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Summary report:

key exchange discussions and collaboration opportunities

UK–China bilateral knowledge exchange 13 to 17 October 2025 on offshore wind end of life and sustainable supply chains

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UK delegation leads

The exchange and this report were developed under the guidance and oversight of the UK delegation leads:

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Please note

The insights provided are synthesised from discussions held during the exchange and have been compiled for informational purposes only. The findings and conclusions presented in this report do not officially represent the views of the Royal Academy of Engineering, His Majesty's government or delegate organisations affiliated with this report.

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Executive summary

Offshore wind is expanding rapidly, with governments awarding a record 56 gigawatts of new projects in 2024 and 48 gigawatts already under construction.[1] By the end of 2024, global installed capacity reached 83 gigawatts, with China and the United Kingdom (UK) leading.[1] China and the UK are the two largest operating markets and both countries have ambitious plans for continued growth.

End-of-life planning

As offshore wind expands, end-of-life (EoL) planning, covering decommissioning, life extension and repowering, is increasingly important, with differing timelines shaping priorities.

- **In China**, near-term EoL impacts are driven by the onshore wind fleet, while offshore retirements are largely a longer-term issue, with volumes expected from the 2040s. Focus is on technical solutions, particularly blade recycling, material recovery and circular design, supported by growing circular economy policies.
- **In the UK**, offshore EoL decisions are more immediate, with the first projects reaching the end of design life in the 2030s. Planning for life extension and repowering are key to managing volumes and timing, but challenges include weather, logistics, ageing assets, and the need for clearer guidance.

Both countries are piloting EoL solutions. China is advancing recycling and life-extension technologies, while the UK is developing trials, regulatory initiatives and planning tools to support safe, cost-effective and circular offshore wind EoL pathways.

China and the UK are the two largest operating markets and both countries have ambitious plans for continued growth.

Sustainable supply chains

Sustainability and circularity span the entire supply chain, from design and manufacturing to operations and maintenance (O&M), data management and through EoL. The delegation discussed different approaches in the UK and China shaped by delivery models, policy and innovation ecosystems:

- **Delivery and policy:** China benefits from vertical integration, with research and development (R&D), design, manufacturing and delivery often managed by single organisations, alongside strong land–sea and grid coordination, guided by nationally set Five-Year Plans.[2] The UK supply chain is more fragmented, requiring early coordination, guided by *The UK's Modern Industrial Strategy and Offshore Wind Industrial Growth Plan,* focusing on priority areas including turbine technology, foundations, cables, and O&M services.[3,4]
- **Support and innovation:** The UK uses Contracts for Difference (CfD) for revenue certainty, and China has moved away from feed-in tariffs to CfD-similar competitive provincial bidding. Shared innovation priorities include floating wind, extreme-weather resilience, hybrid/colocation systems, turbine upscaling, digitalisation, and linking R&D to commercial deployment.
- **Ecosystem and infrastructure:** The UK excels in research and skills, linking academia, industry and policy. China has developed regional colocation hubs integrating R&D, manufacturing, testing, and deployment. Common needs include ports, vessels and skilled workforce, though vessel availability, health and safety standards and installation practices differ.

Opportunities for further collaboration

The exchange highlighted significant opportunities for further UK–China collaboration on offshore wind EoL and sustainable supply chains, in particular through knowledge exchanges and the development of joint initiatives.

Knowledge exchange

The exchange identified considerable potential for further UK–China knowledge exchange to encourage learning from best practice and joint problem-solving. Further exchanges could range from webinars and short meetings to multiday in-person visits, focusing on:

End-of-Life

National EoL regulations and standards, lessons from China's onshore wind experience, early UK offshore EoL learning, and circular economy interventions.

Sustainable supply chains

Supply chain forecasting, grid and port expansion strategies, sustainable seabed leasing, economic and pricing models, health and safety practices, environmental and nature-based design, turbine technology development (size growth, floating, hybrid/colocation), and research-to-commercialisation approaches.

Joint initiatives

A number of opportunities for deeper collaboration through the establishment of joint UK–China initiatives emerged from the visit:

End-of-Life

- collaborate on international standards and design for decommissioning best practice
- promote global EoL regulation through joint leadership in international platforms
- share insights from maintenance and EoL challenges to improve design-stage practices
- develop decision-making frameworks to guide life extension, repowering and decommissioning choices.

Sustainable supply chains

- harmonise definitions, metrics and contract structures across projects
- improve data management and sharing for O&M and EoL, including condition monitoring and remaining useful life estimation
- develop circular supply chain practices, covering design for decommissioning, life extension, repair, and material recovery
- collaborate on environmental and nature-based design best practice.

These opportunities build on both the UK and China's strengths, creating pathways for shared learning, more sustainable offshore wind deployment and leadership in global standards and innovation.

1. Introduction

This report summarises discussions, key insights and potential areas for collaboration from a bilateral exchange between China and the UK experts on offshore wind, taking place between 13 and 17 October 2025 in Guangzhou and Yangjiang, People's Republic of China. The exchange built on a previous bilateral online knowledge exchange on offshore wind in August 2023. It focused on two key sustainability aspects for offshore wind, responding to growing urgency in ensuring that renewable energy sources are scaled responsibly in terms of:

1. end-of-life considerations
2. sustainable supply chains across the lifecycle.

The report's first section gives a high-level overview of the offshore wind sector in both countries. Key insights and findings from the exchange on both focus areas are shared in in the second section. The final section outlines potential topics for collaboration discussed by delegates.

1.1 Setting the scene: offshore wind

1.1.1 Current volumes, key targets and timelines for offshore wind capacity

Offshore wind is expanding rapidly worldwide, with governments awarding a record 56 gigawatts of new projects in 2024 and 48 gigawatts already under construction.1 At the end of 2024, global installed offshore wind capacity reached 83 gigawatts, and China and the UK stand out as the two leading markets driving this growth.[1] China has had the greatest cumulative installed capacity of offshore wind globally since 2021, accounting for roughly half of global capacity by 2024. The UK is an older market than China with the world's largest installed capacity for more than a decade before 2021. Since then, it has had the second-largest installed capacity and continues to scale up rapidly. Both countries have ambitious targets and significant project pipelines, positioning offshore wind as a cornerstone of their strategies to achieve net zero emissions. Table 1 compares key parameters in China and the UK.

1.1.2 Contextual characteristics

Offshore UK has steady, strong winds averaging 10 metres per second at 150 metres above sea level, relevant for current offshore wind turbine hub heights.[12] Water depths vary from tens of metres to 1000 metres, with much nearshore space in water depths which suit fixed-bottom turbines, and plenty of potential for offshore wind in water depths greater than 70 metres. Seabed compositions are varied from past glaciation,

Table 1: Comparative offshore wind data China and UK

Parameters	China	United Kingdom (UK)
Operating capacity (end 2024) (offshore wind)	41.8 gigawatts connected; 41.1 gigawatts fully operational; 4 gigawatts added in 2024.[1]	15.9 gigawatts connected; 14.7 gigawatts fully operational across 45 projects.[5]
Wind in electricity mix	Wind (onshore and offshore) supplied 9.3% (886.9 terawatt hours) of China's electricity in 2023.[6] Estimated that 0.9% of China's electricity was generated by offshore wind.[17]	Wind (onshore and offshore) supplied 29.2% (83.3 terawatt hours) of the UK's electricity in 2024.[8] 17% of UK electricity was generated by offshore wind.[9]
Build pipeline (offshore wind)	Total pipeline 247 gigawatts across 437 projects at various stages.[10] China remained the top market for new installations in 2024.[1]	Total pipeline 95 gigawatts across operational, committed and early stage projects.[5] Government plans to procure at least 12 gigawatts via CfD Allocation Rounds (AR) 8–9 to hit 2030 goals, following AR 7, which procured 8.4 gigawatts in January 2026.[11]

and are dominated by sandy sediments and stiff clay, suiting monopile foundations.[13] In contrast, mean wind speeds in offshore China are generally lower, about 6 to 7 metres per second at 150 metres above sea level, and offshore areas face frequent typhoons with high wind speeds and large waves (up to 60 metres per second winds and 10 metres significant wave height).[12] Offshore China experiences softer seabeds than around the UK, which require jacket foundation designs with deep piles.[14] Both countries are developing plans for floating offshore wind farms in deeper water sites.[14–16]

1.1.3 Grid infrastructure

Electricity demand has grown significantly in China over recent years with electricity consumption increasing by circa 4.5% year on year. This has led to a need to invest in grid infrastructure upgrades to deliver two distinct needs: firstly, to accommodate demand growth and secondly to connect renewable technology with a much more diverse geographic siting to existing grid infrastructure and demand centres. Continued investment in the grid will be required in the coming years to deliver China's carbon peaking and carbon neutrality goals.[17] Both the UK and China have been developing high voltage direct current (HVDC) technology for electricity transmission in recent years. In China, the first offshore HVDC offshore wind connection was commissioned in 2021 comprising of a +/-400 kilovolt, 1.1 gigawatt, 108 kilometre connection. The UK is currently tracking slightly behind China with the first offshore wind HVDC systems currently being commissioned, comprising of a +/-320 kilovolt, 1.2 gigawatt, 130 kilometre connection.[17,18]

Table 2: Policy and target environments in China and the UK

Topic	China	United Kingdom (UK)
Headline clean energy target	Nationally Determined Contributions: By 2035, cut net Green House Gas emissions by 7–10% from peak; raise non fossil fuels >30% of energy; lift wind and solar capacity to over 3,600 gigawatts.[19]	Nationally Determined Contributions: By 2035 cut Green House Gas emissions by 81% from 1990s levels. Clean Power 2030 sets targets for 2030, 95% of electricity generation from clean sources; offshore wind is targeted at 43–50 gigawatts in operation by 2030.[20]
Offshore wind 2030 target	At least 75 gigawatts added from 2026–2030.[21]	Up to 50 gigawatts offshore wind by 2030 (incl. 5 gigawatts floating).[20]
Core instruments	National framework through '1+N' policy architecture (1 = high-level plan for achieving peak carbon and carbon neutrality plus N = sectoral / industrial level action plans)[22–24]; since 2022 large-scale provincial competitive allocation and target setting; Emission Trading System (ETS) expansion.[25]	Contract for Difference auctions; reforms from Review of Electricity Market Arrangements (pricing, capacity, flexibility); National Energy System Operator delivery focus areas (operability, networks, flexibility).[20]
Marine Spatial Planning (MSP)	MSP at national level by Ministry of Natural Resources (MNR).[26]	MSP at devolved national level: MMO (England); Offshore Wind Directorate (Scotland); Welsh Ministers (Wales); DAERA (Northern Ireland).[27]
Sea use	Sea area use right issuing regulated by national framework and administered by provincial departments.[26]	Seabed leasing at national level: Crown Estate (England, Wales, Northern Ireland) and Crown Estate Scotland (Scotland).[27]
Consenting / permitting	Consenting for Power Permit through national level government agencies (National Energy Administration and its local agencies, MNR, Ministry of Ecology and Environment).[26]	Consenting at devolved national level by cross-government bodies.[27]

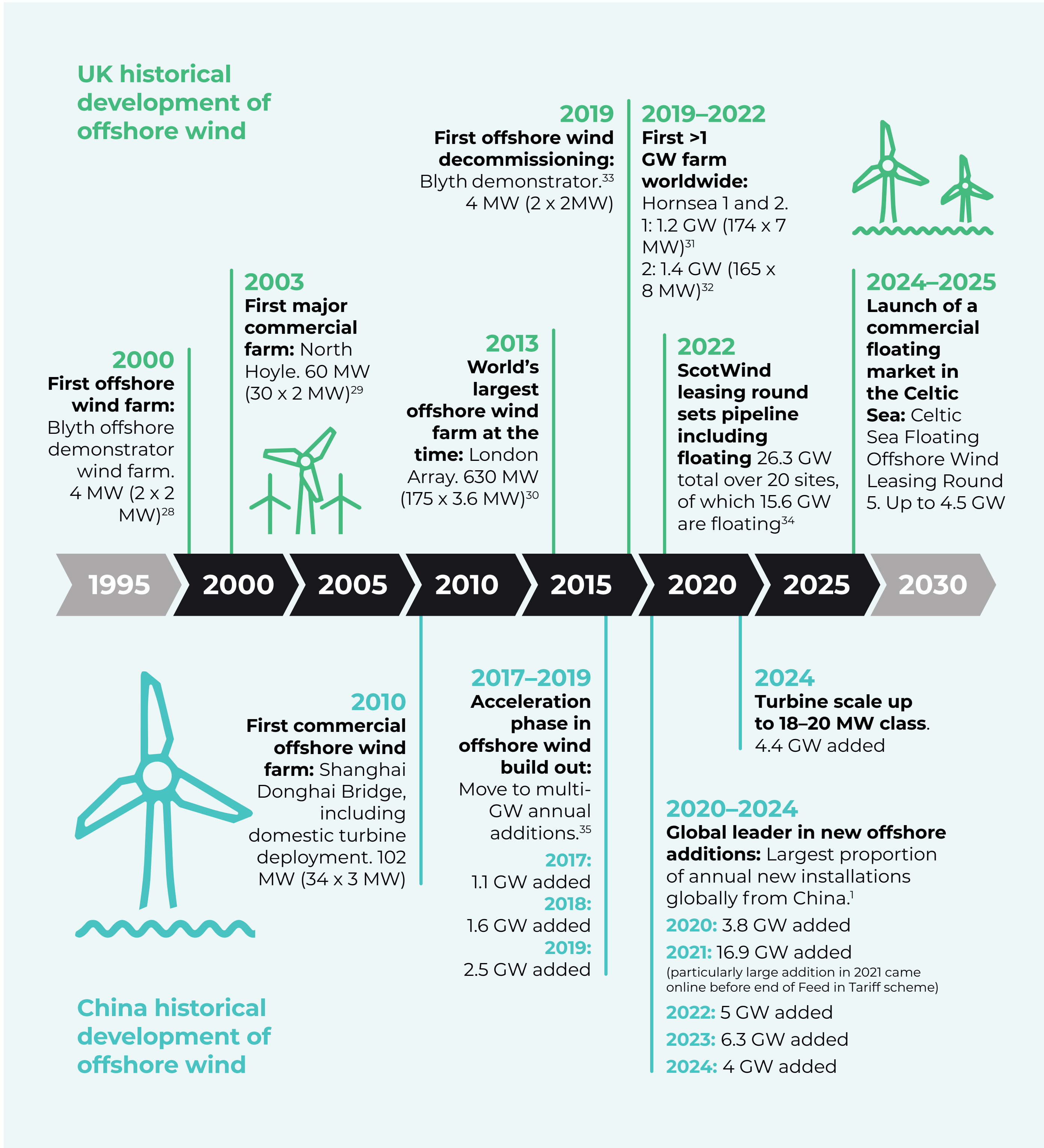
1.1.4 Policy environment

Both the UK and China are deploying a range of instruments and processes to achieve ambitious offshore wind targets as part of wider energy transition and net zero efforts. Table 2 outlines the high-level policy environment in both countries.

1.1.5 Historical development of offshore wind by country

The UK was among the first countries to adopt and scale offshore wind since 2000. China only started building offshore wind in 2010 but scaled its development rapidly to the world's largest cumulative installed capacity by 2021, as the timeline illustrates.

Timeline: Historical development of offshore wind in China and the UK



2. Key exchange discussions

2.1 End-of-life landscape in the UK and China

Given the large offshore wind growth in both countries, there is a strong need to consider what happens when the wind farms reach the end of their operational life. This report defines end-of-life (EoL) to include decommissioning, life extension and repowering considerations.

2.1.1 Scale and timeline

China faces its first large wave of wind turbine retirements this decade. Industry and government estimates suggest that by 2030 more than 34,000 largely onshore units will have reached EoL, about 44.7 gigawatts of capacity and generating roughly 0.95 million tonnes of solid waste that must be handled through refurbishment, recycling or disposal.[36–38] While the onshore EoL discussion has long begun in China due to the significant volumes to require decommissioning in the near future, offshore is not yet a priority given offshore deployment at scale started later than onshore: larger volumes offshore wind are estimated to be decommissioned from 2040 onwards.[39] Geographically, Guangdong is likely to shoulder a disproportionate share of China's offshore EoL workload later in the 2030s and 2040s, reflecting the concentration of leasing and build-out along the province's coast.[40]

In the UK, up to 1 gigawatt of offshore wind is expected to reach the end of its originally anticipated operational design life by 2035, triggering major EoL decisions on decommissioning, life extension or repowering.[41] By 2050, EoL choices could affect more than 10 gigawatts of UK offshore capacity.[42] In Scotland alone, decommissioning of offshore wind turbines could generate between 1.5 and 2.5 million tonnes of materials by 2050.[43] This will require early alignment on standards, permitting, data/traceability, ports and heavy-lift logistics, and certified recycling capacity, all within the UK's Energy Act decommissioning framework and guidance for offshore renewables.[44]

Discussion highlighted the different timelines: While the UK faces EoL decisions and first decommissioning projects in the coming 5 to 10 years, Chinese offshore wind farms are a decade younger and will reach end of initial design life a decade later than those in the UK. Chinese EoL is currently focused strongly on its large onshore wind fleet to be decommissioned, and delegates expect practice for offshore to be strongly based on China's onshore experience. In the more urgent UK offshore wind EoL context, the potential for life extension and repowering are key parameters, in particular predicting volumes and timelines more granularly.[17] While offshore wind assets are designed for about 30 years of operation, practical experience of longer operation, as well as life extension approaches, were shared throughout the exchange and these showed extension of assets by about 5 to 10 years.[17,45] Decision-making on life extension, repowering or decommissioning were emphasised as critical by the UK delegation as the timelines for the UK are more urgent than China[17]

The challenge of managing EoL for offshore wind alongside deployment of new offshore wind farms at scale were also raised as relevant for both countries. The trade-offs between rapid scale up and planning for EoL were highlighted as a challenging tension, for example regarding material choice or component design.

2.1.2 Regulatory landscape and requirements

The exchange highlighted a wide range of regulation relating to EoL practices.

Recycling and reuse of decommissioned wind infrastructure has become more prominent in Chinese policy and regulatory guidelines over the past 5 years: Since 2021, China has linked its carbon peaking goal to a circular economy mandate for wind and solar, prioritising resource efficiency and waste recycling systems.[24] The "Beautiful China" Opinions (2023 to 2024) deepen this with zero waste cities and accelerated recycling of retired equipment toward (2027 to 2035) ecological–civilisation targets. Sector rules now require safety assessment at design EoL, structured retirement/repowering, grid coordination, and explicit obligations to recycle/reuse.[46] The 2023 cross ministerial Guiding Opinions set further milestones: by 2025 initial standards; by 2030 mature full process recycling tech and capacity. [47]

UK end-of-life policy for offshore wind is currently focused on decommissioning and compliance with the UK Energy Act and OSPAR convention. There are however increasing developments towards guidance and industry programmes to scale circular solutions, such as the *UK Critical Minerals Strategy*, plan for a circular economy growth plan and circular economy strategy for Scotland, as well as sector specific roadmaps.[48–51]

While the delegation strongly welcomed these developments, it was highlighted that current processes can be complex to navigate across guidelines on waste, circularity and safety. Participants called for further clarity, proportionality and harmonisation of EoL processes, in particular of regulation and standards.[41,42] Near-term priorities are developing clearer policy for lifetime extension and repowering, offshore transmission owner (OFTO) end-of-life, data/traceability standards, and UK capacity for blade/composite recovery to avoid bottlenecks as the first large wave of offshore wind reaches anticipated EoL in the 2030s.[41]

A lack of clarity about exact decommissioning and other EoL requirements was highlighted. Delegates described a default expectation to remove assets fully at EoL, considering case-by-case evidence on environmental impact, safety and feasibility. An emerging challenge is uncertainty regarding EoL complete removal policies in cases where deployment has required ecological or nature-based components to provide 'marine net gain' through the life of the offshore wind farm.

Participants referenced examples of active work on national guidance and standards (with onshore frameworks more mature in China) and observed that policy clarity would help the sector to sequence decisions and allocate funding for safe and sustainable EoL practices.

2.1.3 Challenges

Given the long timelines until decommissioning for China's offshore wind fleet, key challenges are currently being examined through research and development: Delegate presentations highlighted that currently EoL treatment for wind turbine blades remains inefficient and risk-prone. Disordered, low-yield cutting constrains throughput and product utilisation; depolymerisation typically uses mixed, crushed feedstock, preventing recovery of long (continuous) glass fibres and leaving residues with elevated pollution risks. Resulting outputs are hard to valorise, so materials and components are largely downcycled into low-value products with few certified application pathways. Across the disposal chain real-time monitoring, chemical process control, and traceability are limited, undermining quality assurance, environmental compliance and the economics required to scale circular solutions.[17]

Design for decommissioning and circularity is increasingly embedded upstream, supported by R&D investment, although currently this is predominantly onshore.

In the UK, on the other hand, practical EoL decisions for wind farms and transmission assets are becoming increasingly urgent. The first pilot decommissioning projects in the UK have highlighted challenges, risks and opportunities:[17]

- EoL involves complex decision trade-offs, including whether to extend, repower or fully decommission, and there is a need for strong data and evidence to underpin these choices.
- Weather remains a dominant hazard, making thorough planning essential to minimise both health and safety and programme risk.
- Key factors for successful decommissioning are safe access to ageing structures, vessel availability and port/heavy-lift logistics.
- Moving from bespoke to scalable approaches promises cost reduction but adds complexity.
- Delivering scale safely requires technology innovation to reduce complexity and cost, and robust data collection to enable safe planning and execution.
- Environmental aspects require considerations, for example regarding marine growth adding weight, scour management and debris control through internal cuts.

2.1.4 Examples of existing EoL practices

China is piloting high-efficiency blade recycling, including advanced depolymerisation trials, progressing toward continuous equipment models. Parallel efforts target life extension through 25-year foundation re-evaluation, fatigue assessment, inversion analysis, and repair clamps which are particularly relevant for the country's many jacket foundations. Carbon-fibre recovery projects report strong results in terms of retaining original mechanical properties. Design for decommissioning and circularity is increasingly embedded upstream, supported by R&D investment, although currently this is predominantly onshore.

There is a wide and growing range of activities in the UK looking at EoL, including promising trials for blade life extension and sector mobilisation to use regulatory science to map existing rules and support circular end-of-life pathways for wind assets. Other projects are looking at tools to support operators in planning for decommissioning by comparing scenarios on cost, risk and emissions, including weather uncertainties.[17]

2.2 Sustainable supply chain landscape in the UK and China

While EoL requires particular planning, circularity and sustainability considerations are needed throughout the lifecycle and in relation to the entire supply chain. Design for circularity, maintenance and data collection are just some of the factors that influence the overall sustainability of offshore wind infrastructure.

2.2.1 Delivery structure and pace

Delegates highlighted differences in the delivery structure for offshore wind development in both countries. This reflected wider institutional and market contexts that affect the pace of build-out. The higher pace in China was linked to the vertical integration in the development of wind farms based on the domestic production of the majority of the supply chain: Delivery models often see R&D, wind farm design, and manufacturing of blades and foundations held by the same company. In addition, land–sea coordination for transmission leads to stronger alignment of coastal power base transmission corridors with marine spatial and national/provincial power plans. Such holistic integration enables more streamlined, fast-paced development of wind farms with less complexity and fewer conflicting interests.[52]

While the UK is leading in project development, finance and O&M expertise, its supply chain is generally more fragmented with less joined-up ownership. The numerous interfaces mean that timelines can be longer and processes more complex, requiring stronger, earlier planning and alignment across stakeholders.[52]

2.2.2 Policy environment and strategic alignment

Discussions raised the importance of enabling policy environments that provide the clarity, certainty and direction needed for supply chain development.[52] China's government takes an active role in planning for offshore wind: the five-year plans set by central government across major policy areas are at the core of this. Most recently the *14th Five-Year Plan (2021–2025)* set targets for a combined agenda of large-scale deployment driven by provincial targets, stronger grid integration measures, and industrial upgrading, port and supply chain investments.[2, 53]

While the UK's government takes a less directive approach to offshore wind planning *The UK Modern Industrial Strategy* (2025) sets out a 10-year plan to tackle barriers to investment and growth, focusing on high-growth potential sectors, including Clean Energy Industries.[3] *The UK Offshore Wind Industrial Growth Plan* (2024) sets out a roadmap by industry and government to develop the UK's offshore wind supply chain. It provides a steer for the industry to focus on particular supply chain opportunities: advanced turbine technology, industrialised foundations and substructures, future electrical systems and cables, smart environmental services, and next generation installation and O&M.[4]

2.2.3 Support model

The costs for offshore wind development and the systems in place to support it were discussed as key factors for the supply chain.[52] In the UK, Contracts for Difference (CfD) auctions are used to guarantee a strike price for winning projects. This provides multiyear contractual revenue certainty. The Chinese offshore wind sector has traditionally been supported by generous national subsidies through feed-in tariffs (FiTs). However, since 2021 this has shifted to competitive bidding similar to the UK's CfD auctions administered at a provincial scale, increasing competition in the Chinese market.[54] The decrease in revenue certainty domestically is leading to significant interest in international development, such as the Port of Ardersier plans in the UK.[55]

2.2.4 Grid infrastructure

Although China has developed High-Voltage Direct Current (HVDC) applications for connection of offshore wind farms more rapidly than the UK, the UK has extensive experience of HVDC application on the transmission grid through its interconnectors with Europe. Except for a few links that have been in operation for over 10 years, most interconnectors have come online within the last few years. Interconnectors range in capacity from 500 megawatts to 2 gigawatts with the majority either 1 or 1.4 gigawatts. In addition, the planned build-out of the existing UK transmission grid includes the construction of a further six HVDC offshore links. Five of these links connect Scotland to England and are designed to transfer offshore wind generated energy from Scottish waters to the transmission network. These new point-to-point links comprise +/-525 kilovolts, 2 gigawatts varying in length up to more than 500 kilometres. These HVDC links use onshore converter stations only.[17, 18]

In recent years China has made significant steps forward in the advancement of HVDC technology and are currently looking at grid infrastructure upgrades which will see up to 800 kilovolts underground and overhead line HVDC systems installed. The focus of advancement in these areas is because of the additional challenges faced by China based on the length of onshore transmission distances: over 400 kilometres – more than double the distance typically seen in the UK and Europe. China has therefore focused on developing large-scale integrated land–sea transmission technology utilising multiterminal technology. Significant lengths of underground onshore cables are cost prohibitive in China. This has driven research to pave the way for the adoption of DC overhead line technology. The vision is for up to 6 gigawatts of offshore wind energy to be aggregated at a single converter station and then transmitted onwards through a single, 6 gigawatt DC overhead line to the point of demand.[17]

The vision is for up to 6 gigawatts of offshore wind energy to be aggregated at a single converter station and then transmitted onwards through a single, 6 gigawatt DC overhead line to the point of demand.

2.2.5 Potential future areas for research and innovation discussion

Discussion focused on how the continued and increasing demand for offshore wind energy is pushing further technological developments and innovations. Examples from the exchange that could benefit from further UK–China discussion include:

- Floating offshore wind: The implications of floating offshore wind for supply chains, requiring new mooring, installation and O&M approaches, is a shared challenge across both countries.
- Extreme conditions: Typhoon resistant design approaches in China were highlighted, including for floating structures. There is a UK interest in understanding more as weather conditions change because of climate change.[52, 56]
- Hybrid models: Both countries are exploring different hybrid and colocation concepts, such as wind–wave and wind–solar. China in particular is testing systems such as fisheries in jacket foundations with automated feeding systems.[52]
- Size: Rapid blade scale up to 26 megawatt turbines with 153 metre blades being tested also increases demands on manufacturing, transport and testing facilities.[56]
- Digitalisation: Developments in machine learning tools in the UK, such as mooring optimisation and weather forecasting for O&M decisions, aim to lower costs, increase safety and reduce delays.
- Testing: The integration of demonstration and R&D testing at commercial sites in China was discussed. There has been interest in similar models in the UK, though different planning and licensing requirements for R&D versus commercial projects has hindered this so far.[56]

2.2.6 Ecosystem

The UK's research leadership was highlighted as a key facilitator for the R&D ecosystem. Initiatives such as the UKRI Supergen Offshore Renewable Energy Hub links academia, industry, policy, and the public, using mechanisms such as testing facilities, funding and policy engagement. Government funded Centres for Doctoral Training, such as The Centre for Offshore Wind & Decarbonisation (Aura), connects industry defined problems to relevant PhD research, ultimately supporting supply chain priorities at a regional hub level, as well as developing skilled workforce. The Offshore Renewable Energy Catapult enables acceleration of offshore renewable energy as an innovation centre across a range of challenges.[57] Similarly national bodies such as the Royal Academy of Engineering and Royal Society provide support for offshore renewable energy research through specific schemes focused on innovation and renewable energy.[58, 59]

The Chinese regional colocation model was discussed, which aims to increase efficiency through a 'one-stop-shop' approach, where different parts of the supply chain are integrated in the same location.[52] The Shantou development was discussed as an example. Here, facilities are being developed to support all lifecycle stages, from early design and R&D with all wind turbines and component companies involved, to process flow layout and optimisation across core suppliers, then production and testing of components through the whole manufacturing cycle – from gearbox, to generator, to bearings, turbines and blades.[52]

Delegates highlighted the importance of fit-for-purpose port facilities, sufficient vessel capacity, a skilled workforce, and streamlined processes. Observations included differences between the two countries in terms of vessel availability (higher availability in China than the UK), health and safety requirements (more stringent protocols in the UK than in China), foundation handling approaches, and installation sequencing (component-based approach in the UK vs. turbine-by-turbine approach in China).[52]

3. Opportunities for further collaboration

A range of potential opportunities for further UK–China collaboration, through both knowledge exchange activities and new joint initiatives, based on the insights above and delegate views throughout the exchange are set out below.

3.1 Knowledge exchanges

Considerable potential for further UK–China knowledge exchange was identified to encourage learning from best practice and joint problem-solving. This could range from small-scale individual meetings or webinars to in-depth multiday in-person exchanges. Early, targeted exchanges may help identify priority areas for deeper and longer-term collaboration or joint initiatives (see Section 3.2). Suggested topics include:

3.1.1 End-of-life

- existing national offshore wind EoL regulation and standards
- insights from onshore wind EoL practices in China to enable learning for offshore wind
- insights from early offshore wind EoL in the UK, especially from 2027 onwards
- EoL forecasting
- health and safety practices
- design practices for EoL
- through life monitoring for life extension predictions and adaptive management
- circular economy: practical interventions as well as framework development.

3.1.2 Sustainable supply chain development

- supply chain forecasting
- strategies for grid expansion and connection, in particular learnings from China as early adopters of integrated land–sea transmission technology utilising multiterminal technology and DC overhead line technology. This would significantly de-risk similar future technology application in the UK post-2035
- strategies for port expansion
- effective and sustainable seabed leasing
- economic and pricing models including design of subsidy and pricing schemes for offshore wind and renewables more widely
- health and safety practices
- environmental interaction and opportunities for nature-based design
- technology development including turbine size growth, floating, colocation, and hybrid systems
- research-to-commercialisation transition: approaches to academia–industry collaboration such as Supergen ORE Hub structure.

3.2 Joint initiatives to build on UK and China leadership in offshore wind

Several opportunities for deeper collaboration emerged from the visit which could benefit from longer-term and deeper engagement:

3.2.1 End-of-life

- Shared expert initiatives develop and contribute to international standards on EoL for offshore wind (including decommissioning, life extension and repowering) and design for decommissioning.

  Key stakeholders: standards bodies; subject experts in industry and academia.
- Championing international regulation for EoL as joint leaders to lay the foundations for embedded EoL practices globally, by working internationally and through existing platforms such as the WFO EoL Committee.

  Key stakeholders: UK government; China government; EoL Committee.
- Improving design-for-decommissioning practices by sharing insights from ongoing maintenance and EoL challenges with design-stage stakeholders.

  Key stakeholders: cross-lifecycle industry, research and innovation bodies.
- Development of EoL decision-making frameworks through wider international collaboration by establishing tools and approaches that can guide choices on lifetime extension and repowering viability and requirements.

  Key stakeholders: project developers; academia; UK government; China government.

3.2.2 Sustainable supply chain development

- Continued joint efforts to harmonise definitions, terms, assumptions, metrics, categories, and contract packages.

  Key stakeholders: UK government; China government.
- Improved data management and sharing for O&M and EoL, including establishment of monitoring systems and data frameworks for condition monitoring over the asset lifetime, such as estimation of remaining useful life, to inform decision-making.

  Key stakeholders: operators; research institutions; academia; developers; health and safety bodies.
- Collaboration to develop and champion circularity practices in the supply chain such as design for decommissioning; through life repair and life extension; remaining life assessments and EoL material resource recovery.

  Key stakeholders: research and innovation bodies; government; academia.
- Research collaboration for establishment of best practice on environmental interaction and nature-based design.

  Key stakeholders: research bodies; academia; research funders; government.

4. Annexes

4.1 Seminar agenda: End-of-life

Welcome address

- Chen Jiangfeng CAE Member, Secretary-General of the Chinese Academy of Engineering (CAE)
- Licheng Li, CAE Member, Honorary Chairman of the Expert Committee, South China Power Grid
- Sarah Mann, His Majesty's Consul-General, British Consulate General Guangzhou
- Professor Susan Gourvenec FREng, Deputy Director of Southampton Marine & Maritime Institute, University of Southampton

Keynote session: overview of the national offshore wind landscape

- Hong RAO, CAE Member, Chief Scientist, South China Power Grid: *The Development of China's National Power Grid and Offshore Wind Power*
- Professor Deborah Greaves OBE FREng, University of Oxford (previously University of Plymouth): *Offshore Renewable Energy Research and Innovation Landscape in the UK*

End-of-life: the nature and scale of the challenge

- Endi Zhai, CTO in Goldwind, Director of the Technical Committee in NTIC-WP: *Integrated Design of Ultra-Large Offshore Wind Power for Deep-Sea and Typhoon-Prone Environments: Key Technical Challenges from Fixed-Bottom to Floating Systems*
- Professor Susan Gourvenec FREng: *End-of-life of offshore wind, the nature and scale of the challenge in the UK*

Developments and long-term forecasting

- Zhu Ronghua, Yangjiang Offshore Wind Energy Laboratory, Zhejiang University: *Re-evaluation Strategies for Offshore Wind Infrastructure: Enabling Life Extension*
- William Apps, Offshore Wind Strategy Director – Marine, The Crown Estate

Circularity, policy and regulation

- Guangdong Provincial Energy Administration
- Lorna Bennet, Senior Engineer, Sustainability, Offshore Renewable Energy Catapult

Safety

- Guangdong Provincial Department of Science and Technology
- Professor Susan Gourvenec FREng, Deputy Director of Southampton Marine & Maritime Institute, University of Southampton

Design for end-of-life

- Guokai Yuan, Senior Chief Design Engineer, Deputy Director of Marine Energy Technology Centre: *Post-assessment and Decommissioning of Offshore Wind Farm Support Structures*
- Professor Alireza Maheri, University of Aberdeen: *Offshore Wind End-of-Life: Decision Support, Technology and Design Perspectives*

Case study: Learnings from decommissioning an offshore wind farm

- Haoran Yuan, Deputy Director, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences: *Recycling and Utilization of Decommissioned Wind Power Equipment China*
- Phillipa Slater FREng, Director of Asset Management and Operations Support, National Grid Electricity Distribution

Final reflections: summary of takeaways and next steps

- Licheng Li, CAE Member, Honorary Chairman of the Expert Committee, South China Power Grid
- Professor Susan Gourvenec FREng, Deputy Director of Southampton Marine & Maritime Institute, University of Southampton

4.2 Seminar agenda: Sustainable Supply Chains

Welcome address

- Yangjiang Municipal Government
- Professor Deborah Greaves OBE FREng, University of Oxford (previously University of Plymouth)

Keynote session: Life cycle view of supply chains

- Qiying Zhang, Chief Technology Officer, Mingyang Smart Energy Group: *Development of Floating Wind Power Technology and Its Industrial Chain in China*
- Professor Deborah Greaves OBE FREng, University of Oxford (previously University of Plymouth): *Supergen ORE Hub's Outlook 2040 and beyond; aligning research for offshore wind delivery and supply chain development*

Supply chain strategy

- Haiyan Qin, Secretary-General, Chinese Wind Energy Association: *China's Wind Supply Chain and Manufacturing Hubs - How an Integrated Wind Park Powers Local Development*
- Ajai Ahluwalia, Head of Supply Chain, Renewable UK: *The UK's Offshore Wind Supply Chain Story: Where we are and where we hope to be*
- Duanjiao Li, Vice President, Production Technology Department, Guangdong Power Grid Corporation: *Supply Chain Management for Offshore Wind Power DC Transmission Systems*
- Dr Matthew Ryan Tucker, Department of Energy Security and Net Zero
- Kate Harvey, General Manager, G+ Global Offshore Wind Health and Safety Organisation: *Global offshore wind health and safety learnings and good practice*

Operations innovation to support supply chains

- Shi Hongda, Professor in School of Engineering, Ocean University of China: *Research Progress on Wind–Wave Hybrid System*
- Oscar Festa, Xmoor: *Machine learning innovations to support the FOW value chain*
- Mingyang Smart Energy Group
- Dr Ajit Pillai, Senior Lecturer, University of Exeter: *Reducing Offshore Wind O&M Costs with ML-Based Weather Forecasting*

Design to strengthen supply chains

- China Three Gorges Corporation
- William Apps, Offshore Wind Strategy Director – Marine, The Crown Estate
- Xiaoli Wang, Professor, Guangdong University of Foreign Studies: *The Opportunity and Challenge in the Industrial Chain Cooperation of Sino–UK Offshore Wind Power – a Geopolitical Analysis*
- Professor James Gilbert, University of Hull

Close of session: summary and areas for collaboration

- Dr Yan Li, Chief Technology Expert, CSG
- Professor Deborah Greaves OBE FREng, University of Oxford (previously University of Plymouth)

4.3 List of stakeholders

UK delegation

- Professor Susan Gourvenec FREng, Deputy Director of Southampton Marine & Maritime Institute, University of Southampton (co-lead)
- Professor Deborah Greaves OBE FREng, University of Oxford (previously University of Plymouth) (co-lead)
- Ajai Ahluwalia, Head of Supply Chain, Renewable UK
- William Apps, Offshore Wind Strategy Director – Marine, The Crown Estate
- Lorna Bennet, Senior Engineer, Sustainability, Offshore Renewable Energy Catapult
- Dr Oscar Festa, Xmoor
- Kate Harvey, General Manager, G+ Global Offshore Wind Health and Safety Organisation
- Professor James Gilbert, University of Hull
- Professor Alireza Maheri, University of Aberdeen
- Dr Ajit Pillai, Senior Lecturer, University of Exeter
- Phillipa Slater FREng, Director of Asset Management and Operations Support, National Grid Electricity Distribution
- Dr Matthew Ryan Tucker, Department of Energy Security and Net Zero

China delegation

- Chen Jianfeng, Secretary-General of Chinese Academy of Engineering
- Licheng Li, CAE Member, Honorary Chairman of the Expert Committee, South China Power Grid
- Hong Rao, CAE Member, Chief Scientist, South China Power Grid
- Zhu Ronghua, Yangjiang Offshore Wind Energy Laboratory, Zhejiang University
- Endi Zhai, CTO in Goldwind, Director of the Technical Committee in NTIC-WP
- Haoran Yuan, Deputy Director, Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences

4.4 Abbreviations

Abbreviation	Full term
AR	Allocation Round (UK Contracts for Difference auctions)
CAE	Chinese Academy of Engineering
CfD	Contracts for Difference
CPC	Communist Party of China
CP30	Clean Power 2030 (UK policy framework)
CSPG	China Southern Power Grid
CWEA	Chinese Wind Energy Association
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DESNZ	Department for Energy Security and Net Zero
DUKES	Digest of UK Energy Statistics
EoL	End-of-life
ETS	Emission Trading System
FiT/FiTs	Feed in Tariff(s)
FCDO	Foreign, Commonwealth & Development Office
GHG	Greenhouse Gas
GW	Gigawatt
GWEC	Global Wind Energy Council
HIE	Highlands and Islands Enterprise
HVDC	High Voltage Direct Current
IEA	International Energy Agency
IGSD	Institute for Governance & Sustainable Development
kV	Kilovolt
MNR	Ministry of Natural Resources (China)
MMO	Marine Management Organisation (England)
MW	Megawatt
NDC	Nationally Determined Contribution (Paris Agreement)
NEPC	National Engineering Policy Centre
O&M	Operations and Maintenance
OFTO	Offshore Transmission Owner
ORE	Offshore Renewable Energy (e.g., ORE Catapult)
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PRC	People's Republic of China
TWh	Terawatt-hour
UKRI	UK Research & Innovation
WFO	World Forum Offshore Wind

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