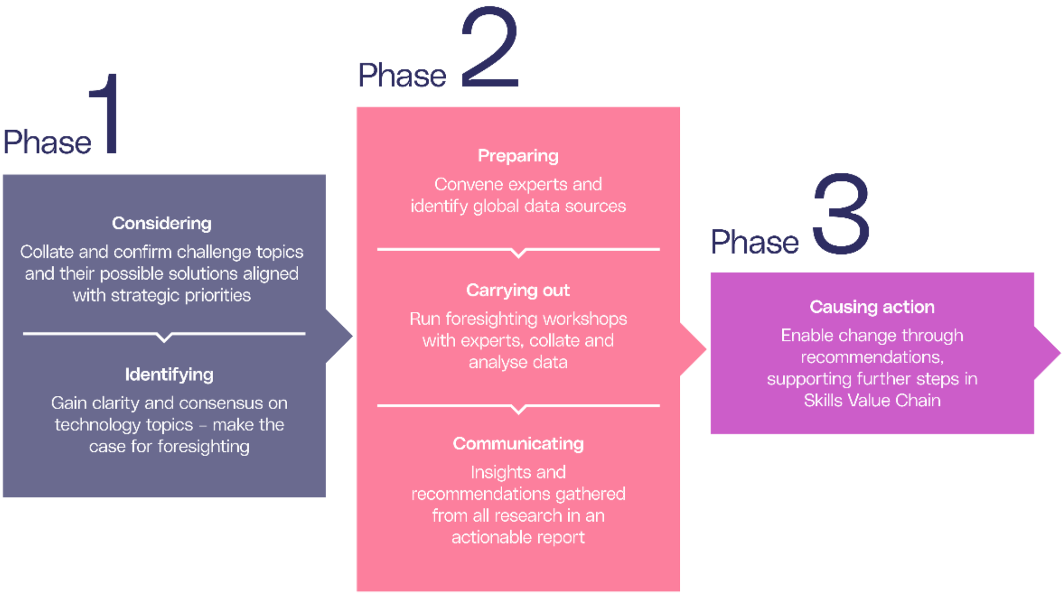


Figure 5: C2. The workforce foresighting process

Forecasting and Foresighting

The result of workforce Foresighting is understanding why skills requirements will need to change to enable the adoption of innovative technologies, and to define what this change is likely to be in terms of future occupations and shorter-term skills gaps. Forecasting of demand can then take these future focused findings and work with industry and government stakeholders to estimate the quantity of workers necessary for an industry to fulfil emerging skill demands at a given time and place. The two approaches are linked in that workforce Foresighting identifies the requirements and forecasting can then determine the quantity needed; the people needing the skills and therefore prepare programmes to deliver them.

Outcomes - insights and recommendations

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 also insight about qualifications and provision that will be required to support new entrants in the future.