

Accelerating the development of floating offshore wind in China

How a strategic partnership with the United Kingdom could overcome key technology & supply chain bottlenecks




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Foreword: what did the experts think?



John Edwards
Her Majesty's Trade Commissioner
for China

The U.K. and China have an established relationship on offshore wind, reaching the eighth annual session of the bilateral Offshore Wind Industry Advisory Group in 2022. Over these past eight years, offshore wind has developed from a niche sector to a booming industry, key for the decarbonisation of power grids across the world, and central to international efforts to limit global warming to below 1.5 degrees.

To date, mass development of offshore wind has focused on near-to-shore areas, with industry now looking towards the opportunities in far and deeper waters. Floating offshore wind – rather than turbines with foundations fixed to the seabed – will become the future of the industry, as cities look for more abundant and cheaper

renewable energy. Floating wind trebles the size of the addressable offshore wind market.

At 26.4GW, China has the world's largest installed capacity of fixed-bottom offshore wind, supported by a strong armada of tier 1 manufacturers. This report now identifies the technical potential to develop 600GW of floating offshore wind in China, given the extended coast line and deep waters. This provides a strong basis for China to develop a world-leading floating offshore wind industry, building on current demonstration projects.

At 10.4GW, the U.K. has the second largest installed capacity of fixed-bottom offshore wind in the world, after China. The UK also has the largest operational capacity of floating offshore wind in the world, following the installation of two commercial floating wind farms. The U.K. plans to have 5GW of floating wind operational by 2030. There are 11 commercial floating wind projects planned in a pipeline totalling 15GW. This high ambition is supported by a thriving industry: universities, innovation hubs and industry clusters that have developed state of the art components, systems and processes.

The report recommends pathways for the U.K. and China to collaborate in order to accelerate floating wind deployment in the Chinese market, and scale the development of components and systems in China for the international market.

Many thanks to CREEI, CREIA, CWEA, the U.K. Offshore Renewable Energy Catapult and Shell for their support for UK-China cooperation on floating offshore wind. I hope that we can implement this report's recommendations together with the support of these partners and the U.K. and Chinese wind industries. Let's take the opportunity to develop better technology, a larger global capacity and stronger industry-to-industry relationships.



Peng Cheng (President, China Renewable Energy Engineering Institute)

China's expansive coastline and deep waters have a high potential for the development of offshore wind power. In deep waters, floating offshore wind is one of the main methods for development. Floating offshore wind technology has vast market potential in China and is of great significance for achieving our carbon peaking and carbon neutrality goals. This report introduces the huge potential for floating offshore wind in China, analyses the comparative advantages of China and the U.K. within the industry-wide supply chain, states the key areas for future bilateral cooperation and identifies a corresponding implementation plan. As the leading partner of the China - U.K. Offshore Wind Industry Advisory Group, we look forward to China and the U.K. working together to advance the large-scale commercial development of floating offshore wind, using our complementary strengths and pragmatic cooperation to contribute to the global energy transition.

Li Dan (Executive Secretary-General, China Renewable Energy Industry Association)

In recent years Chinese and British governments and enterprises have undertaken significant collaboration on the installation, operation and maintenance of deep-sea fixed and floating offshore wind power projects. This report discusses the technical potential, policy framework, market challenges and complementary strengths of China and the U.K. It demonstrates that China and the U.K. can jointly promote the high-quality development of floating offshore wind power through supply chain cooperation, which is beneficial for both markets. The mapping of capabilities across a floating offshore wind project's lifetime (shown in the report) reveals excellent complementarities between the Chinese and U.K. supply chains. It provides a clear direction for the development of floating offshore wind power in China and the U.K., and a pathway to overcome key technology and supply chain bottlenecks.

In future cooperation, the U.K. and China can work tightly together on R&D projects. Taking advantage of China's strong supply chain and the U.K.'s advanced technological capabilities, the two countries can work together to reduce the cost of components and the electricity price for floating offshore wind power. Similarly, China and the U.K. could strengthen industrial clusters and improve efficiency in the construction of offshore wind power, reducing the impact on the marine ecological environment.



Qin Haiyan (Secretary-General, Chinese Wind Energy Association)

With the technology maturing and costs declining, floating offshore wind power is moving towards commercial application, which greatly expands the development potential of the global offshore wind power industry. Combining detailed content and rigorous analysis, this report shows the vast potential of floating offshore wind power development in China, as well as the good prospects for cooperation between China and the U.K. on floating offshore wind power. From this report, we see a "bright future" for floating offshore wind power.



David Findlay (U.K. Offshore Renewable Energy Catapult)

Floating offshore wind presents both a huge challenge and an opportunity. As the world's leading offshore wind markets, China and the U.K. are well positioned to gain first mover advantage in what promises to be one of the largest growth areas of the coming decades. This excellent report from Azure International highlights the opportunity for floating offshore wind in China and the potential for U.K.-China supply chain collaboration, complementing the ongoing work by the ORE Catapult to build international collaboration and engagement in the sector.



Zhang Dongye (Country Manager, Shell Offshore Wind, Renewable & Energy Solutions)

Going to the deep sea is an inevitable direction for the future development of offshore wind power in China. In this process, the coordinated cost reduction and efficiency increase of the industrial chain plays a pivotal role in realizing the large-scale commercial application of floating offshore wind power.

Through the collection of a large amount of information and detailed analysis, this report has provided a comprehensive exposition on how to give full play to the complementary advantages of China and the U.K. and jointly solve existing technical problems. It paints a picture of a future for floating offshore wind power development in which all parties in the industry chain work together.



Key messages from the report

1 China has a floating offshore wind technical potential of 600 GW

A study of China's coasts reveals that the country possesses 600 GW of technical potential, including 230 GW in waters more than 80 meters deep.

2 China has strong supply chain complementarity with the U.K.

The Chinese and U.K. supply chains have different strengths. Gap analysis shows that U.K. companies could support Chinese project development, operations and technology export capability.

3 There are clear benefits of China - U.K. strategic cooperation

A strategic partnership for floating wind supply chain and technology collaboration could accelerate the development of China's floating offshore wind market, and accelerate the global transition to renewable energy.





Key findings:

high potential for floating offshore wind in China and for Sino - U.K. supply chain cooperation

This report summarises the key findings of a series of reports and technical assessment which Azure undertook for the U.K. Government over a period of three months. It has been designed for a wider audience so some information has been omitted or modified.

600 GW of technical potential for floating offshore wind identified in China.



Fig1. China's 600 GW of floating offshore wind technical potential

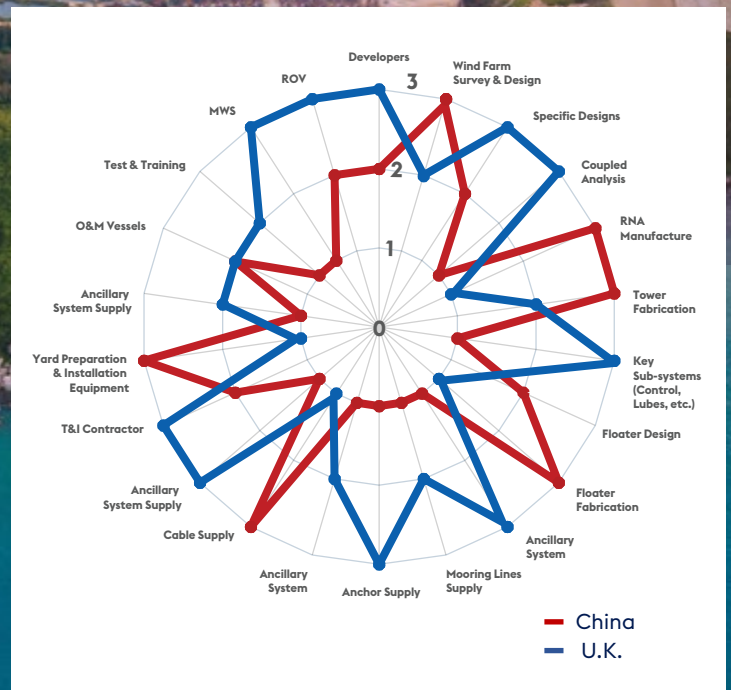


Fig2. China and U.K. supply chains capabilities

- 16 sites were shortlisted across four provinces as most suitable for floating wind. More data points were collected for each site such as average wind speed, distance to shore and water depth. 5 sites overlap planned project areas.
- Gap analysis demonstrated high complementarity between China and U.K. FOW supply chains. China has

a strong armada of tier 1 suppliers while the U.K. has unique and strong capabilities within a wide range of key technical topics and well established tier 2 and tier 3 suppliers.

- China and the U.K. have many opportunities to cooperate on joint project development, supply chain exchanges, and R&D collaborations.

Methodology: understanding China's floating offshore wind market in order to assess opportunities

Our analysis responded to a need to better understand China's floating offshore wind sector

- As offshore wind enters a commercial stage in China, with 16.9 GW installed capacity added in 2021 alone, there has been an increased focus on the sector. China's coastline being approximately 32,000 kilometres long, it is estimated that the country could welcome hundreds of gigawatts of offshore wind capacity along its coasts. However, several areas are too deep or have too difficult seabed conditions for traditional fixed offshore wind turbines. In such cases, floating offshore wind (FOW) technology could become an attractive alternative.
- Floating offshore wind is at demonstration stage in China. A lot of work still needs to be done to understand which areas are suitable for floating technology and which local governments and industry players in China would benefit from deploying floating wind projects. Azure International has been mandated by the United Kingdom's Department of International Trade in China to perform such a study in four provinces of interest in China.



We undertook a comprehensive three-month study to assess opportunities for U.K. FOW developers and supply chain participants

The full study included four parts: a feasibility assessment, a report, a technical review, and an engagement strategy. (See fig3)

This report summarises the key findings of these four parts in support of wider market intelligence. It has been designed for a wide audience so some information collected has been omitted or modified.

Fig3. Four parts of the three-month study to assess opportunities for the U.K. FOW developers and supply chain participants

Feasibility assessment	Report	Technical Review	Engagement strategy
Assessment of FOW potential and identification of suitable sites for short term FOW project development	Presentation of Chinese actors and decision makers, policies, processes and consenting mechanisms; analysis of local supply chains and gaps	Assessment of UK exporting capabilities to China given gaps found in Report; identification of opportunities for Sino-UK cooperation	Pathways for UK actors to achieving assent for a UK-China pre-commercial floating offshore wind project



China's Floating Offshore Wind Technical Potential and Sites Selection



China's 600GW floating offshore wind technical potential

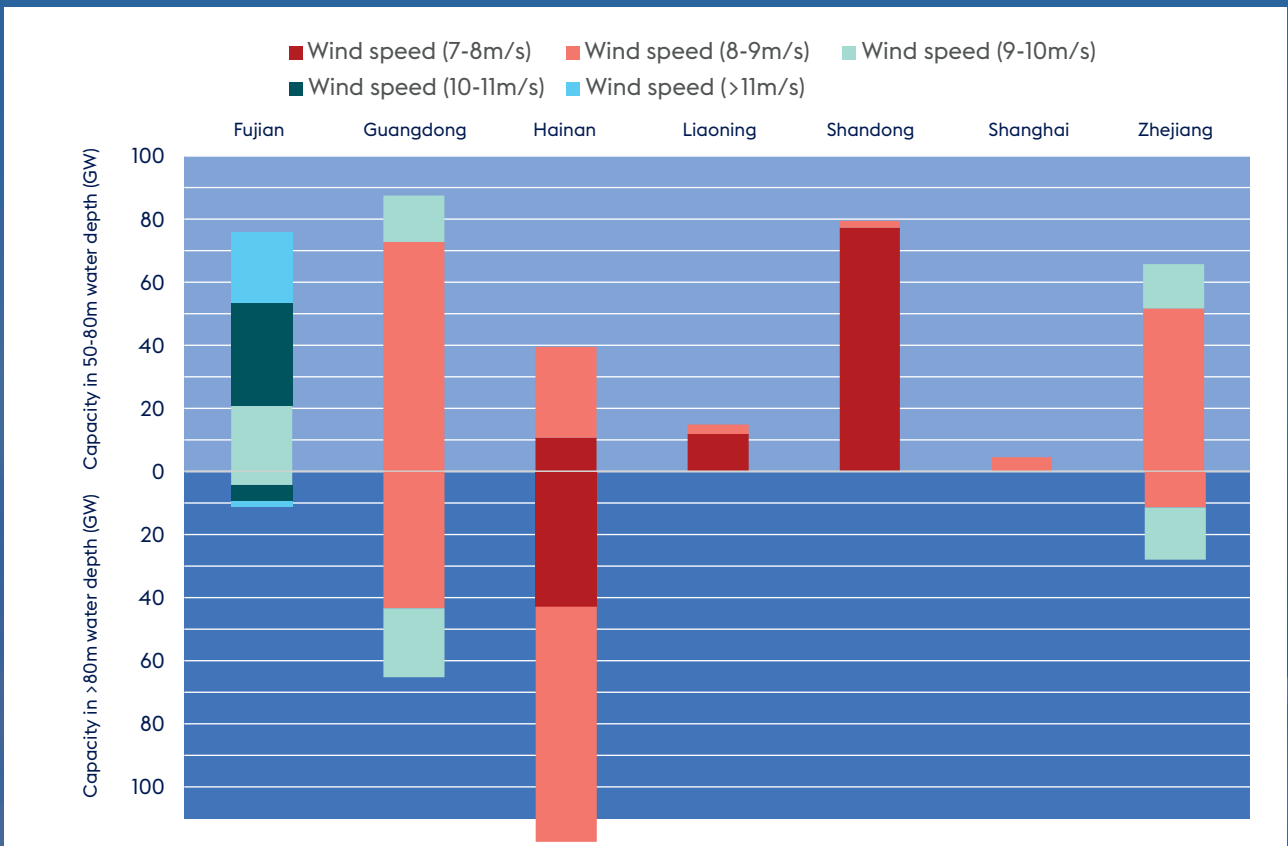


Fig4. Breakdown of floating wind technical potential per province

Estimating China's floating off-shore wind technical potential

- We consider areas within 150km of the coast and assume 3.125 MW/km² density (half of fixed offshore wind density)
- We split up potential between 50-80 meter water depths and >80m.

Floating offshore wind technical potential:

50-80m	>80m	Total
370GW	230GW	600GW*

- Most in Guangdong and Hainan. Strong potential also in Fujian with excellent wind speeds. East Hainan most attractive considering distance to shore.

*"technical potential" refers to maximum capacity taking in account technical conditions (mainly water depth and distance to shore) but ignoring any restrictions on sea-area utilization. In practice, planned capacity would be less.

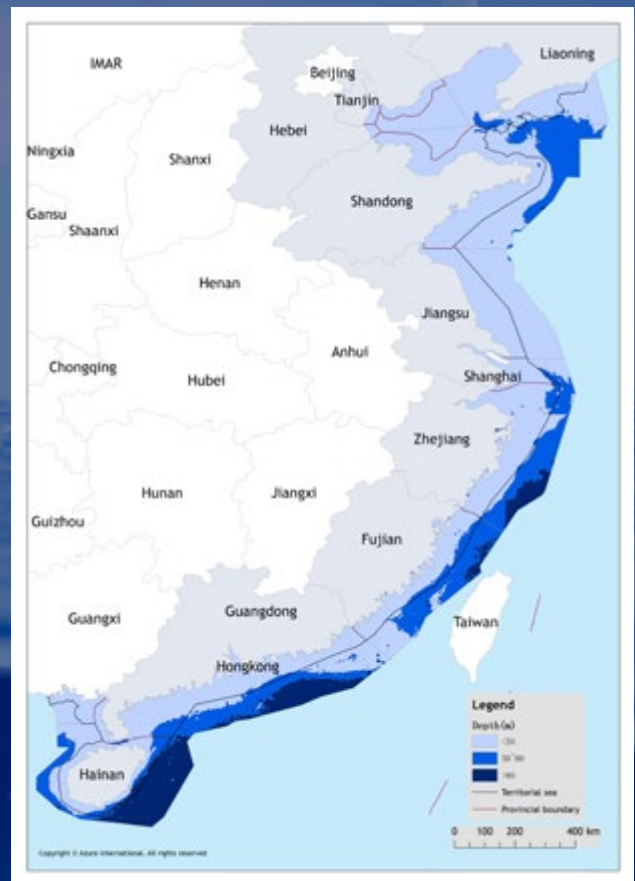


Fig5. China coast water depth

Opportunities exist in the short and medium term

Focus on sites for short to medium term development

As can be seen from the previous slide, the technical potential for floating offshore wind is extremely large. However, few areas would be suitable to welcome a project in the short to medium term. Among 16 sites selected by Azure for the development of a project in the short to medium term, five sites with combined capacity of 3GW overlap planned project areas*. These would be the prime targets for development opportunities in the short term.

An LCOE score has been computed for each site as a function

of distance to shore and average wind speed. A scoring system is then developed to rank the sites, considering not only technical conditions (wind speed, water depth, etc.), but also the supply chain and policy components.

As can be seen, the sites present excellent conditions, with wind speeds superior to 8 m/s in four sites. Three sites overlap planned project areas by 500 MW or more. Other sites with smaller overlap could welcome demonstration projects. Some sites are not within planned offshore wind areas but are located in cities that are active in the sector, which also makes them interesting candidates.



Five sites overlap planned project areas in the selected provinces

Site	Distance to shore (km)	Average wind speed (m/s)	Average water depth (m)	Floating offshore potential within planned project area (MW)	Total site size	LCOE score	City mentioned in provincial policy	Local supply chain	City has floating demo project	Overall score (max 12)
1	130	9.3	-69	971	Large	62	Yes	Good	No	9
2	65	9.3	-53	1,174	Large	78	Yes	Good	No	10
3	85	8.6	-53	121	Large	61	Yes	Good	Yes	10
4	35	8.6	-70	236	Large	77	Yes	Weak	No	8
5	25	7.7	-90	500	Large	76	Yes	Weak	Yes	8

*'Planned projects' refers to sites already included in the city or province offshore wind plans. Only planned projects with published locations have been considered.



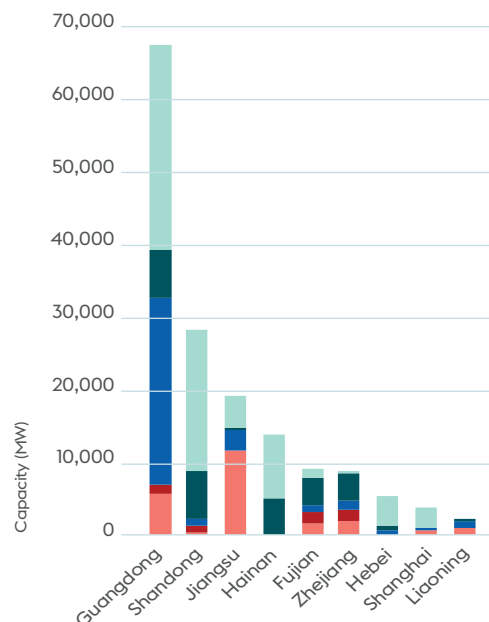
Chinese floating offshore wind policy and supply chain status update

“Deep and far sea”

China's next big challenge

China offshore wind capacity status by province (Q1 2022)

- Operating
- Under-construction
- Approved
- Plan
- Preplan



- China's offshore wind market has boomed in 2021, motivated by strict subsidy deadlines.
- 16GW of projects were connected to the grid during 2021, bringing the total capacity to 24GW.
- Azure has identified more than 150GW of additional planned capacity, which could be built over the 10 to 15 years, most of which within territorial waters and within 50m water depths.
- In parallel, national authorities have started to push for active planning in the EEZ, focusing on the "deep and far sea".
- Some of these policies encourage floating wind, and market players as well as provincial authorities are making some first moves. We anticipate that floating offshore wind could see an accelerated growth during the 15th FYP.

NEA leads the planning and regulation

- National deep-far-sea offshore wind planning has been completed.
- Deep-far-sea offshore wind project development management method is under preparation.
- 5 offshore wind bases have been selected in Shandong peninsula, Yangtze-River-Delta, Southern Fujian, Eastern Guangdong, and Beibu Bay of Guangxi.

Local regulators promote national policies at the local level

Several provincial and city level authorities have included deep-far-sea offshore wind in their renewable energy 14th Five Year Plan, such as:

- Zhejiang province or Jieyang city (Guangdong): develop projects in the EEZ.
- Fujian: carry out a demo offshore wind project in deep-far-sea areas.
- Shandong: gradually promote the development of deep-far-sea offshore; select some sites for demonstration projects and promote innovative applications such as floating wind turbine foundations.
- Jiangsu: plan and research a GW-scale deep-far-sea offshore wind base.

Market players follow the government's lead

- SOE development companies such as Three Gorges, SPIC, CEI, etc. have started to enter the deep-far-sea market.
- OEMs such as Goldwind, Mingyang, CSIC, etc. have invested in floating technology.

Status of China's floating offshore wind demonstration projects



- Currently, one FOW project is in operation, two are in construction, and six are in design or research stages. Five projects can be considered as active at present.
- China floating wind research started in the early 2010s, when Goldwind obtained funds for the “863 plan” for advanced floating wind research.
- In the middle-2010s, there were some early-stage plans for a floating demo such as the Shanghai Green Energy project, but no actual action followed.
- In 2019, CSSC won national funding for its floating wind design and demo project installation. Meanwhile, Mingyang kept putting resources in their own floating wind R&D.
- In 2021, CTG together with Mingyang put the first China floating wind demo in operation. CSSC’s demo will be installed in 2022. Meanwhile, more and more projects are in progress, such as the CNOOC or Longyuan projects.



01 CTG “YinLingHao” project

- First floating project in China
- Located in Yangjiang Shapa
- 35m water depth
- 5.5MW Mingyang WTG
- Floater designed by SIDRI
- In operation since 2021

02 CSSC “FuYaoHao” project

- 1st floating offshore wind turbine in deep water in China
- 65m water depth
- 6.2MW Haizhuang WTG
- In construction, to be completed in 2022

03 Hainan Commercial project

- First commercial scale planned floating wind farm in China
- In planning stage

04 Shanghai Green Energy FOWT project

- 1st FOWT R&D project in 2016
- 40m water depth
- Sinovel 6MW with semi-sub foundation
- Shanghai Electric 3.5MW TLP foundation

05 Longyuan Fujian project

- Planned for 2023
- 35m water depth
- Estimated 4MW WTG
- Floating wind – fishery hybrid demo

06 CNOOC FOWT project

- CNOOC FOWT project
- Hainan Wenchang sea area
- 120m water depth
- Electricity supply to Wenchang 13-2B platform
- Project in construction

Five FOW projects are actively being developed in China



Floating offshore wind represents unique challenges

Compared to fixed-bottom offshore wind, floating faces unique technological, regulatory, and market challenges:

Incentive policy	<ul style="list-style-type: none"> • Only R&D allowance grants from national or provincial science and technology departments. • No special power tariff subsidy to enable a large-scale application of floating wind.
Consenting procedure	<ul style="list-style-type: none"> • The investment-intensive “resource for industry” site allocation practice sets hurdles for floating wind projects. • Most of the sea areas favourable for floating wind development with over 50m water-depth are in the EEZ. Because the consenting process and relevant laws and regulations for the EEZ (e.g. sea-use) are not well formulated, the permitting procedure for floating offshore in the EEZ is rather ambiguous and under the central government’s jurisdiction.
Fixed-bottom still has strong advantages	<ul style="list-style-type: none"> • Almost all the current planned project pipeline is situated in areas with average water-depths of less than 50m (a total of 150GW excluding the projects that are already in operation). Fixed-bottom still has strong advantage in these locations and represents enough capacity to keep the industry busy for a decade. • Fixed bottom is still struggling to reach grid parity and secure its position in the Chinese energy system. For many players, floating wind might not be a priority.
Immaturity of floating wind supply chain	<ul style="list-style-type: none"> • Current supply chain is mainly focused on fixed-bottom. • Key components and technology of floating wind are new in China (e.g. floater design, dynamic cable, mooring system, O&M challenges, etc.). • Ports and harbors able to provide floating wind onshore installation services are scarce.
Contractual framework	<ul style="list-style-type: none"> • A new and complex cooperation model is required between design institutes, wind turbines manufacturers, and other players to design floating wind systems. • EPC frameworks, which are currently the mainstream frameworks for C&I in China, may not work for floating if C&I companies want to avoid risks in such a greenfield sector. • Damages and liabilities are especially difficult to be negotiated in the multi-contracts commercial frameworks and without an overall system warranty.



MARINEexplorer

China offshore wind supply chain overview

Category		Status	Key players examples
Engineering (Design Institutes)		Design institutes (DIs) play a key role in all phases including planning, development (pre-FSR, FSR, EIA, etc.), engineering design (preliminary and detailed design), construction (on-site support, as-built drawings) as well as design quality warranty. Nowadays, DIs are expanding their business towards EPCI.	
Procurement	Turbine OEM	Chinese turbine OEMs have been very active in terms of installation capacity and technological progress:	
		16GW offshore wind installation in 2021; 24GW cumulative offshore wind installation by 2021; top 5 players take 90%+ market.*	
		Offshore wind turbine (OTW) sizes have grown from 4-5MW to 10MW+ (several models in the 11-16MW range are in prototype/design phase). DEC 10MW is in commercial production, Mingyang 11MW and CSIC 10MW won several tenders which will be completed in 2022/2023.	
	Tower & foundation	Fabricators come either from the onshore wind supply chain (tower manufacturers) or the offshore engineering supply chain (such as bridge/shipbuilding/offshore O&G). Capable fabricators are distributed all along the Chinese coast.	
	Floater	Existing floating wind floater fabricators are mostly offshore O&G suppliers or shipbuilding companies that are also involved in offshore engineering. WISON and HWS supplied floaters for the first two Chinese floating wind demo projects.	
	Cable	China submarine cable players have strong technical strength, good quality, and rich references with 35/220kV and higher voltage levels (66/400/500kV). Orient made the first dynamic cable for the CTG Yangjiang Shapa project (China's 1st floating demo project).	
	Mooring system	Mooring components supply in China is limited, only a few suppliers can provide high-quality chains and anchors for heavy duty/severe conditions. Asian Star is the leading player.	
Construction and Installation		Like structural fabricators, C&I contractors mostly come from bridge/harbor or offshore O&G fields. These players have gained their offshore wind experience in the past several years through China's 24 GW of installed capacity.	
		Floating wind C&I is to some extent simpler since there is no need for complex offshore foundation installation and WTG hoisting.	

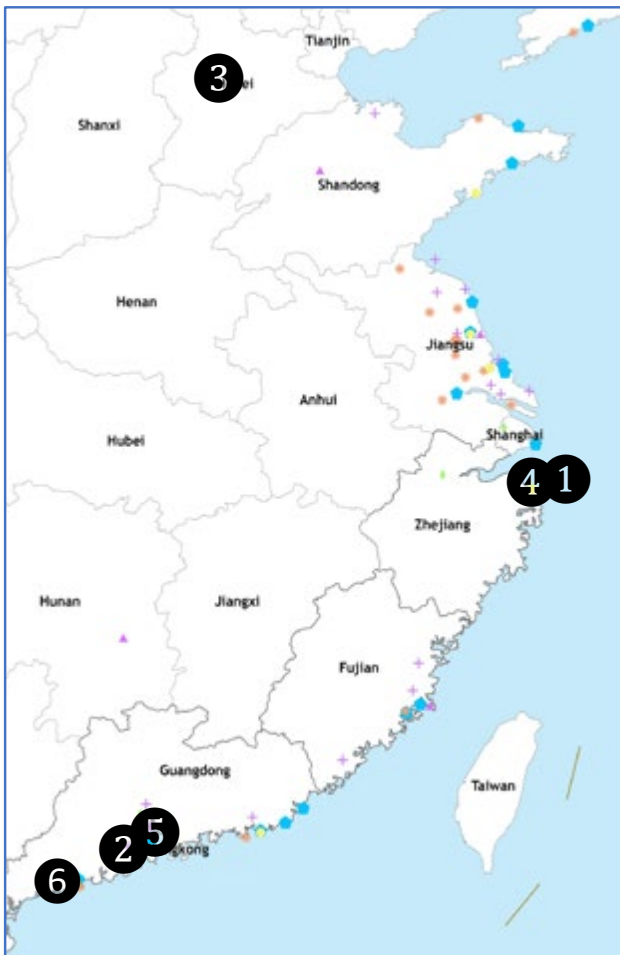
Note: Selected company logos have been included for illustrative purposes only. Other significant companies have not been included.

Floating offshore wind requires cooperation of actors across the country:

Case study of the China Three Gorges Shapa project

Supply chain highlights

- China's 1st floating demo has been installed at a turbine location within the CTG Shapa off-shore wind project in Yangjiang (Guangdong).
- Key components were sourced from different areas of China due to supply chain challenges for this first demo.



- The floater was fabricated in Zhoushan (Zhejiang) by the wet-towed marine engineering company Wison, and then wet-towed ~900 nautical miles to Maoming port in Guangdong.
- Dynamic cables were produced in Zhejiang by Orient, which also supplies cables for the rest of the Shapa wind farm.
- WTG produced by Mingyang in its nearby Guangdong production base.
- The project features an innovative mooring system partially adopting stainless steel wires developed by a Hebei based supplier who is specialized in slings design and production for cranes and lifting works, and partially import-ed hybrid solutions.
- The C&I contractor GSB is also the contractor for the whole Shapa project.
- Despite being in Yangjiang, which is one of the leading fixed offshore wind industrial bases in China, few components for this first floating demo were sourced from the local municipality.

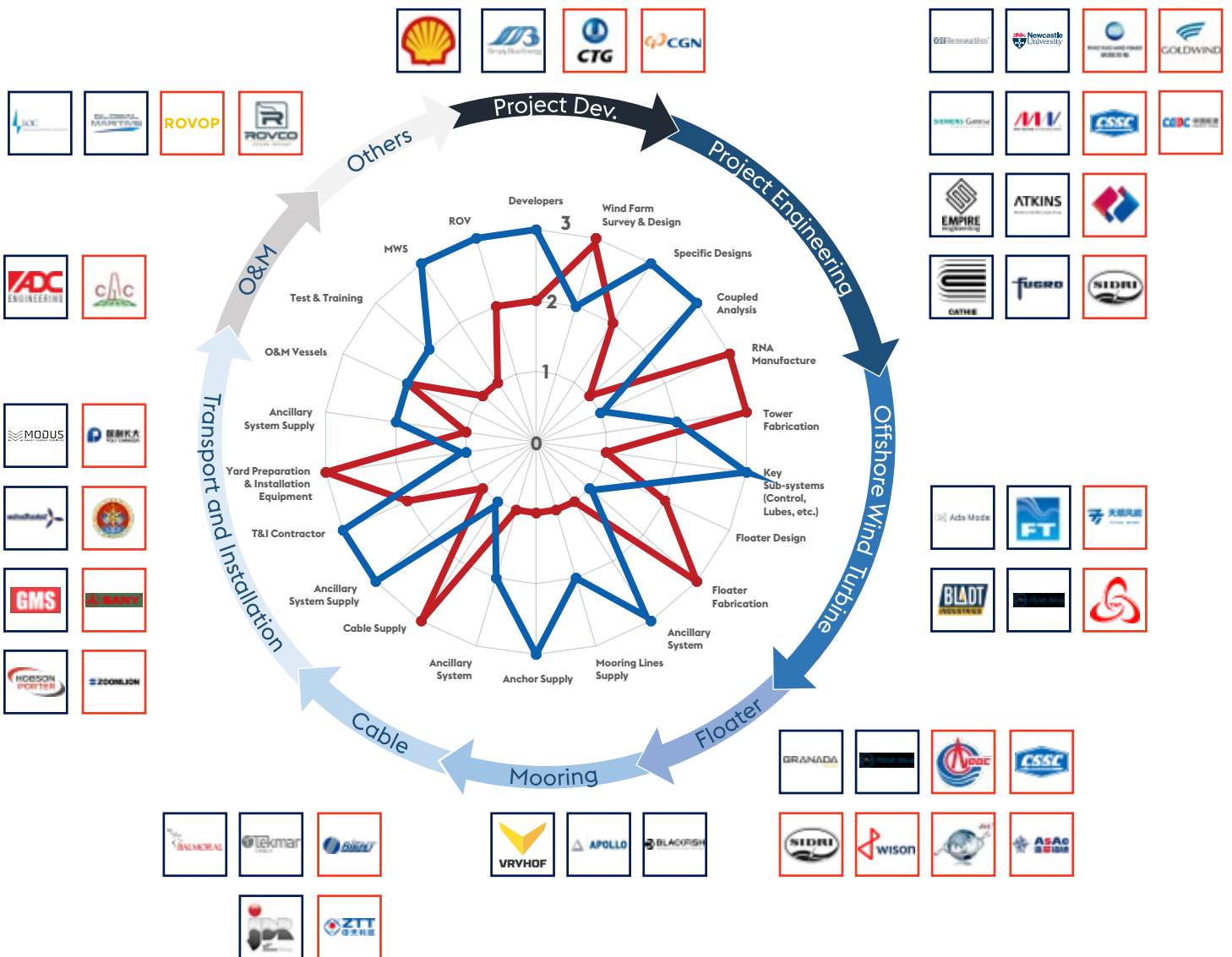
No.	Item	Supplier
1	Floater	WISON
2	WTG	Mingyang 5.5MW
3	Mooring	JULI
4	Dynamic cable	Orient
5	C&I contractor	GSB
6	Assembly	Maoming Port



Opportunities for Sino- U.K. floating offshore wind cooperation

Notes: Listed companies are not exhaustive. Please see the appendix for a more complete list.

— China
— U.K.



Strong complementarity between U.K. and Chinese supply chains

- Based on a rapid scoring of various suppliers and companies in floating offshore wind, we have established a mapping of capabilities across a project's lifetime.
- It is clear that there is excellent complementarity between the Chinese and U.K. supply chains.
- China has a strong armada of tier 1 suppliers covering project engineering, wind turbine, floater and mooring manufacture as well as transport and installation.
- U.K. has unique and strong capabilities covering a wide range of key technical topics such as coupled analysis and system optimization, combined with strong tier 2 and tier 3 suppliers covering areas such as floater and mooring ancillary systems as well as tools and methods for T&I and maintenance.

Key areas for the U.K. to add value in the Chinese supply chain

- U.K. developers can use their capital strength and technical capability to invest/develop OWFs in China and bring international best-practices and technologies to optimize project CAPEX and OPEX.
- Thanks to decades of investment, U.K. has built strong state-of-art technologies that can help China with engineering design, testing, coupled-analysis, and other technical analysis and optimizations.
- Though China possesses a strong supply chain for major components of FOWTs, it still lacks capabilities for several sub-systems and ancillary equipment with high-tech and high added value content.
- Thanks to Britain's advanced OWF pipeline, U.K. suppliers have gathered rich experience for T&I and O&M services and products and could provide value to China in these sectors.

Meeting supply chain gaps

Project

- Project development
- Capital investment



R&D

- Design & tests



O&M

- O&M equipment
- O&M expertise



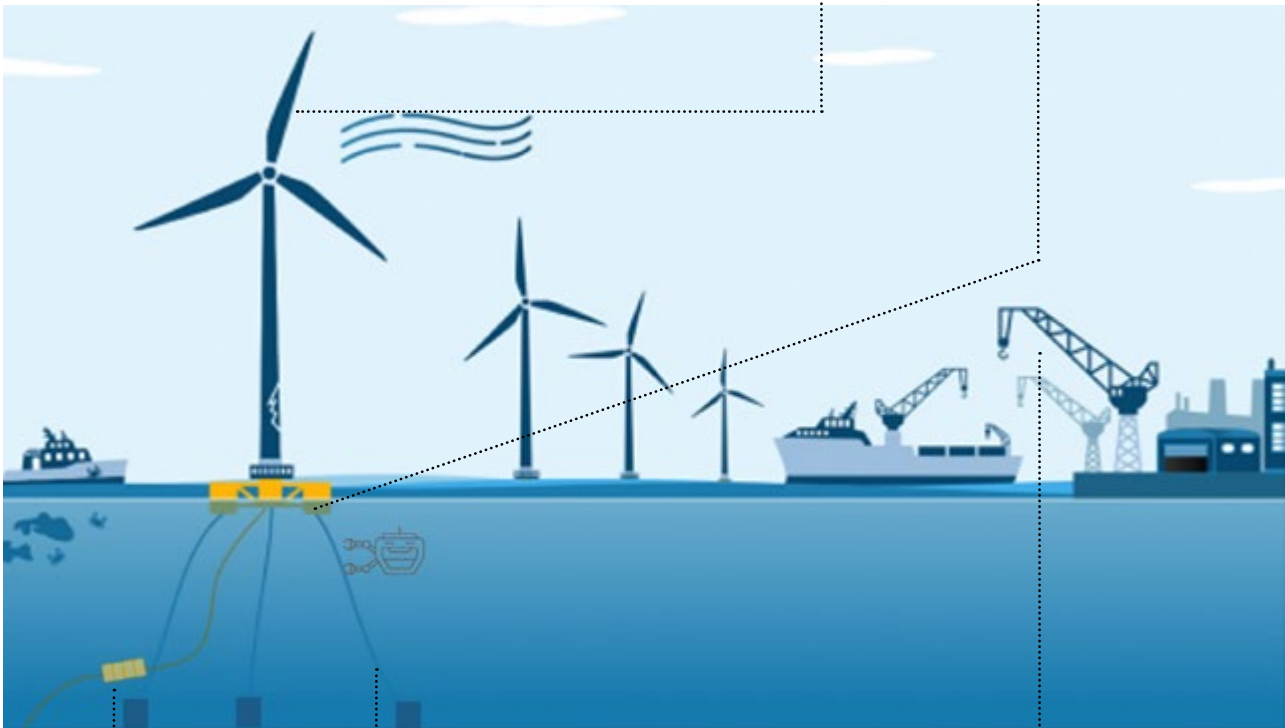
OWT

- Coupled-analysis
- Tests & certification
- Ancillary devices (eg. electronics, sensors)



Floater

- Floater design
- Ancillary devices (eg. ballasting, winch, crane)



Cable

- Dynamic cable design/analysis
- Ancillary devices (eg. buoy, CPS)



Mooring

- Mooring system design
- Advanced mooring materials
- connectors
- Anchor design



T&I

- T&I expertise
- MWS
- T&I devices and equipment (eg. ROV, inspection, monitoring, PPE)
- Vessel design



Complementary supply chains could give rise to many opportunities

- Chinese and UK supply chains have different strengths and weaknesses.
- Cooperation on supply chain and R&D would benefit industry stakeholders in both countries.



U.K. and China could work tightly on R&D projects for missing technology or existing technical pain points such as:

- Integrated floating offshore wind design and analysis
- Floating wind mooring optimization
- Floating wind cable dynamics
- Modular floating wind systems
- FOW logistics challenges
- FOW digital twin/smart O&M
- Minimizing Environmental Impact of Floating Wind

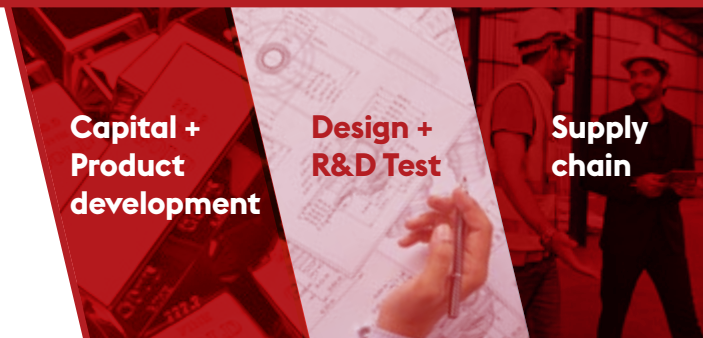


U.K. and China can best use their supply capabilities to feed the demands of both markets:

**Capital +
Product
development**

**Design +
R&D Test**

**Supply
chain**

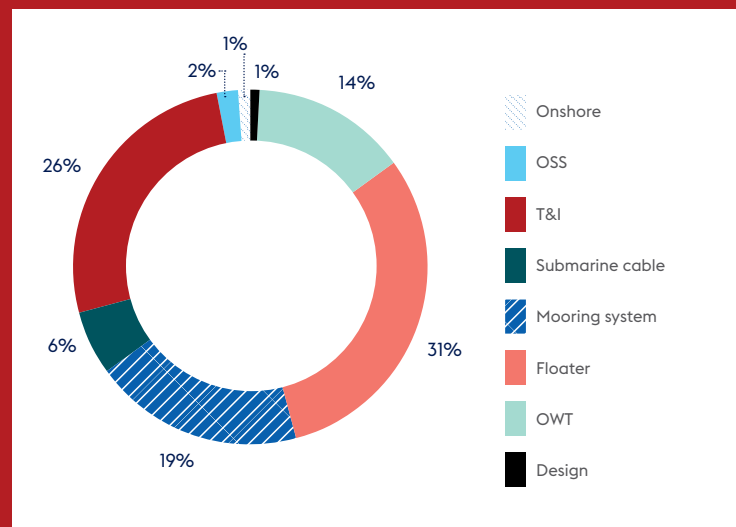


Project size	500MW	
Wind speed	8.0 - 8.5	m/s
Distance	30 - 36	Km
Water depth	94 - 100	m

GBP 500 million value for U.K. companies for a single 500MW demo

Based on a number of assumptions for a hypothetical floating wind project, we calculate the potential value which U.K. companies and investors could contribute for a single 500MW demo. Further value could be secured in the future depending on the roll-out of other projects and evolution of CAPEX and supply chain.

FOW demo CAPEX breakdown
Total estimated to be 35,000 RMB/kW



CAPEX Supply

Based on a detailed review of supply chain gaps, we estimate that U.K. companies could supply products and services representing at least 5% of CAPEX, representing a value of RMB 875 million (~GBP 105 million).

OPEX Supply

Further value could be secured in the operation phase including supply of O&M equipment and solutions as well as on items such as re-insurance, but which are still difficult to assess at this stage given the lack of references globally.

Investment

By taking a 49% stake in the 500MW project, and assuming a standard equity to debt ratio of 35% / 65%, a U.K. investment would represent a value of RMB 3 billion (~ GBP 360 million).



A strategic bilateral agreement could accelerate FOW development

The U.K. could support a rapid acceleration of the floating offshore wind projects in China by filling key R&D and supply chain gaps. The U.K. can also support Chinese export capability. The U.K. has an ambition of 50GW offshore wind, including 5GW floating offshore wind before 2030. A diverse supply of components into the European market is beneficial for competition and cost-reduction. The U.K. is well-positioned to support Chinese companies develop components that can supply this market.

Acronyms & abbreviations

Acronym	Full name	Acronym	Full Name
C&I	Construction and Installation	ILA	Integrated Load Analysis
CEI	China Energy Investment	LCOE	Levelized cost of electricity
CGN	China General Nuclear Power Group	MOU	Memorandum of Understanding
CHNG	China Huaneng Group	MSP	Marine Spatial Planning
CNOOC	China National Offshore Oil Corporation	MWS	Marine Warranty Surveyor
COD	Commercial Operation Date	NEA	National Energy Administration
CPECC-NEPDI	Northeast Electric Power Design Institute Co., Ltd. Of China Power Engineering Consulting Group	O&G	Oil and gas
CPS	Cable Protection System	O&M	Operation and Maintenance
CSSC	China State Shipbuilding Corporation	OEM	Original Equipment Manufacturer
CTG	China Three Gorges Group	OSS	Offshore SubStation
DEC	Dongfang Electric Co.	OWF	Offshore Wind Farm
DI	Design Institute	OWT	Offshore wind turbine
DRC	Development and Reform Commission	PPE	Personal Protection Equipment
EEZ	Exclusive Economic Zone	R&D	Research and Development
EIA	Environment Impact Assessment	REDF	Renewable Energy Development Fund
EPC	Engineering, Procurement and Construction	RNA	Rotor Nacelle Assembly
EPCI	Engineering, Procurement, Construction and Installation	ROV	Remote Operation Vehicle
FIT	Feed-in Tariff	SOE	State Owned Enterprise
FOW	Floating Offshore Wind	SPIC	State Power Investment Corporation
FOWT	Floating Offshore Wind Turbine	SPV	Special Purpose Vehicle
FSR	Feasibility Study Report	T&I	Transportation and Installation
GSB	Guangzhou Salvage Bureau	TLP	Tension leg platform
HVDC	High Voltage Direct Current	WTG	Wind Turbine Generator
HWS	Huangpu Wenchong Shipbuilding	XEMC	Xiang Dian Electric Manufacturing Group Co.,Ltd.

List of key U.K. floating offshore wind suppliers

Company	Business/Product	Company	Business/Product
Shell Renewables	Offshore wind developer	Air Traffic Control Services	Consulting-radar mitigation
EDF China	Offshore wind developer	Bibby Marine	Surveys, vessels, offshore logistics
Simply Blue Group	A leading blue economy project developer in the US	First Subsea	Cable protection system
BVG Associates	Leading independent renewable energy strategic consulting provider with expertise in the business, economics and technology of renewable energy generation systems	Granada Material Handling	Davit cranes
Empire Engineering	Deliver early-stage designs of Monopile, Jacket and Gravity Base Foundations	HiDef Aerial Surveying	Offshore survey
Quotient	Quantification, Optimization, and Environmental Impacts of Marine Renewable Energy	James Fisher	Offshore operations
Peak to Peak	Supplying standard and non-standard embedded sensor technology; permanently embedded micro-lutrasonic transducers for the measurement of interfaces and materials	Leck Construction	Civil engineering
Ada Mode	Monitor the health and performance of critical turbine components and rotating plant to minimise unplanned downtime and optimise offshore maintenance schedules.	MMP North West	Marine construction
MIROS	Specializing in measuring the ocean surface by providing sensors and systems for the environmental monitoring to the global offshore and maritime industry.	Neil Martin Group	Civil engineering
WindHoist	Leading wind turbine installation contractor offering heavy crange and mechanical/electrical services. Supply an integrated package reducing interfaces and wind risks	Power Systems Design Solutions Ltd	Engineering services

Company	Business/Product	Company	Business/Product
Pict Offshore	JV of Orsted and Limpet, Providing heave-compensated personnel hoist at transforming the way that maintenance technicians access OWT.	RXPE	HV & dynamic reactive compensation technology & engineering
Dangle Ropes	Provides comprehensive inspection, access, coating and composite (IACC) industrial services	AMS No Dig	Directional drilling
Offshore Renewable Energy Catapult	The ORE Catapult is the U.K.'s flagship technology innovation and research center for advanced wind wave and tidal energy.	CallMac	Offshore scaffolding
Balmoral	Buoyancy for floating systems	Carlomb Shipping	Shipping agent
Anatec	Maritime consultancy	Counter Context	Stakeholder management & communications
Attollo Offshore	Accommodation jack up unit	Hobson & Porter	Civil engineering/ construction
Oceaneering	Boulder clearance	Mainprize	Surveys, vessels (guard)
Global Maritime Consultancy	Marine warranty surveyors	Mott MacDonald	Engineering consultancy
Gulf Marine Services	Accommodation jack-up vessel	Rix Marine	Vessels (CTV)
ABL (OWC, LOC)	Leading global independent energy and marine consultant working in energy and oceans to de-risk and drive the energy transition across the renewables, maritime and O&G sectors	Siemens Gamesa Renewable Energy (SGRE)	Wind turbine OEM, blade manufacturing
Pict Offshore	Engineering innovation	Specialist Marine Consultants Ltd	Offshore & vessel inspection
Deepwind Cluster	the largest offshore wind representative body in Scotland with over 690 members drawn from industry, academia and the public sector.	LDAdesign	Design consultancy

Company	Business/Product	Company	Business/Product
Gardline	Offshore Surveys	Atkins (Bristol)	Design & Engineering
Seajacks	WTG Installation	BGB Scaffolding Ltd	Scaffolding
Niras Consulting	Consenting & Licensing	Jones Bros	Civil Engineering/ Construction
Northern Offshore Services	Vessels	Marine Designs	Marine Wngineering
Ordtek	UXO Risk Management	MSA Latchways	PPE
Raytheon Systems	Radar Mitigation	Portakabin	Temporary Offices
Red7 Marine	Offshore Construction	Prysmian	Array Cable
RML	Offshore Operations	Turbine Transfers	Vessels (CTV)
Aditus Solutions	Logistics	Trelleborg	Cable routing, cable management and EMC technology, Trelleborg offers highly efficient and economical solutions
Apem	Surveys	4subsea	Delivering key decision support for optimized production from offshore wind turbines
BPP Technical Solutions	Engineering & Technical Consultancy	First Marine	Offering a full marine & mooring lifecycle package to the renewables sector from system design through to site decommissioning, owning fleet of mooring equipment
Dalcour Maclaren	Site & Land Rights Services	OSI Renewables	Global provider of integrated energy systems and solutions.
EGS International	Cable Survey	Tension Technology (TTI)	Consulting group specializing in flexible tension member systems. TTI is an independent research, design and development company.
Fugro	Surveys, Inspection & Monitoring	Flowave TT	Test facility with a 30m circular concrete basin containing the 25m diameter, 2m deep wave and current tank and supplies software.

Company	Business/Product	Company	Business/Product
Geotechnical Consulting Group	Engineering & Technical Consultancy	Sensewind	Self-Erecting Nacelle and Service System that installs and services large wind turbines without special cranes or crane vessels.
H&Askham	Cable Pulling & Jointing	Floatation Energy	Leading developer and owner of offshore wind projects.
HR Wallingford	Surveys & Engineering	Sennen	Structured relational database with configurable templates of information for each technology type (wind, solar, etc.).
J Murphy's & Sons	Civil Engineering; Onshore Works	ZynQ 360	Proven and trusted, cloud-based software application suitable for any industry and project size, making your data truly accessible to maximize collaboration
London Offshore Consultants	Marine Warranty Surveyor	REOptimize	Revolutionary system for optimization of wind, tidal and hydro turbine control parameters. It uses machine learning techniques combined with accurate component models
MeteoGroup Ltd	Meteorological Services	Acteon	Has one of the largest global fleets of specialist equipment, including pile hammers and subsea drills; specialising in digital information data collection and survey techniques
MHI Vestas	Wind Turbine OEM, Blade manufacturing	Gavin & Doherty Geosolutions	A specialist geotechnical engineering consultancy, providing innovative geotechnical solutions
Orcina	Providing Dynamic Analysis Software Orcaflex	BMT	Vessel design
Mwaves	Marine Warranty Surveyors	Principle Power	Leading floater design company providing proven floater product with active ballasting system

Company	Business/Product	Company	Business/Product
Allied Exploration & Geotechnics	Site investigations	Wood Group	One of the world's leading consulting and engineering companies operating across Energy and the Built Environment.
Cathie Associates	Geoscience & geotechnical engineering, surveys	Siemens Metering	Metering
JDR Cables	Array cables	Royal Haskoning DHV	Environmental consultancy
Modus Seabed Intervention Ltd	ROV inspection & EOD services	Reach Engineering & Diving Services (REDS)	Diving
Procomm Site Services	Site offices	6 Alpha Associates	UXO
Tekmar Energy	Cables protection system	Brown & May Marine	Surveys & EIA consultancy
Wilton Engineering	Transition pieces	CWind	Offshore operations
Osprey Consulting Services	Safety & engineering support	Brydon-Bekaert	World's premier supplier of mission-critical advanced cords and ropes. As a leading innovator, developer and producer of the best performing ropes and advanced cords globally
Oxford Archaeology	Archaeology	Dublin Offshore	Particularly focused on the fixed and floating offshore wind sector
Quod	Planning consultants	Nexans	Leading submarine cable supplier providing dynamic cables for floating wind projects
Red Penguin Marine	Marine warranty surveyor	OSBIT	Design offshore wind equipment like trenching, cable-lay,
RPS Energy	EIA consultancy	North Star Group	Providing support vessels, lifeboats and barges for geophysical surveys, drilling and coring, meteorological buoys and spars, marine mammal surveys and a variety of other projects in support of the offshore wind sector.
Seacat Services	Vessels (CTV)	BMT	Leading offshore wind design firm dedicated in geo and structural design.

Company	Business/Product	Company	Business/Product
Spectrum GEO	Surveys	Petrofac	Use its engineering know-how and consultancy expertise to design, build, and operate world-class energy facilities
The Environment Partnership	Support for ecological works	Aleron	Specialising in the rental & sale of complete ROV solutions globally for an array of applications.
Theta Services	Marine warranty surveyors	WSP	Onshore substation design
Robertson Group Ltd	Civil engineering/ construction	GE Grid Solutions	Electrical systems
StormGeo	Meteorological services	Craneking	Crane services
Kelvin Power Structures	Transformer & fire enclosures	ARUP	Founded in London in 1946, Arup is now one of the world's largest, the most successful and comprehensive engineering consulting company, covering civil engineering, architecture, planning, geo technics, etc.
Balfour Beatty Civil	Onshore substation construction	Offshore Solutions	Dedicated to leading the industrialization of floating offshore wind and delivering mission critical moorings & anchoring foundations
VolkerInfra	Onshore export cable installation	MasterFilter	Specialising in the design and manufacture of Dual Flow Filtration Systems for use on all types of fluid power applications to keep hydraulic oils ultra clean.

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