FLOATING OFFSHORE WIND CENTRE OF EXCELLENCE

Delivered by CATAPULT Offshore Renewable Energy

INDUSTRIAL LEADERSHIP – UNLOCKING THE UK'S FLOATING WIND POTENTIAL

Image: Photo courtesy of Principle Power. Artist: DOCK90.

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PREFACE

The Floating Offshore Wind Centre of Excellence (FOW CoE) was established by the Offshore Renewable Energy (ORE) Catapult in 2019 to accelerate the commercialisation of floating offshore wind. The FOW CoE is a collaborative programme working with industry, Government, academic and supply chain partners to ensure floating offshore wind plays a key role in delivering a cost-effective Net Zero, whilst driving economic growth – within the UK and beyond.

The programme was established to address the specific opportunities and challenges the UK faces in developing floating offshore wind. There is the opportunity for the development of the UK market to lead the world and in doing so, support floating offshore wind to have a significant global impact on reducing carbon emissions whilst supporting UK economic growth.

Over the first two years, partners have committed more than £3.5m in funding and supported the development and delivery of more than 20 projects. Through these projects, the FOW CoE has delivered evidence and guidance to partners and stakeholders regarding the commercialisation of floating offshore wind. Working across four workstreams – technology, supply chain and operations, development and consenting and delivering Net Zero (policy) – the multi-disciplinary structure of the programme reflects the diverse and inter-related topic areas key to commercialisation and broader industrial strategy.

FOREWORD

SEPTEMBER, 2021

Earlier this year, the Climate Change Committee provided updated guidance on the role of offshore wind in delivering Net Zero[1]. This guidance suggests the UK shall require almost 100GW of offshore wind to deliver Net Zero, with a number of pathways suggesting even greater levels of deployment. As the scale of deployment has become apparent, Government and industry have continued to develop their understanding of when, where and how this can be delivered – noting that it requires an almost tenfold increase in installed capacity over the next 30 years.

In the UK, and a number of other key international markets, floating offshore wind shall play a critical role in achieving the scale of installed capacity required to deliver a cost-effective Net Zero. In the UK, as much as 50% of the 100GW by 2050 target being floating wind[2]. In other markets, with deeper waters such as Ireland, Norway, France, South Korea, Japan and the United States, floating offshore wind shall play an even more significant role.

Delivering 100GW of offshore wind by 2050 represents a huge industrial challenge for the UK, but also a huge economic opportunity. Within this, floating offshore wind presents a particular opportunity. Firstly, floating offshore wind has the potential to be "subsidy free" by 2030, unlocking the potential for large-scale cost-effective deployment of offshore wind around the UK[3]. Secondly, the UK is already a world leader in floating offshore wind, and floating offshore wind technology is closely linked to existing technologies employed in oil and gas, and fixed bottom wind, all areas where the UK has existing world leading skill and capability. This provides a unique "first mover" advantage to the UK supply chain. Thirdly, the first large scale projects are 6-8 years away, allowing time for key enabling actions to be implemented if we act soon. Finally, and perhaps most importantly, industry, Government and stakeholders in the UK have engaged early and constructively to ensure the lessons learned from the development of fixed bottom wind in the UK are utilised to accelerate the commercialisation of floating offshore wind, whilst maximising the financial, social and environmental benefits to the UK.

Time is of the essence, both to ensure the UK develops the capacity and capability to deploy the scale of offshore wind required, but also to ensure this is done in a manner which maximises the benefits in the UK. In this context, the industry continues to make significant progress in terms of cost reduction, innovation, supply chain development and project investment. However, further key enabling actions are required. These enabling actions, drawn from extensive engagement across the industry, and from lessons learned from the development of fixed bottom wind, will ensure that floating offshore wind supports the delivery of a cost-effective Net Zero, accelerates the energy transition, drives regional economic growth and delivers an excellent return on investment for the UK.

Floating offshore wind offers a "once in a generation" opportunity for the UK. Coordinated, collaborative, strategic enabling actions implemented in the short term, will deliver long term economic, social and environmental benefits across the UK for decades to come.

Andrew Jamieson, Chief Executive Officer, The Offshore Renewable Energy Catapult

Claire Mack, Chief Executive Officer, Scottish Renewables

Dan McGrail, Chief Executive Officer, Renewable UK

1 **6th Carbon Budget**, CCC, 2021
2 Strategic Infrastructure and Supply Chain Project, FOW CoE, 2021
3 **FOW Cost Reduction Pathways Project**, FOW CoE, 2021

EXECUTIVE SUMMARY

The UK will require almost 100GW of offshore wind to deliver Net Zero, with floating offshore wind expected to play a key role in this. With just over 10GW of offshore wind installed today, delivering this presents both challenges and opportunities for the UK.

Floating offshore wind presents a particular set of challenges and opportunities. The UK, with its world leading skills and experience in fixed bottom offshore wind, oil and gas and subsea engineering, is well placed to develop a floating offshore wind industry which enables the energy transition, supports the delivery of a cost-effective Net Zero and drives regional economic growth. However, to ensure the opportunities which floating offshore wind presents are secured, and challenges addressed, concerted collaborative action is required.

Building on existing effective engagement between industry, Government and stakeholders, a range of key enabling actions to support the growth of the industry have been identified.

These actions are broad in scope and combined form a coordinated industrial strategy. Actions identified address key areas including…

- Credible, Ambitious Policy Targets
- Regional Development Strategy
- Revenue Support Mechanisms
- Intermediate Scale Project Activity
- Long Term Spatial Planning
- Technology Innovation
- Strategic Infrastructure and Supply Chain Development

Whilst the industry requires an element of support in the short term, enacting these actions will ensure floating offshore wind delivers an excellent return on investment for the UK. The industry has the potential to deliver £43.6bn in UK gross value add (GVA) by 2050, creating more than 29,000 jobs in the process. This is in return for an estimated £2.2bn in support in the early stages of development.

THIS REPORT OUTLINES AN EVIDENCE-BASED SET OF ENABLING ACTIONS WHICH, IF DELIVERED, WILL ACCELERATE THE GROWTH OF THE UK FLOATING OFFSHORE WIND INDUSTRY, ENABLE THE ENERGY TRANSITION, SUPPORT THE DELIVERY OF A COST-EFFECTIVE NET ZERO AND DRIVE REGIONAL ECONOMIC GROWTH. IN ADDITION, IT WILL ENSURE THE UK LEADS THE WORLD IN THE DEVELOPMENT OF FLOATING WIND, ENSURING UK-BASED INNOVATION, RESEARCH AND INDUSTRIAL ACTIVITY SUPPORTS THE GLOBAL COMMUNITY IN DELIVERING NET ZERO.

Image: TetraSpar Demonstrator ApS.

INTRODUCTION

Since the launch of the *Floating Wind – The UK Industry Ambition* report by RenewableUK and Scottish Renewables in 2019, the floating offshore wind industry in the UK and internationally has developed rapidly. In addition, the world has experienced the COVID-19 pandemic, leading to discussions about how to pursue a 'green economic recovery', and has more fully recognised the urgency of action required to address climate change[4].

In this context, ORE Catapult, RenewableUK and Scottish Renewables have prepared this document to summarise the status of the industry, the progress made in areas critical to the commercialisation of floating offshore wind and the key enabling actions to ensure the UK maximises the opportunity associated with it.

Drawing on learning and evidence from the FOW CoE and broader industry, this document provides an evidence-based set of enabling actions which, if delivered, will accelerate the growth of the UK floating offshore wind industry, enable the energy transition, support the delivery of a cost-effective Net Zero and drive regional economic growth. In addition, it will ensure the UK leads the world in the development of floating wind, ensuring UK-based innovation, research and industrial activity supports the global community in delivering Net Zero.

4 **IPCC Sixth Assessment Report**, 2021

CONTEXT – UK AND INTERNATIONAL MARKET DEVELOPMENT

UK STATUS

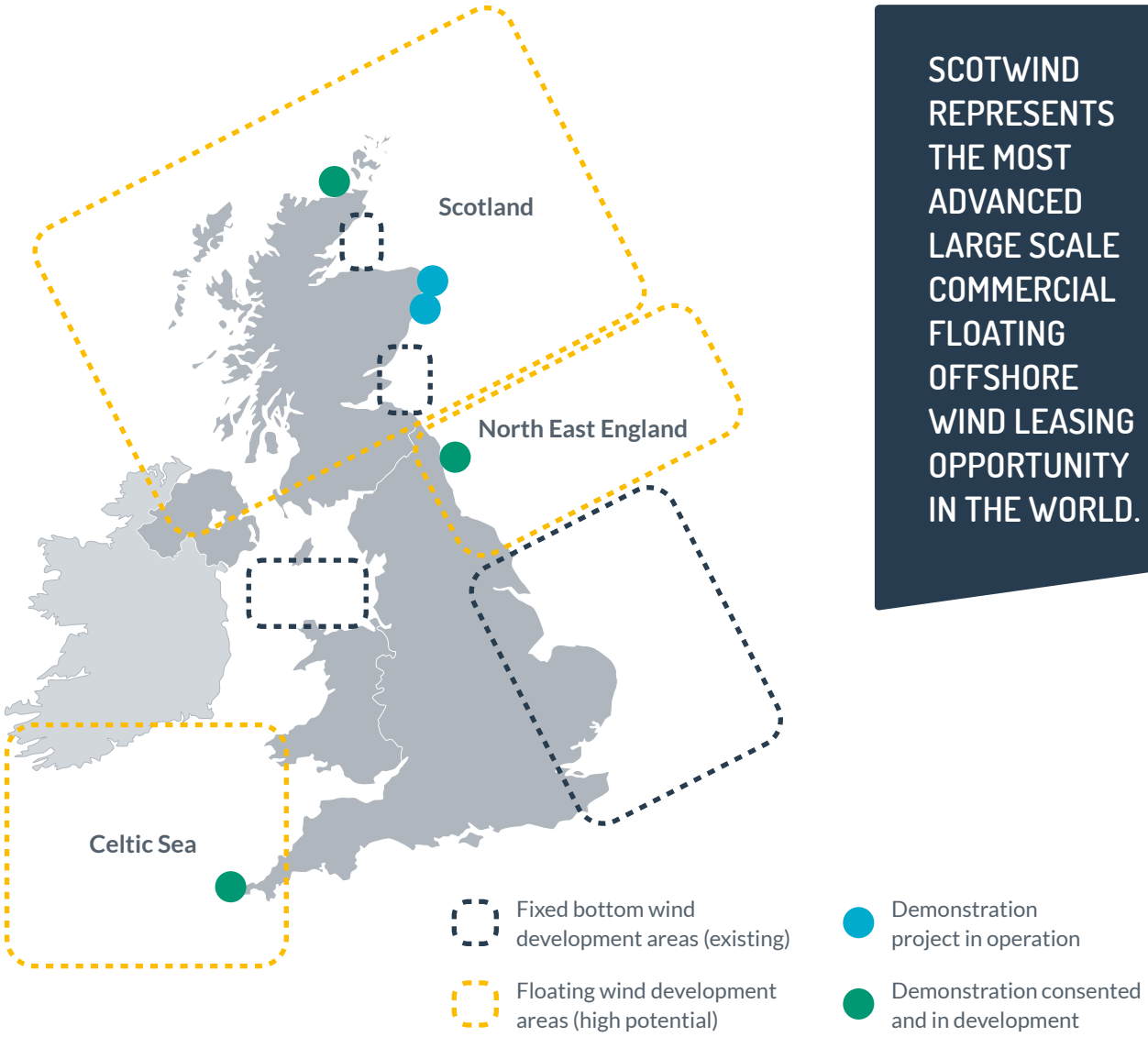
The UK remains the world's leading floating offshore wind market, both in terms of the installed capacity and near-term development opportunities. The world's first floating offshore wind farm, Hywind Scotland, was installed in Scotland in 2017, demonstrating that floating wind technology can be deployed at array scale to harness the power of the high wind speeds in areas of deeper water. This 30MW project utilised a spar substructure design, similar to that utilised by the Hywind Demo project. In the three years since installation, the Hywind Scotland floating wind farm has consistently delivered the highest capacity factor of any offshore wind farm in UK waters[5]. Hywind Scotland has recently been superseded as the world's largest floating offshore wind farm through the deployment of the Kincardine Project, located close to Hywind Scotland and approximately 15km southeast of Aberdeen[6]. The five-turbine array utilises turbines which are 50% larger than Hywind Scotland and has a combined installed capacity of 50MW. The wind farm has successfully utilised a semi-submersible substructure design and alternative turbine manufacturer – demonstrating that the floating offshore wind industry now has access to a number of fully commercial technology providers.

FLOATING OFFSHORE WIND HAS THE POTENTIAL TO BE DEPLOYED ACROSS THE UK.

Floating offshore wind has the potential to be deployed across the UK, with Scotland, North East England and the Celtic Sea being the most appropriate areas for cost effective, large scale deployment[7]. Each of these areas possess large areas considered suitable for floating offshore wind project development.

Scotland has launched the world's first fully commercial leasing round which will support large scale floating wind. The first ScotWind leasing round was launched by Crown Estate Scotland in 2019 and received a total of 74 separate lease applications in July 2021, demonstrating the huge appetite for investment in floating offshore wind project activity[8]. The ScotWind leasing process is the primary mechanism for delivering the Scottish Government's target of between 8-11GW of offshore wind in Scotland by 2030[9]. Approximately 70% of the lease areas identified in the current Sectoral Marine Plan are likely to support floating offshore wind technology, which represents a combined installed capacity of around 7GW[10]. This represents the most advanced large scale commercial floating offshore wind leasing opportunity in the world, with the first projects anticipated to be operational from 2028.

5 **Floating Wind Overview**, Equinor, 2021
6 **Overview**, Kincardine Offshore Wind farm Limited, 2021
7 **FOW Cost Reduction Pathways Project**, FOW CoE, 2021
8 **News**, Crown Estate Scotland, 2021
9 **Offshore Wind Policy Statement**, Scottish Government, 2020
10 **Initial Predictions for Offshore Wind Farms in the ScotWind Leasing Round**, ORE Catapult, 2021



SCOTWIND REPRESENTS THE MOST ADVANCED LARGE SCALE COMMERCIAL FLOATING OFFSHORE WIND LEASING OPPORTUNITY IN THE WORLD.

Scotland has also launched the world's first offshore wind leasing round targeting oil and gas decarbonisation, within which floating offshore wind will play a key role. The launch of Marine Scotland's Innovation and Targeted Oil and Gas Decarbonisation (INTOG)[11] sectoral marine planning process shall facilitate access to seabed leases for offshore wind, for the purposes of electrifying oil and gas operations. This leasing round has the potential to deliver up to 4GW of offshore wind capacity. Floating offshore wind will play a critical role in the delivery of the North Sea Sector Deal emission reduction targets by providing low carbon electricity to oil and gas operations in the North Sea. With a target of 50% emission reductions by 2030, floating offshore wind offers a cost-effective solution for many oil and gas assets located far from shore and / or in deeper water.

A floating offshore wind leasing round is in development in the Celtic Sea to support intermediate scale projects in the region. The Crown Estate have signalled their intention to facilitate access to leasing opportunities in the Celtic Sea region for intermediate scale projects (100-300MW) to support the development of the supply chain in that region[12].

11 **Sectoral Marine Plan for Offshore Wind Innovation and Targeted Oil and Gas Decarbonisation**, Marine Scotland, 2021
12 **Energy Transition Outlook**, DNV, 2020

Image: Balmoral floating wind solutions undergo extensive assessment at the company's in-house test centre. Image courtesy of Balmoral.

BALMORAL

Balmoral's extensive experience in providing integrated surface and subsurface buoyancy and protection solutions means the company is ideally placed to support the rapid growth of the floating offshore wind market.

From its base in North East Scotland, the company has already secured contracts in floating offshore wind. The company was recently awarded a contract to significantly reduce the life cycle costs of dynamic cable buoyancy for a high-profile North Sea floating wind project.

Balmoral's technical team value-engineered a solution that saw the size of the subsurface buoyancy modules increase, thus reducing the quantity required, and the introduction of its patented clamping system, reducing installation times by 70%.

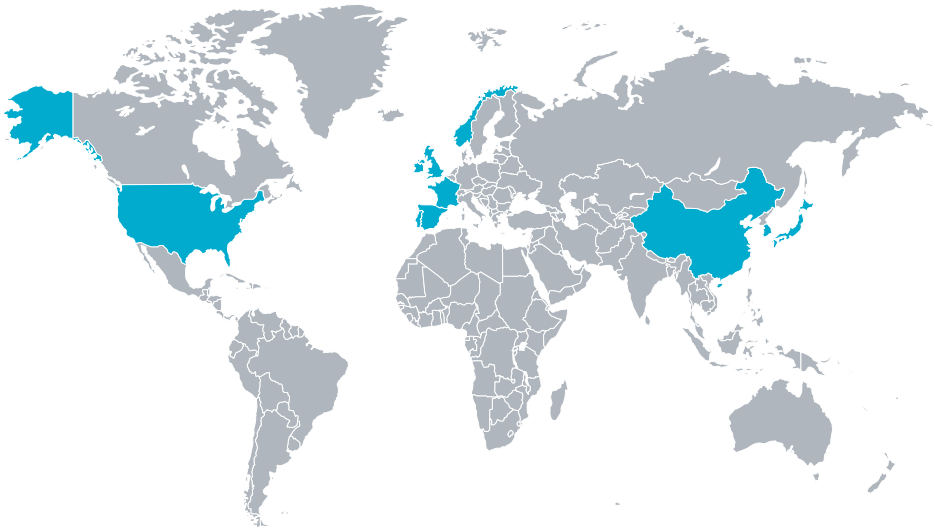
Balmoral have demonstrated that early engagement with key suppliers can deliver real savings for project developers through optimised design. Balmoral's in-house expertise – including R&D, hydrodynamic engineering and project management, supported by comprehensive test facilities – brings a unique offering to the offshore wind sector, allowing the sector to benefit from decades of experience of dynamic surface and subsea systems.

Building on an existing portfolio of patented fibre-technology cable protection systems and buoyancy systems, their solutions continue to be developed to meet the needs of the sector – utilising world leading expertise to offer competitive, high-performance products and services.

INTERNATIONAL CONTEXT

The international floating offshore wind market has grown rapidly in recent years – both in terms of installed capacity and future scale of deployment. Current projections suggest the scale of the international market to be between 200-250GW by 2050[13], which represents between £400-500bn in capital expenditure investment alone[14]. Near term market opportunities exist in Europe, South East Asia and North America. Longer term opportunities exist across the globe including Southern Africa, Australia, India, Middle East and South America[15].

WHILST INTERNATIONAL MARKET DEVELOPMENT ACTIVITY PROVIDES UK EXPORT OPPORTUNITIES, IT ALSO HIGHLIGHTS THE GROWING INTERNATIONAL COMPETITION TO ATTRACT INVESTMENT INTO FLOATING OFFSHORE WIND PROJECTS, SUPPLY CHAIN, ENABLING INFRASTRUCTURE, RESEARCH AND DEVELOPMENT ACTIVITIES.



Major developments in international markets are happening over short time periods. Below is snapshot of recent international market development activities…

- Spain announces target of 1-3GW of floating offshore wind by 2030 (July 2021);
- France awards lease for 270MW floating wind farm, with two further 250MW projects to follow shortly. Leases are being awarded using an accelerated process which uses pre-selection and competitive dialogue to award leases (July 2021);
- Norway announces intention to launch 1.5GW of floating wind leasing in 2022, with further large scale leasing opportunities to launch in 2023 (June 2021);
- US State of Oregon introduces bill to support development of 3GW of floating wind by 2030 (March 2021);
- US State of California introduces bill to support development of 3GW of floating wind by 2030 (February 2021);
- Japan sets an offshore wind target of 10GW by 2030 and 30 – 45GW by 2040, a significant proportion of which will be floating wind (December 2020);
- Ireland's Programme for Government sets target of 5GW of offshore wind by 2030 and long-term target of 30GW of floating wind off its Atlantic Coast (June 2020).

13 **Energy Transition Outlook**, DNV, 2020
14 **FOW Cost Reduction Pathways Project**, FOW CoE, 2021
15 Various, 2021

BUSINESS CASE - DELIVERING NET ZERO, ECONOMIC GROWTH, ENERGY TRANSITION AND COST REDUCTION

DELIVERING NET ZERO

The UK will require almost 100GW of offshore wind to deliver Net Zero, with floating offshore wind expected to play a key role in this[16]. This could see up to 50% of offshore wind being floating wind by 2050, rising to 60% if the aggregate installed capacity target rises to 150GW[17]. Given the spatial constraints fixed bottom wind will experience in time, the larger the installed capacity of offshore wind required, the more important the role of floating offshore wind will be. An assessment of the energy system benefits of floating offshore wind has also highlighted the potential for it to deliver savings in energy system operational expenditure, reduce the costs / requirements of carbon capture technologies and deliver increased electricity export revenue[18]. It is also likely to play a key role in the integration of offshore and onshore green hydrogen production, helping accelerate the development of the green hydrogen market in the UK and supporting the delivery of the (at least) 2TWh of hydrogen storage required by 2035[19].

THE UK WILL REQUIRE ALMOST 100GW OF OFFSHORE WIND TO DELIVER NET ZERO, WITH FLOATING OFFSHORE WIND EXPECTED TO PLAY A KEY ROLE IN THIS.

ECONOMIC GROWTH

Floating offshore wind can be a major driver of economic growth. Within the UK, floating offshore wind is well suited to deployment in waters north and east of Scotland, east of North East England and within the Celtic Sea. With large scale projects in these regions 5-10 years away, there is an opportunity for the appropriate infrastructure and supply chain capability to be developed in the near term, delivering significant local supply chain opportunities in these regions, and in turn driving regional economic growth.

Floating offshore wind will provide an excellent return on investment for the UK. The industry has the potential to deliver £43.6bn in UK gross value add (GVA) by 2050, creating more than 29,000 jobs in the process. This is in return for an estimated £2.2bn in support in the early stages of development[20].

THE INDUSTRY HAS THE POTENTIAL TO DELIVER £43.6BN IN UK GROSS VALUE ADD (GVA) BY 2050, CREATING MORE THAN 29,000 JOBS IN THE PROCESS.

16 **CCC 6th Carbon Budget**, 2021
17 Strategic Infrastructure and Supply Chain Project, FOW CoE, 2021
18 FOW Energy Systems Benefits Project, FOW CoE, 2021
19 **Future Energy Scenarios**, National Grid ESO, 2021
20 Updated analysis based on original work in **Macroeconomic Benefits of Floating Offshore Wind**, ORE Catapult, 2018

Image: Kincardine Offshore Wind Farm turbine and substructure at Port of Cromarty Firth. Image courtesy of Port of Cromarty Firth.

PORT OF CROMARTY FIRTH

The Port of Cromarty Firth is utilising location, experience and facilities to accelerate the energy transition. Its strategic location in the Cromarty Firth, on the doorstep of the ScotWind and proposed INTOG leasing areas, means there is nowhere in Scotland better placed to capitalise on the opportunities floating offshore wind offers.

The Port has already invested over £50 million in infrastructure over recent years, aligned to the requirements of the offshore renewables industry. This includes facilities to support the manufacturing and deployment of commercial scale floating offshore wind technologies. The latest expansion, Quay West, is a new 372m deep-water berth with over 22 acres of accompanying laydown area.

The Port has already built a successful track record within the offshore wind industry, having supported the delivery of the 950MW Moray East and 588MW Beatrice offshore wind farms and also the 50MW Kincardine floating offshore wind farm.

Floating offshore wind plays a central role in the Port's broader development of a green hydrogen hub in the Cromarty Firth. The hub shall link offshore wind and associated green hydrogen production, with local supply chain development and sustainable jobs to decarbonise onshore activities and drive economic growth in the region.

Image: Steisdal Offshore Technologies Tetra-Spar Demonstrator Project. Image courtesy of Fugro.

FUGRO

Fugro is the world's leading geo-data specialist, with decades of experience supporting the design and delivery of offshore wind and, most recently, floating offshore wind projects.

Fugro has been directly involved with over 90% of the offshore wind projects developed across Europe. The company has a growing portfolio of floating wind project experience, including supporting the delivery of the WindFloat Atlantic project, providing positioning support to Bourbon Subsea Services to install the three semi-submersible units at the project site.

As part of the Floating Wind Technology Acceleration Competition (FLW TAC), Fugro worked with AS Mosley and the University of Strathclyde to develop an industry-leading remote monitoring solution to minimise the need for subsea inspection. Funding was made available by the Scottish Government through a grant agreement with the Carbon Trust.

As a key part of the energy transition, floating offshore wind is a focus area for Fugro, leveraging existing expertise in offshore wind and utilising transferable knowledge of floating structures from the oil and gas industry to support the sector.

ENERGY TRANSITION

Floating offshore wind is playing a key role in driving the energy transition, attracting a range of new players to the offshore wind market, including large international operators and Tier 1 supply chain organisations who have previously focused on the oil and gas[21]. These organisations bring relevant experience from the oil and gas sector into the offshore wind sector, with floating wind identified as a particular focus given the cross over in key technology areas including floating substructures, mooring and anchoring systems and dynamic cable systems. More broadly, floating offshore wind is supporting the transition of highly skilled jobs from oil and gas into offshore renewable energy, as well as enabling vessels and other assets developed to serve the oil and gas market to be repurposed to support offshore renewable energy.

Floating offshore wind projects are being developed in the UK and shall support the decarbonisation of oil and gas activities in the North Sea. Floating offshore wind will play a key role in supporting the oil and gas sector reduce its emissions by 50% by 2030[22], specifically for assets and activities located far from shore and / or in deeper water. In doing so, it will drive innovation in decarbonisation and accelerate the transition of highly skilled jobs from oil and gas into offshore wind and the broader green economy.

21 Various, 2021
22 **North Sea Transition Deal**, UK Government, 2021

COST REDUCTION

Floating offshore wind can be "subsidy free" by 2030[23]. Cost reduction is happening even faster for floating wind than has been the case for fixed bottom wind. The key driver of cost reduction in the short and medium term is scale of deployment, with innovation playing a key role in medium- and longer-term cost reduction. The UK is likely to constitute a significant proportion of global installed capacity of floating offshore wind in the coming decades, and hence will play a globally significant role in driving cost reduction[24].

Accelerating the rate of cost reduction in floating wind can be achieved in a number of ways…

- Accelerate deployment, and associated strategic supply chain and infrastructure development;
- Enhance learning rates, through collaboration, knowledge capture, monitoring, evaluation and optimisation;
- Accelerate innovation, through research, development, testing and demonstration.

Floating offshore wind continues to deliver substantial cost reduction. Since early testing and demonstration-scale projects, the cost of floating offshore wind is dropping substantially as the technology matures and scale grows. Hywind Scotland, a 30MW project, reduced costs by 70% compared to the Hywind Pilot. Hywind Tampen, an 88MW project to be installed off Norway in 2022, is estimated to have reduced costs by 40% compared to Hywind Scotland[25]. Most recently, the first tender for an "intermediate scale" floating offshore wind project (270MW) in France, is estimated to have secured a strike price below EUR100/MWhr[26]. The project is estimated to be operational by 2025[27].

23 **FOW Cost Reduction Pathways Project,** FOW CoE, 2021
24 Various, 2021
25 **Floating Wind Overview,** Equinor, 2021
26 Note, the strike price achieved in this tender has not been made publicly available at the point of publication and requires minor adjustment to account for benchmark year and the exclusion of certain transmission costs. However, based on the information available at the point of publication, the strike price achieved shows a considerable reduction in the cost of floating offshore wind at this scale.
27 **News,** WindEurope, 2021

Image: Subsea 7 services. Image courtesy of Subsea 7.

SUBSEA 7

For over 10 years Subsea 7 has been a top tier service provider to the offshore wind industry, having supplied and installed more than 7GW of offshore wind infrastructure.

Seaway 7, the renewables business of Subsea 7, is currently delivering the $1bn engineering, procurement, construction and installation (EPCI) contract for the Seagreen offshore wind project. The project, off the Angus coast in the North Sea, comprises 114 jackets foundations and associated inter-array cables.

In July 2021, Subsea 7 announced the proposed combination of its Renewables business with OHT ASA to form Seaway 7 ASA. Seaway 7 ASA will be a dedicated renewables company, offering an enhanced range of services for the installation of wind turbines, fixed and floating foundations, offshore substations, submarine cables and heavy transport.

Subsea 7 has also entered into an agreement to acquire a majority interest in Nautilus Floating Solutions S.L., a developer of technology for floating offshore wind substructures.

The company's ambition is to continue its growth in the sector and become a leading service provider in floating offshore wind by 2030.

SHORT TERM COST REDUCTION WITH SCALE

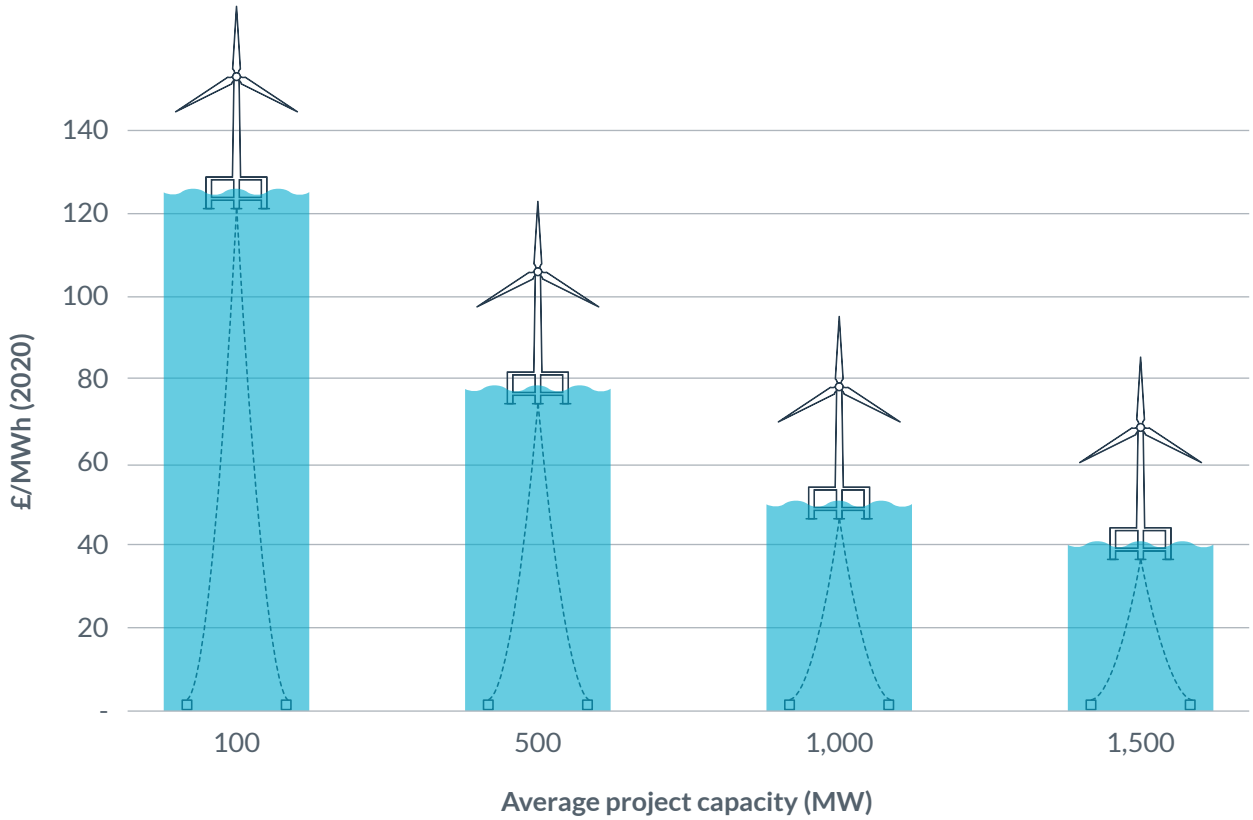


Image: Photo courtesy of Principle Power. Artist: DOCK90.

PROGRESS AND ENABLING ACTIONS – PIPELINE, POLICY AND PROJECTS

PIPELINE

Strong growth in a pipeline of large scale floating offshore wind projects is required to drive down the cost of floating offshore wind, create opportunities for the UK supply chain and unlock investment in UK project development, supply chain organisations, infrastructure, research and development. Commitment to a 2030 target for floating offshore wind is important and brings focus on ensuring timely delivery of the first large scale projects in the UK; however, the UK has the potential to deliver significantly more than the current 1GW target by 2030[28]. Delivering a higher 2030 target will allow the UK to retain its position as a global leader in floating offshore wind and ensure the growth trajectory of the industry is aligned with the deployment rates required in the 2030s and beyond. In addition, the visibility of a long term pipeline of project activity is required to increase market confidence and unlock major investments in infrastructure and strategic supply chain capability. Investment decisions such as those required to develop strategic infrastructure and supply chain capability are significant in scale (hundreds of millions of pounds each), underpinned by medium / long term business cases (>20 years) and have a long lead time (5-10 years). Establishing a floating offshore wind target for 2040 is critical to unlocking such long term investment in time for these to be realised in advance of the first large scale projects. It will also accelerate and enhance investment in UK project development, innovation and research by fostering a long-term approach to these activities within the UK market.

A long-term strategic plan for the deployment of offshore wind in the UK is required to underpin the Climate Change Committee deployment targets. Both industry and Government studies looking at deployment constraints, drivers and scenarios to deliver Net Zero are ongoing[29,30]. These should be utilised to develop a strategic plan for the deployment of (fixed and floating) offshore wind in the UK, providing guidance on the role of each in the future energy system. This would not only increase investor confidence but provide clear targets for Government and industry to work towards, establishing necessary working groups and policy reforms to address barriers to growth.

Enabling Action – an increased target for floating wind deployment by 2030 should be established to reflect the potential for such deployment by 2030, and the UK's ambition to retain its role as a global leader.

Enabling Action – a 2040 target for floating offshore wind deployment in the UK should be established, informed by deployment scenario studies, to provide clear guidance to the supply chain, project developers and the broader international community as to the scale of the industry in the UK in the medium term.

28 **Raising the Bar**, RenewableUK, 2021
29 Strategic Infrastructure and Supply Chain Development Project, FOW CoE, 2021
30 Future **Offshore Wind Scenarios Project**, OWEC, 2021

Image: Stevadjuster® by Vryhof. Image courtesy of Vryhof.

VRYHOF

Vryhof Anchors provides drag anchors and related mooring equipment for larger floating structures, to the offshore energy industries as well as for offshore civil applications. Vryhof has a focus on the opportunities floating offshore wind offers and is already innovating to support the growth of the sector.

Vryhof has recently launched the Stevadjuster® which has been installed for a floating offshore wind project off the coast of Norway. The device was installed in one mooring line and used to load the three-line mooring system to the required pre-tension, and was supplied by Vryhof as part of the complete mooring system scope.

The Stevadjuster® was designed to reduce the time and cost of mooring installation for floating offshore wind. The technology uses simple mechanical principles to enable the length of a mooring line to be adjusted, thus altering the tension in the line. It operates on a chain by locking onto it at the required length/tension. This chain remains locked in place until either the system requires re-tensioning or relaxing, whereupon the chain can be released and is able to be further shortened or lengthened as required.

The development of Stevadjuster® was funded by the Scottish Government through a grant agreement with the Carbon Trust as part of the Floating Wind Technology Acceleration Competition (FLW TAC).

A coordinated approach to the development of floating offshore wind activity across the UK is required. This is critical to ensure areas where development is facilitated are supported to develop the infrastructure and supply chain capability required to secure significant local economic benefits. The three main areas considered suitable for development in the UK – Scotland, North East England and the Celtic Sea – each have their own challenges and opportunities with respect to floating offshore wind[31]. These are understood by industry and key regional stakeholders but need to be recognised and incorporated into a strategic development approach for floating offshore wind across the UK. In the absence of such a strategic approach, some regions may be unable to capitalise on the opportunities presented by floating offshore wind and / or the overall growth of floating offshore wind in the UK may be slowed. Offshore wind clusters in North East England and the recently launched Celtic Sea cluster have a strong focus on floating wind, and are actively supporting their members to understand the opportunities floating offshore wind represents. In Scotland, the Scottish Government, SOWEC and offshore wind clusters are coordinating the development of the industry through the development of Offshore Wind Policy Statements[32], Strategic Investment Assessments[33] etc.

Enabling Action – a strategic approach to floating offshore wind development across the UK should be taken, establishing clear guidance on the scale and timing of floating offshore wind development in each relevant area of the UK. This needs to account for regional differences but take a UK-wide approach to the development of the industry as a whole.

POLICY

The UK has established targets for floating offshore wind deployment and the Contracts for Difference (CfD) mechanism will play a critical role in ensuring these are delivered. The UK government has put forward amendments to the CfD mechanism which recognise that, in the short-term, floating offshore wind projects cannot compete directly with large scale fixed bottom wind projects on strike price alone. These amendments, developed after constructive engagement between industry and Government, shall be implemented in Allocation Round (AR) 4, offering a credible opportunity for a number of floating offshore wind projects in the UK to secure a CfD.

With the potential to deploy more than 2GW of floating offshore wind by 2030[34], the UK is well placed to support the rapid growth of the industry through future allocation rounds and retain its role as the leading floating offshore wind market in the world. It is recognised that support for growth needs to deliver cost reduction and UK value. Industry is already collaborating to drive cost reduction whilst creating opportunities for floating wind to deliver value for the UK in the process[35]. An open and constructive dialogue between industry, Government and stakeholders about how this activity can be augmented by enabling action is critical to the successful and sustainable growth of the UK industry.

Enabling Action – the format and structure of the CfD mechanism should be developed iteratively to support the delivery of the short- and medium-term targets for floating offshore wind, recognising that strong consistent growth in the deployment rate is required, from now, to maximise cost reduction and opportunities for the UK supply chain, whilst ensuring the industry is able to grow sustainably to the scale required to deliver Net Zero.

31 FOW Development and Consenting Project, FOW CoE, 2021
32 **Offshore Wind Policy Statement**, Scottish Government, 2020
33 **Strategic Investment Assessment**, SOWEC, 2021
34 **FOW Cost Reduction Pathways Project**, FOW CoE, 2021
35 Cost Reduction Through Innovation Project, FOW CoE, 2021

PROJECTS

Intermediate scale projects (~100-300MW) delivered in the mid-2020s would offer an opportunity for the UK industry to ramp up in advance of large-scale projects (>500MW) being delivered towards the end of the 2020s. This "ramp up", as opposed to "step up", allows project developers and the supply chain to gain experience of serial manufacture, assembly and installation, in advance of the large-scale projects. This learning and experience would further de-risk the delivery of larger projects and help unlock investment in infrastructure and supply chain growth in the short term. However, the timing of these projects is critical both to their impact on supply chain and infrastructure development and the viability of the projects themselves. In addition, it is vital any such projects augment the development and delivery of large-scale projects later in the 2020s and do not inadvertently delay or hinder the delivery of such projects.

Enabling Action – opportunities to deliver "intermediate scale" projects should utilise processes which ensure these augment the timely delivery of large scale projects and recognise the value of these projects, in supporting the UK supply chain to develop through experience and innovation, is explicitly linked to the timing of their delivery, in advance of larger scale projects.

Project Type	Scale	Description	Role
Testing and demonstration	<100MW	Projects facilitate the testing and demonstration of (high Technology Readiness Level) major floating offshore wind innovations in a "real world" environment, prior to larger scale deployment.	Demonstrate commercial readiness of major new technologies.
Intermediate scale	100-300MW	Projects facilitate enhanced innovation through demonstration and optimisation of serial manufacturing, assembly, commissioning and installation activities, in addition to the testing and demonstration of select (high Technology Readiness Level) technology components. Projects unlock early supply chain and infrastructure investment and planning required to deliver future large scale projects.	Support the sustainable growth of supply chain and infrastructure capacity and capability. Further de-risk and reduce costs of delivery of large-scale projects.
Large scale	>500MW	Projects provide cost effective low carbon energy generation at utility scale.	Increase aggregate capacity of low carbon energy generation in the UK energy system.

PROGRESS AND ENABLING ACTIONS – DEVELOPMENT AND CONSENTING

With ongoing coordinated activity and engagement between industry, Government and key stakeholders, large scale floating offshore wind can be deployed later this decade based on an appropriate understanding of its environmental interactions and impacts[36]. There is a requirement for industry, stakeholders and academia to work together to identify, assess and address knowledge gaps relating to the environmental interaction of floating offshore wind and the marine environment. However, work is already ongoing in this area both at the project and industry level to assess the broader environmental interactions[37] and to ensure specific interactions, for example with the fishing industry, are understood and development managed in a way which mitigates impacts[38,39]. With work ongoing, floating offshore wind has an opportunity to rapidly develop a good understanding of environmental interactions, allowing industry and stakeholders to have greater confidence in associated assessments and expediting the consenting process.

The majority of barriers to deployment for floating offshore wind that have been identified are common to broader offshore wind. In the context of development and consenting, the two main barriers are the timescales associated with projects passing through the regulatory processes and the complexity / uncertainty associated with cumulative and in-combination impacts of projects - albeit the latter is anticipated to be a lesser concern for floating offshore wind projects, given their (potential) broader geographic distribution[40].

The scale of deployment of offshore wind to 2050, currently estimated to be almost 100GW, compared to 10GW today, requires a long term strategic spatial planning approach. This is key to supporting the development of offshore wind alongside other marine users. Where possible, identifying and facilitating opportunities for collaboration between industries and minimising the potential for unforeseen interactions. This strategic spatial planning approach is also key to longer term cost reduction for floating offshore wind. At a regional level, strategic development of floating offshore wind is key to ensuring regional infrastructure (including ports and offshore transmission networks) and supply chain capability is well utilised, minimising cost and risk for both supply chain and project developers.

Enabling Action – a long term spatial planning approach should be taken to support the development of fixed and floating wind around UK to 2050. Floating offshore wind represents an opportunity for industry, Government and other key stakeholders to collaborate in advance of large-scale project deployment to ensure the environmental interactions of floating wind are understood and incorporated into such a plan, supporting the timely and efficient development of the industry, in collaboration and alongside a range of other marine users.

36 FOW Development and Consenting Project, FOW CoE, 2021
37 Environmental Interaction Data and Research Project, FOW CoE, 2021
38 FOW and Fishing Project, FOW CoE, 2021
39 **Floating Offshore Wind Fishing Trials**, Equinor, 2021
40 FOW Development and Consenting Project, FOW CoE, 2021

PROGRESS AND ENABLING ACTIONS – TECHNOLOGY AND INNOVATION

Floating offshore wind is a fully commercial technology, with a proven track record of operating reliably and in line with design assumptions at the utility scale. Whilst a wide range of concepts exist, commercial development is focused on just a small number of main typologies – semi-submersible, barge, spar and tension leg platform (TLP). Across these four typologies, technology exists to deploy floating offshore wind across the globe, with specific typologies being more or less well suited to the metocean conditions, water depths and ground conditions which exist in different markets. Within each market, a subset of typologies is likely to prevail, based on these conditions but also local supply chain capability and capacity. The ability to manufacture floating offshore wind substructures in relative proximity to project location has a significant impact on the cost of floating offshore wind, something which substructure designers consider carefully in the design process.

FLOATING OFFSHORE WIND IS A FULLY COMMERCIAL TECHNOLOGY, WITH A PROVEN TRACK RECORD OF OPERATING RELIABLY AND IN LINE WITH DESIGN ASSUMPTIONS AT THE UTILITY SCALE.

Image: TetraSpar Demonstrator ApS.

Whilst the fundamental technology required to deploy floating offshore wind at the utility scale exists, there is a need, and significant opportunities, for innovation within the industry. Innovation shall be a key driver of medium- and long-term cost reduction. Without enhanced innovation, LCOE is estimated to be approximately 10% higher in 2030 and 20% higher in 2040 than it could have been with appropriate support. Innovation will also be key to maximising UK GVA from floating offshore wind, through higher UK content in UK projects and exports[41].

The industry is advanced in its understanding of the innovations required to reduce the cost of floating offshore wind and is tracking progress against these. The Offshore Wind Innovation Hub's technology road map for floating wind is well developed and maintained by an industry working group[42]. In addition, a range of collaborative industry programmes are supporting innovation in key areas. Examples include the Offshore Wind Innovation Hub, Offshore Wind Innovation Exchange, Floating Offshore Wind Centre of Excellence, BEIS Floating Wind Demonstration Programme and Carbon Trust FLOW JIP.

Of particular relevance to the UK are the opportunities for innovation in the following areas…

- Surveying and environmental data collection;
- Substructure design, manufacture and assembly;
- Mooring and anchoring systems;
- Dynamic cable systems;
- Transportation and installation;
- Operations and maintenance, including subsea inspection and monitoring.

Innovation will reduce costs directly through more efficient and optimised development, design, manufacture, installation and operation, and indirectly through risk reduction. Innovation in these areas also offers significant export opportunities for the UK supply chain[43].

Accelerating cost reduction through innovation requires a collaborative approach to technology development, qualification, testing and demonstration. Absolutely critical to this is access to representative technology testing and demonstration opportunities for the supply chain and project developers. The leading floating offshore wind markets in the world have a unique opportunity to facilitate such access, enhancing learning rates, driving innovation which in turn reduces costs and enhances GVA. The impact of such opportunities on the UK supply chain will be significant, with the difference between the UK taking a "market leader" or "market follower" approach to developing floating offshore wind, having the potential for UK content to fall from 65% to 22% as measured across the whole project lifecycle[44].

Enabling Action – a medium term programme to support technology innovation in UK floating wind should be established, with a specific focus on maximising the value of the early projects deployed in the UK (to 2030), through enhanced innovation, learning, cost and risk reduction.

41 **FOW Cost Reduction Pathways**, FOW CoE, 2021
42 **Offshore Wind Innovation Hub**, ORE Catapult, ongoing
43 FOW CoE Strategic Infrastructure and Supply Chain Development Project, 2021
44 **Macroeconomic Benefits of Floating Wind**, ORE Catapult, 2018

PROGRESS AND ENABLING ACTIONS – SUPPLY CHAIN AND INFRASTRUCTURE

Strategic infrastructure and supply chain capability is critical to the cost-effective deployment of floating offshore wind. To facilitate the efficient manufacture, marshalling, assembly, commissioning, installation and ongoing operation and maintenance, the industry needs appropriate infrastructure, particularly around major ports. The infrastructure and strategic supply chain investment required to achieve this is significant in scale (hundreds of millions per intervention), underpinned by medium / long term business cases (>20 years) and has a long lead time (5-10 years).

THE STRATEGIC INFRASTRUCTURE AND SUPPLY CHAIN INVESTMENT REQUIRED IS SIGNIFICANT IN SCALE (HUNDREDS OF MILLIONS PER INTERVENTION), UNDERPINNED BY MEDIUM / LONG TERM BUSINESS CASES (>20 YEARS) AND HAS A LONG LEAD TIME (5-10 YEARS).

The UK does not currently possess the infrastructure and strategic supply chain capability to deliver large scale floating offshore wind farms. However, it has a range of relevant infrastructure and supply chain organisations who are well placed to develop the required capacity and capability in advance of large-scale project delivery at the end of the 2020s. The strategic development of such capability will play a major role in the UK securing significant economic value from floating offshore wind. Without the relevant infrastructure, projects will be more expensive to deliver and / or will be delivered from outside the UK. The latter would both result in the direct loss of value of these activities to the UK and present a significant barrier to the broader supply chain in securing a share of related activity.

Within the UK, different regions have different opportunities and challenges associated with infrastructure and supply chain capability development. Industry is already well engaged with regional stakeholders and devolved Government's to support the development of relevant strategic supply chain capability and infrastructure, for example SOWEC's recent Strategic Investment Assessment[45] for Scotland. However, understanding future UK offshore wind deployment scenarios is important when considering what infrastructure and supply chain capability needs to be developed, where and when. Of particular relevance is the medium to long term aggregate installed capacity in the UK and the regional distribution of this. In addition, the visibility of this is critical in ensuring that private sector investment into such development is maximised.

45 **Strategic Investment Assessment**, SOWEC, 2021

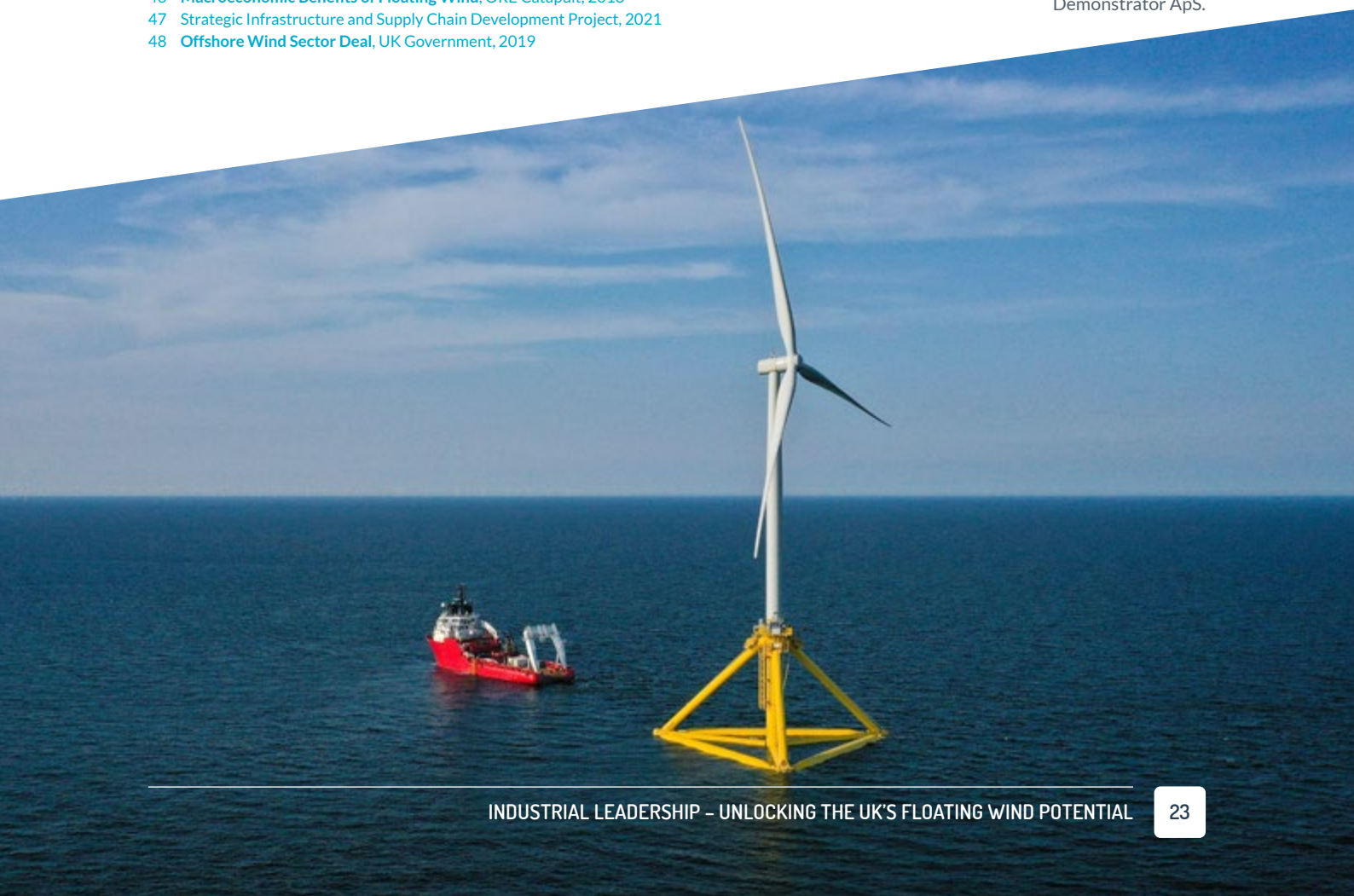
The UK has an opportunity to grow and attract strategic supply chain organisations to deliver substructure fabrication and assembly activities to the UK. Such capability would have a significant impact on the UK content of floating offshore wind projects – for example, increasing UK content in substructures from as low as 15% to more than 60% (CAPEX)[46]. Similar opportunities exist for mooring and anchoring system components, and electrical system components[47]. In the absence of appropriate strategic infrastructure and supply chain investment and associated capability development, it is not clear how projects will deliver UK content levels in line with the target of 60%[48].

Co-investment by Government in strategic infrastructure and supply chain capability will increase UK content in projects, support high-value green jobs and drive regional economic growth. For example, the recent £75m Government investment in the ABLE Marine Park infrastructure unlocked more than £260m in private investment in the co-located SeAH monopile manufacturing facility and £78m from GRI Renewable Industries investment in a co-located wind turbine tower factory. This co-investment model can be utilised in the early stages of the growth of the floating offshore wind industry to ensure the UK maximises the potential of floating offshore wind from the outset.

Enabling Action – a medium-term programme of strategic infrastructure and supply chain investment should be delivered. Investment should be linked to coordinated infrastructure development strategies for offshore wind, with a specific focus on floating offshore wind. Investment and associated development in Scotland should be scheduled to deliver capability and capacity in advance of the first large scale projects in Scotland from 2028 onwards. Investment and development in North East England and the Celtic Sea should be linked to the development pipelines in those regions.

46 **Macroeconomic Benefits of Floating Wind**, ORE Catapult, 2018
47 Strategic Infrastructure and Supply Chain Development Project, 2021
48 **Offshore Wind Sector Deal**, UK Government, 2019

Image: TetraSpar Demonstrator ApS.



SUMMARY AND ENABLING ACTIONS

Floating offshore wind offers the UK a significant opportunity to deliver a cost-effective Net Zero whilst driving regional economic growth over the next three decades and beyond. In the context of the COVID-19 pandemic, the energy transition and in recognition of the urgency of action required to address climate change, few industries offer the opportunity to deliver such positive long term economic, social and environmental impact as floating offshore wind does. Both through increased levels of UK content in UK projects and through the export of UK products and services to international markets.

Industry, Government and stakeholders are already working closely to support the growth of the floating offshore wind industry in the UK. This engagement can be the basis for effective, long-term collaboration between industry, Government and stakeholders, with the further development and co-delivery of enabling actions below as the basis for a new collaborative approach in offshore wind.

Strategic support from Government at this stage, will unlock significant industry investment in projects, infrastructure and supply chain, offering an excellent return on investment for the UK over the coming decades. In addition, it will support the global community to utilise floating offshore wind to reduce carbon emissions, supporting the UK's leadership role by delivering positive economic, social and environmental impact globally.

Image: Photo courtesy of Principle Power. Artist: DOCK90.

Area	Enabling Actions
Credible, Ambitious Targets	An increased target for floating wind deployment by 2030 should be established to reflect the potential for such deployment by 2030, and the UK's ambition to retain its role as a global leader. A 2040 target for floating offshore wind deployment in the UK should be established, informed by deployment scenario studies, to provide clear guidance to the supply chain, project developers and the broader international community as to the scale of the industry in the UK in the medium term.
Regional Development Strategy	A strategic approach to floating offshore wind development across the UK should be taken, establishing clear guidance on the scale and timing of floating offshore wind development in each relevant area of the UK. This needs to account for regional differences but take a UK-wide approach to the development of the industry as a whole.
Revenue Support Mechanism	The format and structure of the CfD mechanism should be developed iteratively to support the delivery of the short- and medium-term targets for floating offshore wind, recognising that strong consistent growth in the deployment rate is required, from now, to maximise cost reduction and opportunities for the UK supply chain, whilst ensuring the industry is able to grow sustainably to the scale required to deliver Net Zero.
Intermediate Scale Projects	Opportunities to deliver "intermediate scale" projects should utilise processes which ensure these augment the timely delivery of large scale projects and recognise the value of these projects, in supporting the UK supply chain to develop through experience and innovation, is explicitly linked to the timing of their delivery, in advance of larger scale projects.
Long Term Spatial Planning	A long term spatial planning approach should be taken to support the development of fixed and floating wind around UK to 2050. Floating offshore wind represents an opportunity for industry, Government and other key stakeholders to collaborate in advance of large-scale project deployment to ensure the environmental interactions of floating wind are understood and incorporated into such a plan, supporting the timely and efficient development of the industry, in collaboration and alongside a range of other marine users.
Technology Innovation Programme	A medium term programme to support technology innovation in UK floating wind should be established, with a specific focus on maximising the value of the early projects deployed in the UK (to 2030), through enhanced innovation, learning, cost and risk reduction.
Strategic Infrastructure and Supply Chain Development	A medium-term programme of strategic infrastructure and supply chain investment should be delivered. Investment should be linked to coordinated infrastructure development strategies for offshore wind, with a specific focus on floating offshore wind. Investment and associated development in Scotland should be scheduled to deliver capability and capacity in advance of the first large scale projects in Scotland from 2028 onwards. Investment and development in North East England and the Celtic Sea should be linked to the development pipelines in those regions.

Image: ABP Port Talbot Floating offshore wind development plan. Image courtesy of Associated British Ports.

ABP, PORT TALBOT

The Port of Port Talbot has the scale and capacity to deliver a major hub for Floating Offshore wind in the Celtic Sea. This is an opportunity to create transformational change - spinning out skilled jobs, triggering the growth of a new supply chain, and creating new export opportunities. Its strategic location on the south Wales coast, in close proximity to the Celtic Sea means there is nowhere in England and Wales better placed to capitalise on the opportunities floating offshore wind offers.

ABP has developed phased plans for the creation of new laydown space and new heavy lift quays specifically for the offshore wind industry, supporting substructure fabrication, WTG and foundation assembly, and export of commercial scale floating offshore wind technologies. The new heavy lift quays will offer deep water (up to a maximum of 21m) with tug berthing, whilst the sheltered harbour will provide ability to wet store structures before tow-out to site for final installation.

ABP has a significant track record in the development of offshore wind infrastructure in partnership with public and private investors, having invested £150m in the Green Port Hull facility and hosting O&M facilities in Grimsby, Lowestoft and Barrow.

The development of offshore wind infrastructure at Port Talbot along with developments in carbon capture utilisation and storage, zero carbon manufacturing, hydrogen production, alternative fuels and on-port renewable power generation, is part of a business wide initiative to strengthen ABP's ability to support the UK's net zero ambitions.

KEY REFERENCES

General

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- **Future Energy Scenarios**, National Grid ESO, 2021
- **Macroeconomic Benefits of Floating Offshore Wind**, ORE Catapult, 2018
- **North Sea Transition Deal**, UK Government, 2021
- **Offshore Wind Sector Deal**, UK Government, 2019
- **Offshore Wind Policy Statement**, Scottish Government, 2021
- **Offshore Wind Innovation Hub** Technology Roadmaps, ORE Catapult, ongoing

Floating Offshore Wind Centre of Excellence Project References

- PR1 – Floating Offshore Wind Development and Consent Risks and Opportunities
- PR2 – Floating Offshore Wind Standards, Classification and Certification Risks and Opportunities
- PR3 – Floating Offshore Wind Project Finance and Insurance
- PR5 – Dynamic Cables Systems – Technology Requirements and State of the Art Review
- PR6 – Mooring Systems – Technology Requirements and State of the Art Review
- PR7 – Floating Offshore Wind Cost Reduction Pathways
- PR8 – Floating Offshore Wind Energy System Benefits
- PR11 – Strategic Supply Chain Data and Development
- PR12 – Floating Offshore Wind International Market Overview
- PR19 – Floating Offshore Wind Strategic Infrastructure and Supply Chain Investment
- PR20 – Floating Offshore Wind H&S Roadmap
- PR24 – Floating Offshore Wind and Fishing Interaction Roadmap
- PR26 – Floating Offshore Wind O&M Model Review and Benchmarking
- PR27 – Dynamic Cabling Systems Technology Development and Qualification (Phase 1)
- PR28 – Mooring and Anchoring Systems Technology Development and Qualification (Phase 1)
- PR29 – Cost Reduction Through Technology Innovation
- PR30 – Reducing Project Delivery Risk
- PR31 – Floating Offshore Wind Environmental Interaction, Data and Research (Phase 1)
- PR32 – Floating Offshore Wind Spatial Planning and Deployment
- PR33 – Net Zero 2050 Vision for Floating Offshore Wind

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