

FLOATING OFFSHORE WIND
CENTRE OF EXCELLENCE

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Offshore Renewable Energy

FLOATING OFFSHORE WIND CENTRE OF EXCELLENCE

UK 2050 OFFSHORE WIND DEPLOYMENT SCENARIOS



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CONTENTS

1	Executive Summary	9
2	Introduction	13
2.1	Project background	13
2.2	ORE Catapult	14
2.3	Floating Offshore Centre of Excellence	14
2.4	Deployment Forecasts and National Targets	14
3	Model Overview	16
3.1	Deployment modelling approach	16
3.2	Scenario explanation	17
3.3	Cost inputs from FOW Cost Reduction Pathways Project	17
3.4	Technical Assumptions for Reference FOW Sites	18
3.5	GIS modelling	19
3.6	Regions within the model	21
3.7	Model Inputs	22
4	Future leasing rounds	25
5	Port Infrastructure Development	26
5.1	Model methodology	26
5.2	Model Inputs	26
5.3	Model Outputs	27
6	Grid Infrastructure Development	30
6.1	Grid Methodology	30
6.2	Grid Inputs	30
6.3	Grid Outputs	31
7	CfD Allocation rounds	32
7.1	CfD Methodology	32
7.2	CfD Inputs	32
7.3	CfD Outputs	33
8	Vessel Availability	34
8.1	Methodology	34
8.2	Vessel Availability Inputs	35
8.3	Outputs	35
9	Supply Chain Capability and Capacity	37
9.1	Model Methodology	37

9.2	Model Inputs	37
9.3	Model Outputs	38
10	Workforce.....	44
10.1	Methodology.....	44
10.2	Inputs.....	44
10.3	Outputs.....	45
11	Deployment Scenarios.....	46
11.1	Base Case Scenario.....	47
12	Key enabling actions and deployment scenarios.....	48
13	Conclusion	52

LIST OF FIGURES

Figure 1: Base case deployment profile (see Section 0 for full explanation of how this is derived)	10
Figure 2: Overview of Modelling Interactions.....	16
Figure 3: Modelled project pipeline	17
Figure 4: FOW Exclusion Map.....	20
Figure 5: Fixed-bottom Exclusion Map.....	20
Figure 6: 2030 FOW LCOE Map. Note this does not depict further expected cost reduction beyond 2030.....	21
Figure 7: Combined Existing Pipeline	22
Figure 8: Consenting Timeframes Identified in "Independent Report of the Offshore Wind Champion"	23
Figure 9: Costs of Required Upgrades	27
Figure 10: UK Port Capacity – Base Case Scenario	28
Figure 11: Scotland Port Capacity – Base Case Scenario.....	28
Figure 12: Celtic Sea Port Capacity – Base Case Scenario	29
Figure 13: Grid Infrastructure Development Costs - Base Case Scenario	31
Figure 14: Budget Impact Comparison.....	33
Figure 15: FOW CfD Budget Impact – Base Case Scenario	34
Figure 16: Total Vessel Days in Selected Periods - Base Case Scenario	36
Figure 17: Blade Demand by Scenario against Existing Supply Chain Capacity	39
Figure 18: Tower Demand Against Existing Capacity	40
Figure 19: Array Cable Demand Against Existing Capacity.....	42
Figure 20: HVDC Cable Demand Against Existing Capacity	43
Figure 21: Total FTEs by Scenario.....	45
Figure 22: Base Case Deployment Scenario	47
Figure 23: FOW Deployment by Region - Base Case Scenario	47

LIST OF TABLES

Table 1: Overview of Key Constraints	12
Table 2: Deployment Scenario Summary	13
Table 3: Average annual deployment	15
Table 4: Deployment Scenario Description	17
Table 5: FOW Site Technical Overview	18
Table 6: Exclusion Parameters	19
Table 7: Project attrition rates	23
Table 8: Consenting Time Frames Used for Modelling	24
Table 9: Leasing Round Design	25
Table 10: Port Capacities	27
Table 11: Port utilisation	27
Table 12: Base Case Scenario - Sensitivities	32
Table 13: CfD Reference Prices in AR6	32
Table 14: Budget Impact in Each Scenario	33
Table 15: Vessel Days per Windfarm Phase	35
Table 16: Peak Vessel Demand – Base Case Scenario	36
Table 17: Supply Chain Assumptions - Sensitivity 1	38
Table 18: Existing and Publicly Announced UK Supply Chain Capacity	38
Table 19: Factory utilisation rates	39
Table 20: Blade Factory Requirements & Utilisation Rates	40
Table 21: Tower Factory Requirements & Utilisation Rates	41
Table 22: Array Cable Factory Requirements & Utilisation Rates	42
Table 23: FTEs/GW	44
Table 24: Total FTEs by Scenario	45
Table 25: Occupations in Selected Years – Base Case Scenario	45
Table 26: Final OSW Deployment Figures by Scenario	46
Table 27: Key Enabling Actions by Deployment Scenario	51

NOMENCLATURE

AEP	Annual Energy Production
AI	Artificial Intelligence
ASTI	Accelerated Strategic Transmission Investments
CAPEX	Capital Expenditure
CMP	Constraint Management Plans
CoE	Centre of Excellence
CMP	Constraint Management Plans
CPI	Consumer Price Index
CRMF	Cost Reduction Monitoring Framework
CRP	Cost Reduction Pathways
CSV	Construction Support Vessel
CTV	Crew Transfer Vessel
DEA	Drag Embedded Anchors
DECEX	Decommissioning Expenditure
DEVEX	Development Expenditure
EIA	Environmental Impact Assessment
ESO	Electricity System Operator
FEED	Front End Engineering Design
FOW	Floating Offshore Wind
FY	Financial Year
HND	Holistic Network Design
HNDFUE	Holistic Network Design Follow-Up Exercise
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IRR	Internal Rate of Return

LCOE	Levelised Cost of Energy
LP	Locational Pricing
MCE	Major Component Exchange
O&G	Oil and Gas
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
OFTO	Offshore Electricity Transmission
OPEX	Operating Expenditure
ORE	Offshore Renewable Energy
OSS	Offshore Substation
RAS	Robotic and Autonomous Systems
REMA	Review of Electricity Market Arrangements
SIR	Sustainable Industry Award
SOV	Service Operation Vessel
TLP	Tension Leg Platform
TNUoS	Transmission Network Use of System
WACC	Weighted Average Cost of Capital

1 Executive Summary

On behalf of the Floating Offshore Wind Centre of Excellence (FOW CoE) and the Floating Offshore Wind Task Force, ORE Catapult has developed a set of future deployment scenarios for use and common reference across the offshore wind (OSW) industry. The project forms part of a larger piece of work titled “Development of UK FLOW Vision to 2050”, which aims to establish a shared vision for the future of floating offshore wind in the UK.

This report is a summary of the work conducted which delivers an assessment of the UK’s readiness to deploy FOW at the rate and scale necessary to meet future energy demands. By articulating key enabling actions required to facilitate this future deployment, the study addresses critical questions regarding the growth of OSW in the UK, and how to create an economically sustainable industry.

This study’s deployment scenarios will be utilised to outline the impact of key enablers and blockers. **The scenarios presented in this study are not intended to foresee the “most likely” future deployment profile. Instead, they seek to provide an evidence base for policymakers when making decisions which can influence OSW deployment.** Policymakers and regulators can leverage these scenarios to gain insight into the current state of OSW development, as well as evaluate the potential impact of policy and regulatory changes on the scale, location and timing of deployment.

There is still potential to deploy fixed-bottom wind, however, cheap available sites are limited and FOW is essential to reach net zero ambitions. Managing this will require a strategic view on marine spatial planning, incorporating the needs of other industries.

Findings from the study have outlined the criticality of the enablers and blockers considered. The model relies on existing project pipeline projections. This creates a challenge for the industry as there are set to be many projects coming online between now and the late 2030s, meaning, particularly in the lower ambition scenarios, there is a significant slowdown in deployment after this. To create a sustainable and investable industry, steady deployment is required rather than a large glut in the next 15 years, leading to overcapacity and underutilisation of key infrastructure.

Constraints are not all equal, and some will be more difficult to overcome. Physical constraints, such as port and grid infrastructure pose a major risk to deployment and must be built on time. However, developing and consenting for these infrastructure projects takes a long time, and therefore resolving these issues will not only have a large impact, but is also urgent. Other constraints, such as how future leasing rounds are run or the design of the Contracts for Difference (CfD) scheme, will have a significant impact on deployment, but are less urgent to resolve.

Figure 1 highlights the deployment profile for the Base Case Scenario only which is based on a requirement for 100GW of OSW by 2050. The scenario reaches this target by 2050, dependant on the wide range of interventions and conditions outlined in this report, with c67GW of fixed-bottom OSW and c32GW of FOW deployed. A “top-down” and “bottom-up” approach has been used to construct the forecast, whereby the existing OSW project pipeline forms the “bottom-up” approach. The “top-down” approach considers future leasing rounds and project development timelines to forecast OSW deployment beyond the existing pipeline. The combination of these two approaches results in a unified deployment forecast through to 2050.

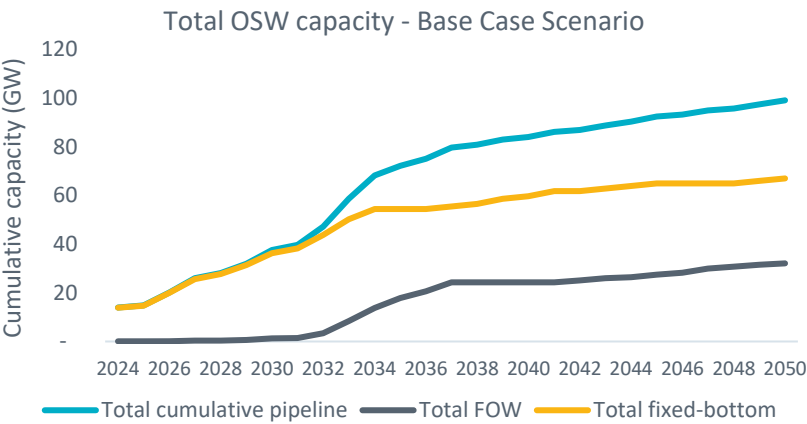


Figure 1: Base case deployment profile (see Section 0 for full explanation of how this is derived)

The following table highlights some key aspects of the blockers to deployment, their impact and the enabling actions required to facilitate the deployment scenarios outlined in this report.

Constraint	Detail	Impact	Urgency
Port Infrastructure	Port infrastructure will likely be the most significant constraining factor on any deployment scenario without considerable investment in the next 2-3 years to begin port upgrades. Greater coordination between ports is required to reach the higher ambition scenarios. Alongside the necessary investment, another key enabling action will be to continue focus on future port demand from OSW and other industries. Key stakeholders: UK Government, Devolved Governments, Ports, Vessel owner/operators, Vessel yards, Developers via FOW CoE	High	High
Grid	The existing transmission network design will increasingly constrain any deployment profile without major investment. With long project timelines, investment must be made urgently to ensure this is not a bottleneck on future deployment. The majority of this spend must be made in the early 2030s, particularly in Scotland to support the delivery of ScotWind. £7.1bn of grid investment will need to be secured and deployed by 2028 to enable the first 2GW of ScotWind projects. A key enabling action will be to streamline the consenting process for grid connections, particularly for more complex multi-link HVDC connections. Key stakeholders, UK Government, National Grid, Consenting authorities	High	High
Existing Project Pipeline	The existing deployment profile creates several challenges for the supply chain and ports, the key consideration being the overbuild of capacity required to deploy projects in the short to medium-term, followed by a subsequent drop in deployment in the following decades. To resolve this issue and create a smoother deployment profile, lease option extensions, in particular for ScotWind and Leasing Round 4 projects which will otherwise expire after 10 years should be considered. Allowing projects to be pushed further into the future.	High	Med
Future Leasing Rounds	The future growth of FOW is dependent on a steady rate of deployment to attract investment and provide certainty of opportunity to developers. This can be encouraged through a more staggered leasing process in future. In addition, future leasing rounds should be designed more objectively to help reach an agreed-upon target, too much or too little capacity will create the wrong signals for the supply chain, ports and other key areas. In the Low Ambition Scenario, this equates to 400MW leased in each Leasing round, 2.5GW in the Base Case Scenario, 3.5GW in the IGP Aligned Scenario, and 4.75GW in the High Ambition Scenario (assumptions for project timelines and existing project pipeline are explained in the report). Key stakeholders: UK Government, Devolved Governments, Leasing bodies	High	Med
Project Development and Consenting	Streamlining the process of obtaining consent for OSW development will be crucial if OSW is to play a pivotal role in the UK's decarbonisation and net zero efforts. To streamline or even maintain the current development timeline, significant investment is required to adequately staff consenting bodies, and modernise the process to reduce the total resource requirement per application. Action should also be taken to provide clear and consistent criteria for developers to follow when outlining the environmental impact of the project. Additionally, clearer criteria around compensatory measures is also needed. Key stakeholders: UK Government, Devolved Governments, DESNZ, Leasing bodies, Developers via FOW CoE	High	Med

Vessel Availability	Vessel availability will be a key constraint on deployment, particularly in the short term. The key enabling actions will be ensuring vessels are available for FOW deployment by identifying which vessels will likely have availability constraints, in addition to encouraging coordination between developers to ensure vessels are used efficiently. Key stakeholders: UK Government, Devolved Governments, Ports, Vessel owner/operators, Vessel yards, Developers via FOW CoE	Med	High
Supply Chain Capacity and Capability	The UK Government must determine the extent to which the UK wants to capture supply chain value. The tension is between faster and cheaper deployment, and creating value and jobs in the UK. The key enabling actions required to allow the UK to capture maximum value are ensuring the UK remains a competitive place to invest, providing a visible and consistent pipeline to attract investments, creating a stable regulatory and political environment, and continued investment in skills. UK supply chain constraints are unlikely to have significant impacts on deployment as components can be bought from overseas, providing there is adequate capacity in these supply chains. Key Stakeholders, UK Government, Devolved Governments, OEMs, Developers, DESNZ	Med	Med
Workforce	The OSW industry will require a ramp-up in the size of the workforce to facilitate varying levels of deployment. This is unlikely to cause significant delays on projects, as developers and operators can hire from other industries though potentially at higher cost. The key enabling actions include developing a new Workforce Strategy to plan for future workforce requirements and placing focus on attracting, recruiting and retaining skilled workers. Additionally, the industry should conduct a training skills analysis to understand where skills gaps currently exist, and then place focus on providing training to address those gaps. The easiest short-term “win” is in assisting North Sea oil and gas workers transfer their skills to the industry. Key stakeholders: UK Government, Devolved Governments, DoE, Developers	Low	Med
CfD	The CfD scheme is unlike other constraints, as it is designed to be a constraint and create competition in the market. From a purely practical view, other than value for money considerations, it is possible for government to award CfDs to all eligible projects.	Low	Low

Table 1: Overview of Key Constraints

2 INTRODUCTION

2.1 Project background

OSW has emerged as a remarkable success story in the UK as a means to generate low-carbon electricity. The UK has proven itself as a world leader in the development of the industry, by successfully delivering large-scale commercial projects while reducing consumer costs. Looking ahead, OSW is expected to play a vital role in the UK's decarbonisation and energy security ambitions. In 2022, the UK Government, in the British Energy Security Strategy, set an ambitious 2030 OSW target of 50GW which includes 5GW of FOW. Achieving these targets will contribute significantly to the UK's progress on delivering Net Zero by 2050, and maintain its position as a global leader in OSW deployment.

Central to achieving these targets and sustaining the growth of the OSW industry in the UK is an understanding of future OSW deployment. Currently, no common set of reference deployment scenarios exist, leading to divergent strategies and viewpoints among industry bodies. A clear outlook highlighting the trajectory of the industry would provide stakeholders with clarity in their strategic planning and benefit several industry bodies including key stakeholders, policymakers, project developers and operators, supply chain organisations and enabling infrastructure developers (grid, ports, etc.). Furthermore, a range of credible deployment scenarios would help bridge the gap between long-term policy ambitions and the short to medium-term regulatory and industrial development actions, and innovation programmes required to achieve them.

ORE Catapult, as part of the FOW Centre of Excellence (FOW CoE), has developed a set of deployment scenarios and the key enabling actions required to achieve them, for use and common reference across the OSW industry. These scenarios consider a set of identified enablers and blockers to deployment and clear assumptions which explain how each may hinder or enable OSW deployment. In the context of this project, a deployment scenario is defined as; a profile of future OSW deployment which could be facilitated in response to associated enabling actions.

This study's deployment scenarios will be utilised to outline the impact of varying deployment levels on key enablers and blockers. The scenarios presented in this study are not intended to foresee the "most likely" future deployment profile. Instead, they seek to provide an evidence base for policymakers when forming policies which can influence OSW deployment. In particular, policymakers and regulators can leverage these scenarios to gain insight into the current state of OSW development and deployment, as well as evaluate the potential impact of policy and regulatory changes on the scale, location and timing of deployment.

Four key 2050 deployment targets were defined; 75GW, 100GW, and 125GW, as well as Renewable UK's Industrial Growth Plan's (IGP) scenario of 115GW. Each target represents the cumulative capacity which might be achieved in the UK by 2050 depending on the level of action taken to facilitate deployment. These targets are listed in Table 2 and have been informed through previous deployment scenario publications and collaboration with key stakeholders.

Table 2: Deployment Scenario Summary

2050 Deployment Target (GW)	Scenario name
100	Base Case Scenario
75	Low Ambition Scenario
115	IGP Aligned Scenario
125	High Ambition Scenario

A model was constructed which aimed to highlight the available pathways to achieving each deployment target outlined above. To do this, the model considered several “enablers” and “blockers” to deployment and output the actions needed to overcome each one and facilitate the level of deployment required. These enablers and blockers included: the existing project pipeline; consenting timeframe; future leasing rounds; grid infrastructure development; port infrastructure development; supply chain capacity and capability; technology development, cost and risk; vessel availability; and workforce.

The findings from this study will deliver a set of enabling actions designed to allow the UK to meet its ambitious OSW deployment and Net Zero targets, within the context of creating a sustainable FOW industry. Many of these actions have been highlighted by other organisations and individuals, this study aims to collate these actions, update them where necessary, and apply them to FOW. Many will apply to fixed-bottom as well. By articulating the key enabling actions required to facilitate this future deployment, the study addresses critical questions regarding the potential growth of FOW in the UK.

2.2 ORE Catapult

ORE Catapult acts as an independent, centralised, forward-thinking organisation at the heart of the offshore renewable energy industry, working closely with partners across industry and academia to develop new ways of working and prove, de-risk and develop promising new technologies. This publicly available report has been compiled by ORE Catapult using internal modelling informed by related industry engagement, in conjunction with Geographic Information System (GIS) modelling expertise provided by Aquatera Ltd.

2.3 Floating Offshore Centre of Excellence

To boost the FOW industry, ORE Catapult has established the FOW CoE to develop an internationally recognised initiative to reduce the cost of energy of FOW. The FOW CoE will accelerate the build-out of floating sites, create opportunities for the supply chain, and drive innovations in manufacturing, installation and O&M. FOW CoE is seeking to ensure that FOW-specific risks and opportunities are considered in the short term, alongside the broader risks and opportunities for the OSW industry in the UK and more broadly. The FOW CoE is a collaborative programme between industry, academia and stakeholder partners.

2.4 Deployment Forecasts and National Targets

The UK Government has set ambitious targets for offshore wind, with 50GW to be deployed by 2030, with ambitions for 5GW of floating wind. With a disappointing Allocation Round 5 (AR5) auction resulting in no bids, and projects handing back Contracts for Difference (CfDs) awarded in earlier Allocation Rounds, these targets are at risk.

The language around these targets has softened since they were first announced, from “UK’s ambitious targets to increase offshore wind fivefold to 50GW by 2030” in December 2022 to “a world-leading ambition to deploy up to 50GW by 2030, with up to 5GW coming from floating offshore wind” in March 2023. With around 17GW expected to be deployed by the end of 2024, this leaves six years to add 33GW or 5.5GW per year. While there is sufficient capacity in the pipeline, the timeframe to move projects from consent to financial close and construction is very challenging. The

maximum capacity the UK has previously installed in a single year is 2.2GW (in 2022), so the run rate would need to double from the maximum achieved to date.

Short-term (2030) targets need to be viewed in the context of longer-term ambitions on Net Zero. The UK has a legally binding target to reach Net Zero by 2050 (and 2045 in Scotland). The earlier that clean power generation comes online, the greater the emissions reduction in the period to 2050, so from that perspective accelerating deployment is the ideal scenario. This would also accelerate energy independence and cement the UK's position as a market leader, boosting credibility and export opportunities.

However, the ideal deployment rate is different when looking at it from a supply chain and UK economically sustainable perspective. The UK offshore wind sector has suffered from a form of "boom and bust" in the last decade, with project awards (and as a result project spending) being volatile and regionally disparate. Keeping deployment rates consistent allows the supply chain to optimise investments in capacity and develop expertise to improve reliability and reduce costs. A range of 2050 scenarios have been presented in this report. If 50GW is achieved in 2030, then the average annual deployment rates are outlined in the table below. These will be slightly higher from ~2040 as decommissioned capacity needs to be replaced.

Table 3: Average annual deployment

Scenario	Average annual deployment 2031-2050 (MW)
75 GW	1,250
100 GW	2,500
115 GW	3,200
125 GW	3,750

To deploy rapidly in the short term would require either a large reduction in local content or an over-investment in supply chain capacity which would be under-utilised beyond 2030. If the aim is to maximise local content and UK economic benefit, then significant investment in supply chain and ports would be required immediately. This report concludes that there is insufficient port and grid capacity at present to deploy 5.5GW/year, and the timeframe from FID to works completed for port and grid upgrades is likely to push into the early 2030s. The challenge is even greater for floating wind, which requires early-stage demonstrators and intermediate-scale projects to achieve cost reduction for commercial deployment.

3 MODEL OVERVIEW

The following section provides details of the methodology used to create the framework and model for future deployment scenarios for OSW.

The biggest, and most important, assumption in this modelling exercise, which needs to be highlighted here, is the model decides to deploy fixed-bottom or FOW based purely on economic rationale; whichever technology is cheapest to deploy, in LCOE terms. This is a significant limitation in the modelling, however, it is also the only way in which a reasonably accurate and robust decision-making process can be modelled. The specifics of how this works will be explained later in this section. In reality, whether fixed-bottom wind or FOW are deployed will involve a compromise of economic and strategic rationale.

3.1 Deployment modelling approach

In discussions on how to approach the creation of the model for this project, two broad approaches were considered. One where enablers and blockers are separate from each other and interact by creating constraints on deployment. (E.g. if there is only 50GW of grid capacity, then deployment above this is removed from the model). In this approach modules of the model would interact sequentially, and replicate the process an OSW project moves through from leasing to commissioning. This was thought of as the “hard constraint” approach. A second approach, where modules do not prevent deployment was also investigated. This “soft constraints” approach means, for example, CfD module outputs are shown as “how big would the budget need to be to clear the deployment”, meaning no “pot size” is set but rather the deployment determines the pot size as outputs. A mixture of these two approaches has been chosen, where port marshalling capacity and CfDs act as hard constraints on deployment.

An overview of the model’s functionality and interaction with the other models is shown in Figure 2:

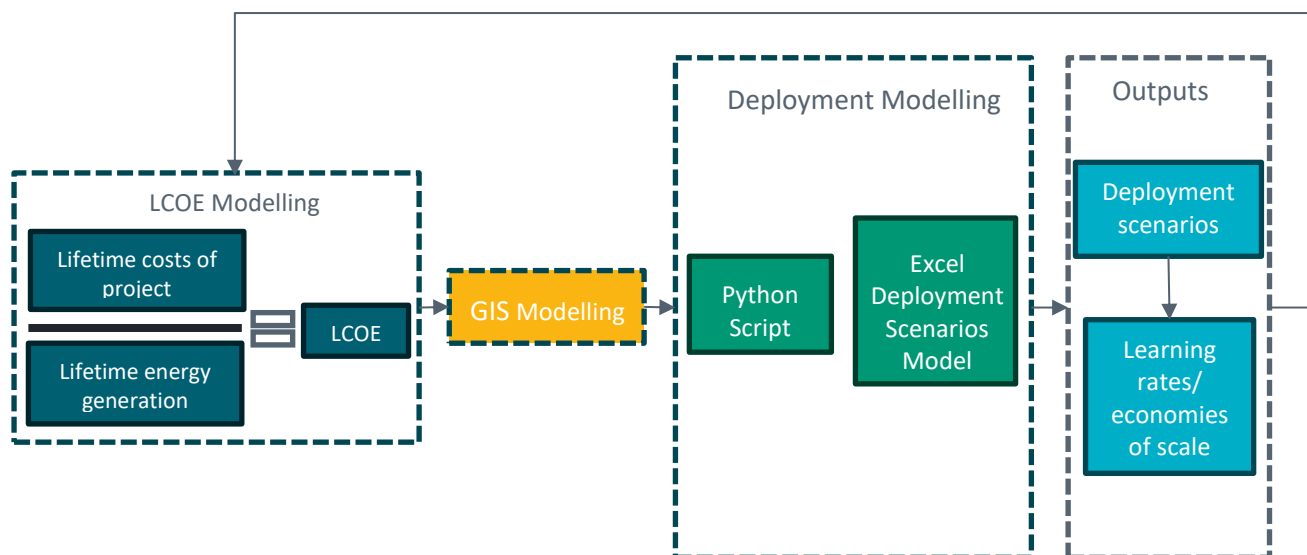


Figure 2: Overview of Modelling Interactions

This model consists of three components;

1. Cost modelling provided from the FOW Cost Reduction Pathways Project for FOW and ORE Catapults’ Cost Reduction Pathways (CRP) model for fixed-bottom,
2. A GIS model,

3. And the deployment scenario model.

The methodology utilised in this project comprises a “bottom-up” and “top-down” approach which work in combination (Figure 3). The “bottom-up” approach focuses on existing project data to determine the short- to medium-term deployment trajectory, The “top-down” approach, on the other hand, considers general trends and long-term ambitions to build a vision of medium- to long-term deployment. The output is a deployment scenario through to 2050 which incorporates both approaches and reaches one of the 2050 deployment targets (75,100,115,125GW) listed previously in Table 2.

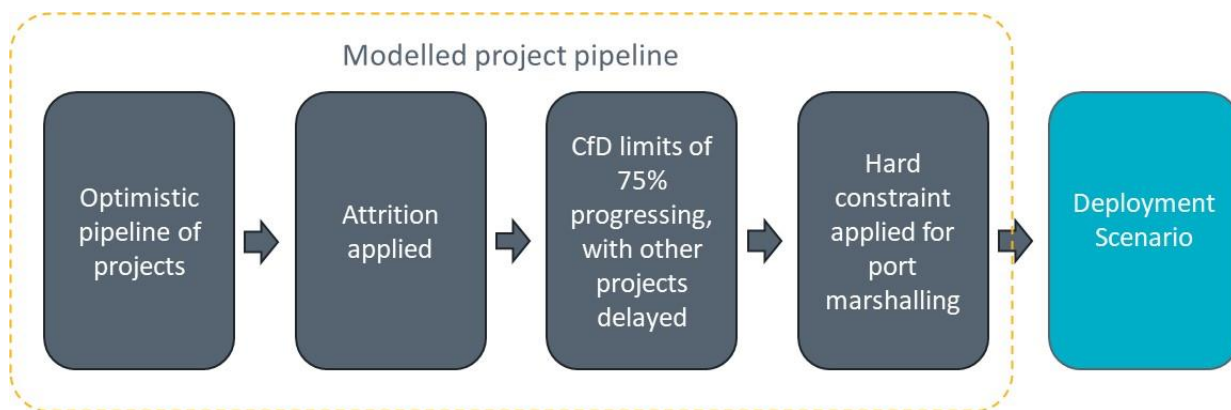


Figure 3: Modelled project pipeline

3.2 Scenario explanation

This study models four different scenarios representing differing levels of ambition and realisation of the UK's OSW and Net Zero targets. These scenarios are outlined in Table 4.

Table 4: Deployment Scenario Description

2050 Deployment Target (GW)	Scenario description
100	Base Case Scenario –Common target across industry found in multiple other studies.
75	Low Ambition Scenario – Will require minimal change from the status quo to facilitate this level of deployment.
115	IGP Aligned Scenario – Informed from IGP, a joint industry collaboration.
125	High Ambition Scenario – Illustrates the maximum ambition level that the industry can endure before the enabling actions, as identified in this study, transition to hard constraining factors and begin to impede deployment.

3.3 Cost inputs from FOW Cost Reduction Pathways Project

3.3.1 Cost Inputs

LCOE figures, provided from FOW Cost Reduction Pathways (CRP) Project, were utilised as inputs to the GIS modelling. To produce these LCOE inputs, the FOW CRP Project developed a FOW Cost Reduction Pathways (CRP) techno-economic model which relied on future deployment forecasts, industry consultation and learning rate analysis.

The model developed in the FOW CRP Project has two main components to it:

1. A cost model and;
2. A CRP model.

The cost model has the functionality to calculate the LCOE for defined projects at different points in time. The CRP model utilises a range of cost drivers to model variation in different cost factors over time, and develop a cost reduction “pathway”. This is linked to assumptions regarding cost factors which influence LCOE and are summarised as learning rates.

The methodology used to derive the assumptions used in the cost model consisted of a “bottom-up” and “top-down” approach. The “bottom-up” part relied on input from supply chain and industry to understand the costs on a component level for both reference sites. The “top-down” approach involved interaction with project developers to comment and feedback on these costs on a higher level.

Learning rates for FOW were formulated using identified cost drivers and deployment data from ORE Catapult’s in-house market intelligence. Cost reductions through learning are driven by deployment rates. The FOW CRP Project assumed a global deployment of 4GW would be reached before learning rates were applied which accounts for deployment across markets not delivering learnings immediately and to avoid modelling unrealistic cost reductions in the early days when doubling of capacity happens very quickly. The cost model differentiates between global and UK deployment and accordingly applies learning rates related to the UK in specific areas.

As part of the CRP FOW model, a cash flow model was developed which output LCOE in 2012. Fixed-bottom LCOE figures over time were informed from ORE Catapult’s existing fixed-bottom cost model. These LCOE figures were then utilised to inform the GIS modelling.

3.4 Technical Assumptions for Reference FOW Sites

The cost model considered two reference sites to use as a benchmark for establishing base case prices. These were: demonstration-scale projects of 100MW commissioned in 2025 (taking FID 2025-2029), and commercial-scale projects of 1GW commissioned in 2030 (taking FID 2030-2050). Two projects of different scales outline how costs are expected to change over time and reflect FOW development from emerging technology to commercial-scale deployment. **It's important to note that commissioning the 1GW wind farm in 2033 is relatively early for FOW technology, leading to higher costs compared to projects expected to reach this scale in the late 2030s to early 2040s.**

Table 5: FOW Site Technical Overview.

Site Parameters	Units	100MW	1GW
Year of FID	#	2025	2030
Commissioning Year	#	2028	2033
Project Lifetime	Years	25	25
Number of Turbines	#	9	56
Water Depth Average	m	100	100
Wave Conditions	Text	Harsh	Harsh
Seabed Conditions	Text	Sandy Gravel	Sandy Gravel
Turbine Rating	MW	12MW	18MW
Windfarm Capacity	MW	108	1008
Distance Between Turbines	Km	1.76	2.08
Hub Height	m	135.00	160.00

3.4.1 Technical Assumptions for Reference Fixed-Bottom Sites

The reference fixed-bottom projects were designed in parallel to the FOW project to ensure that many similarities between FOW projects and fixed-bottom projects were created, allowing for greater comparison of costs. The technical details for the two fixed-bottom sites are the same, however, a different base LCOE was defined to allow for a more accurate comparison between the 2025 FOW and fixed-bottom projects, and the 2030 and beyond projects. While the LCOE for FOW projects was assumed to continue to reduce, the LCOE for fixed-bottom was assumed to be held constant from 2030 to 2050, as fixed-bottom wind has hit the bottom of its cost curve. To derive these different LCOEs, the WACC was changed between the two fixed-bottom projects, as changes in LCOE are more likely to come from changes in capital costs than input costs.

3.5 GIS modelling

This study also utilised Geographic Information System (GIS) modelling to evaluate GIS-based techno-economic deployment drivers. The aim was to spatially represent the distribution of viable OSW development, both fixed-bottom and FOW and to show the variations in LCOE across the United Kingdom's Exclusive Economic Zone (EEZ). To achieve this, the work was broken down into three stages: constraint mapping, LCOE mapping and installed capacity calculations.

The mapping was conducted whereby the whole of the UK's EEZ was rasterised to a 100m x 100m grid cell. This approach allowed various sources of data of differing input types to be normalised for use in the model.

3.5.1 Constraint Mapping

The first task was to determine where OSW could and could not be developed in UK waters. This was achieved by considering the hard constraints outlined in Table 6 below. Hard constraints account for areas in which OSW could not be developed, resultantly these areas were eliminated. Each constraint was incorporated into the 100m x 100m grid system and combined, leaving only areas suitable for fixed-bottom or FOW development as viable areas. These are shown in Figure 5 & Figure 4.

Table 6: Exclusion Parameters

Factor	Parameter
Bathymetry	60m threshold between fixed-bottom and floating technologies
O&G infrastructure	Surface features plus a 2km buffer were excluded. Defined areas for CCUS not excluded as assumed there is potential for co-location with offshore wind.
Pipelines	Pipelines plus a 2km buffer were excluded
Cables	Cables plus a 2km buffer were excluded
Proximity to shore	Waters within 10.4 km of inhabited land, or 5.5 km of uninhabited land were deemed unsuitable
Existing offshore renewable sites	Areas with existing OSW site agreements were deemed unsuitable
ORE Catapult Exclusion Zone	Areas of seabed down the West and South Coast were excluded where development is known to be prohibited based on previous project experience
Annual average wind speed	Annual average wind speeds had to exceed 9m/s

Fixed-bottom potential

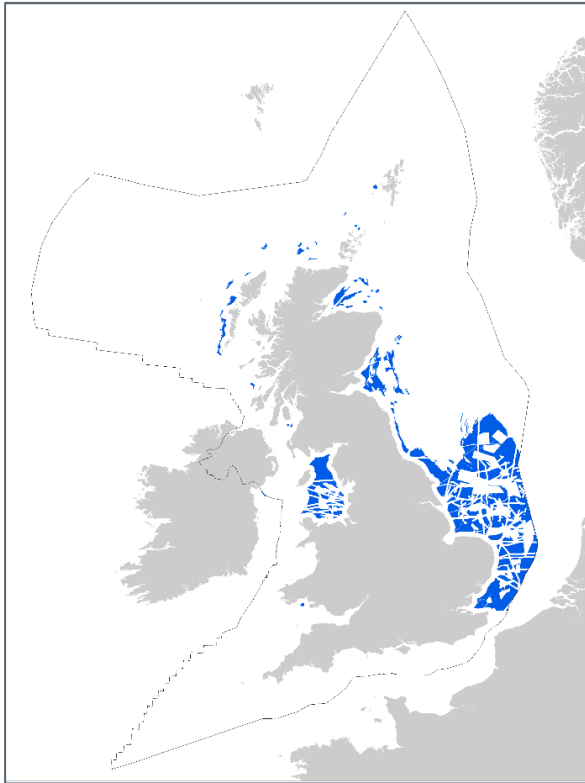


Figure 5: Fixed-bottom Exclusion Map

FOW potential

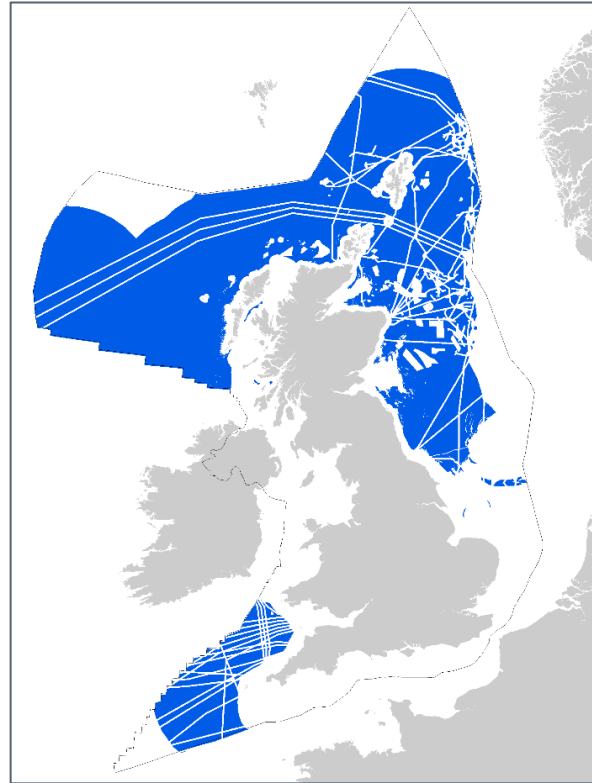


Figure 4: FOW Exclusion Map

3.5.2 LCOE Mapping

Secondly, each 100m x 100m cell identified as suitable for development was modelled to provide the LCOE for that cell. The LCOE was calculated separately for fixed and FOW for each year of interest in the study through to 2050 by considering several parameters that can affect the LCOE of OSW, including water depth, construction distance to port and wind speed.

UK waters were divided into regions (detailed in 4.7) and the total area of development potential in km² at LCOE intervals of £5/MW was calculated per year of interest and technology. By way of example, for one particular year, this is shown below as a map outlining these areas for **FOW only in 2030**. It should be noted that the image in Figure 6 presents LCOE in 2030, which does not depict the expected cost reduction for the later early GW scale floating projects. To convert these areas of development potential into a depiction of possible capacity, power density figures were formulated for both technologies and multiplied by the area in km² giving a total capacity in MW per LCOE band.

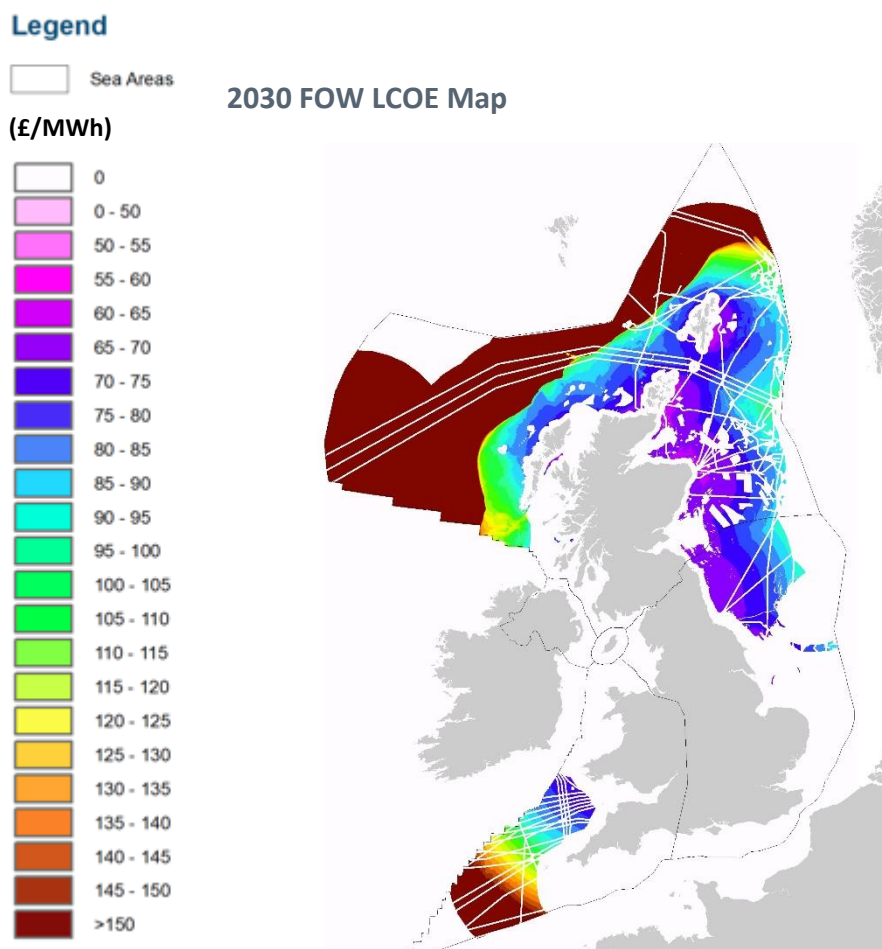


Figure 6: 2030 FOW LCOE Map. Note this does not depict further expected cost reduction beyond 2030.

The area in red in North Scotland depicts an LCOE of > £150/MWh. This is a result of very deep waters which makes it expensive to develop FOW in that area.

3.5.3 Python script

A Python script was developed to model fixed-bottom and FOW leasing rounds in the top-down approach. The script assumes that the projects with the lowest LCOE are installed first, rather than having leasing rounds for specific technologies. Geographical space in terms of MW (the GIS model outputs) and the required leasing round capacity are inputs defined by the user of the script.

The script iterates through LCOE ranges, through each year and each region. From the user inputs it identifies how many MW are available for fixed-bottom and FOW in each region in each LCOE band. Projects are split into 1GW sizes (the same as the reference sites) and the Python Script finds the cheapest technology to deploy with space available. Once space has been leased, it does not re-enter the calculation. Therefore cheap fixed-bottom space is used before the model awards leases to FOW.

3.6 Regions within the model

The model breaks the UK down into 3 broad regions: England, Scotland and the Celtic Sea. This breakdown was determined to be an appropriate level of detail to best highlight the differences in

FOW potential based on geographical factors. In addition, further division into smaller regions (regardless of which unit was used) would have overly complicated the model without providing an equivalent level of insight.

The regions chosen to model in the study align with the location of future leasing rounds. The model assumes that future leasing rounds are run on an individual basis whereby England, Scotland and the Celtic Sea have alternating scheduled rounds every x number of years (dependent on the scenario). The previous ScotWind and planned Celtic Sea FOW leasing rounds are examples of targeted auctions aimed at utilising the OSW potential in these areas. Northern Irish waters are included in the Scottish region for GIS mapping, however Northern Ireland's grid is regulated differently to Great Britain's and currently Northern Irish projects are ineligible to apply for a CfD. Therefore the report has not focused on Northern Ireland.

3.7 Model Inputs

3.7.1 Existing Project Pipeline

The model uses both a “bottom-up” approach and a “top-down” approach. The existing project pipeline makes up the bottom-up approach. The study utilised RenewableUK's EnergyPulse database to extract the existing project pipeline. This pipeline highlights all existing planned projects and we have applied an attrition rate for each deployment scenario. This creates the pipeline shown in Figure 7.

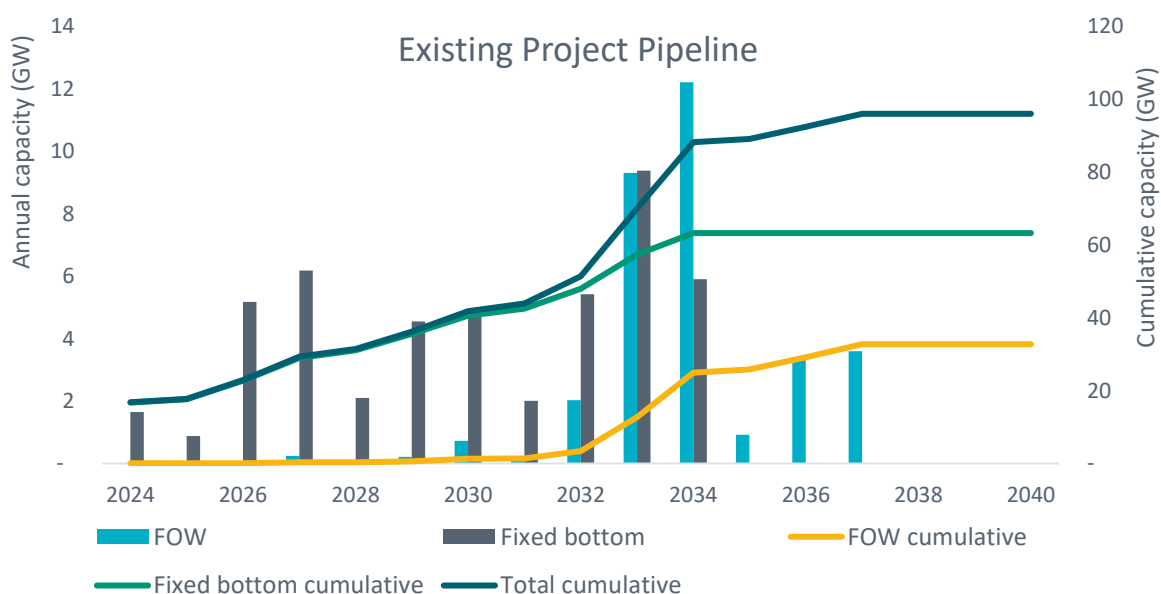


Figure 7: Combined Existing Pipeline

RenewableUK's project pipeline shows the UK reaching 96GW by 2040, consisting of 32GW of FOW and 63GW of fixed-bottom. As shown in the graph, all fixed-bottom projects will be online by 2034 and all FOW projects by 2037.

3.7.2 Project Attrition Rates

The attrition rates shown in Table 7 were applied to the existing pipeline forming the bottom-up part of the model and to the future leasing rounds which make up the top-down part. The rates were applied across all additional capacity added in a year instead of to specific projects.

Attrition rates were formulated for each scenario and these were applied only to projects due to be deployed after 2030. It was assumed that projects coming online prior to 2030 are in later stage development and therefore have a greater certainty associated with them.

Table 7: Project attrition rates

Scenario	Attrition Rate (%)
Base Case	30%
Low Ambition	50%
IGP Aligned	20%
High Ambition	20%

3.7.3 Consenting Timeframe

As detailed above, consenting timeframes are an important variable coming under scrutiny from the industry and government. In the model, consenting times determine how fast projects moved through the pipeline. In the Base Case Scenario, it was assumed the consenting timeframe was the same as the one outlined in the “Independent Report of the Offshore Wind Champion”, shown in Figure 8, and summarised in Table 8.

Figure 8: Consenting Timeframes Identified in "Independent Report of the Offshore Wind Champion"

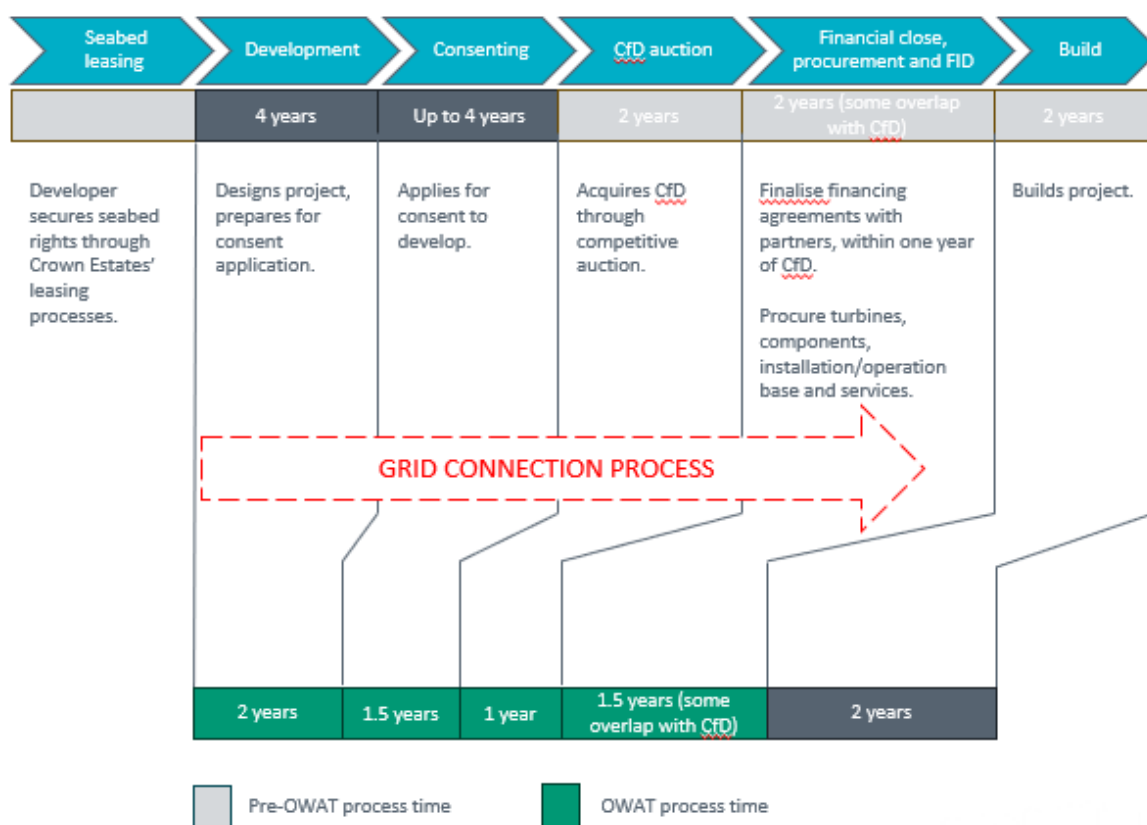


Table 8: Consenting Time Frames Used for Modelling

Consenting phasing (years)	Phase of project	Low Ambition scenario	Base Case scenario	IGP Aligned scenario	High Ambition scenario
Development	DEVEX	4	3	2	2
Consenting		4	3	1.5	1.5
CfD Auction		2	1.5	1	1
Financial close, procurement and FID		2	1.5	1.5	1.5
Build	CAPEX	2	2	2	2
Total project development time		14	11	8	8
Project life	OPEX	30	30	30	30

While the base case scenario is representative of the timeframe outlined by Tim Pick, the numbers have been changed to remove the overlap of phases, purely for simplifying modelling.

The Base Case Scenario is business as usual, but as explained above will still need some investment and careful planning from the Government and consenting bodies to ensure timelines do not slip further. The Low Ambition scenario assumes that timelines slip further due to the reasons outlined above. This scenario adds a further three years to the consenting and development stages. Both the IGP Aligned and High Ambition Scenarios assume the changes recommended by Tim Pick are implemented and therefore ORE Catapult uses this as the timeframe, speeding up the total development timeline by three years.

4 FUTURE LEASING ROUNDS

This module drives total deployment and forms the “top-down” portion of the model. Table 9 below outlines how often leasing rounds are run and how much space is awarded, space is measured as MW rather than area, as it is impossible to predict exactly how projects will be developed. Projects are considered “leased” when a lease is awarded.

At the leasing round, the model selects which foundation type to deploy. This process is explained in the Python Script section.

Table 9: Leasing Round Design

Leasing Round Design			
First top-down leasing rounds			2026
Leasing round frequency			
	First year of leasing	Frequency	Capacity
Base Case	Year	Years	MW
England	2026	6	4,500
Celtic Sea	2030	6	4,500
Scotland	2028	6	6,000
High Ambition	Year	Years	MW
England	2026	6	6,000
Celtic Sea	2030	6	6,000
Scotland	2028	6	7,500
Low Ambition	Year	Years	MW
England	2026	8	3,000
Celtic Sea	2032	8	3,000
Scotland	2028	8	3,000
IGP Aligned	Year	Years	MW
England	2026	6	4,500
Celtic Sea	2030	6	6,000
Scotland	2028	6	6,000

5 PORT INFRASTRUCTURE DEVELOPMENT

5.1 Model methodology

To model port infrastructure development, this project has leaned heavily on previous work carried out by the FOW CoE. This previous work identified the ports most suitable for deploying FOW, reviewed the current capacity of these ports, analysed how much potential capacity they could reach, and the costs of the required upgrades.

Capacity is defined by two key tasks:

- **Marshalling & assembly** – the storing of components within the port before load-out. The facility is defined as the location where the turbine and components are fitted to the foundation.
- **Fabricating** – A port able to assemble raw materials required and fabricate either steel or concrete sub-structures

This module does not distinguish between steel and concrete semi-submersible foundation fabricating ports, as substructure technology is not yet decided on an industry level. The assumption is therefore that steel and concrete substructures are equally viable, and comparable in cost, leading to greater fabricating capacity.

The costs associated with each of the port upgrades were identified through the use of a readiness metric. The levels of readiness are High, Medium and Low, ranging from minor works required at a High readiness port, to completely new quays constructed at a Low readiness port.

Port capacities for each region were created based on the ports within the region's capabilities and the timeline for upgrades. All upgrades are started in the first year of modelling (2024). These port capacities were compared to each deployment scenario's turbine requirements per year, working on the assumption that all turbines required for each project are output in one year. In reality, it is likely that turbine output activity, in some cases, would be spread over two years.

This approach does not consider demand from other industries such as fixed-bottom, O&G, etc. and in moving forward, a better understanding of the interaction between these demands is required to plan port usage. A "tow to port" strategy was assumed for O&M, therefore existing FOW capacity creates a reduction in port capacity as these turbines will take up space in ports. Tow to port was only assumed for major component exchange, and it was assumed one turbine being repaired represented one turbine that could not be deployed. Turbines were assumed to have a 3.5% failure rate per year, which encompassed all major components.

Lastly, port marshalling capacity limits deployment, by using this capacity as a limit, with projects above this limit being delayed into the next year. This process is completed until all projects are deployed. Therefore this does not apply any attrition, only project delays.

5.2 Model Inputs

The cost of port upgrades was taken from previous FOW CoE work. The ports considered were split by region and the average costs of upgrades per region were calculated.

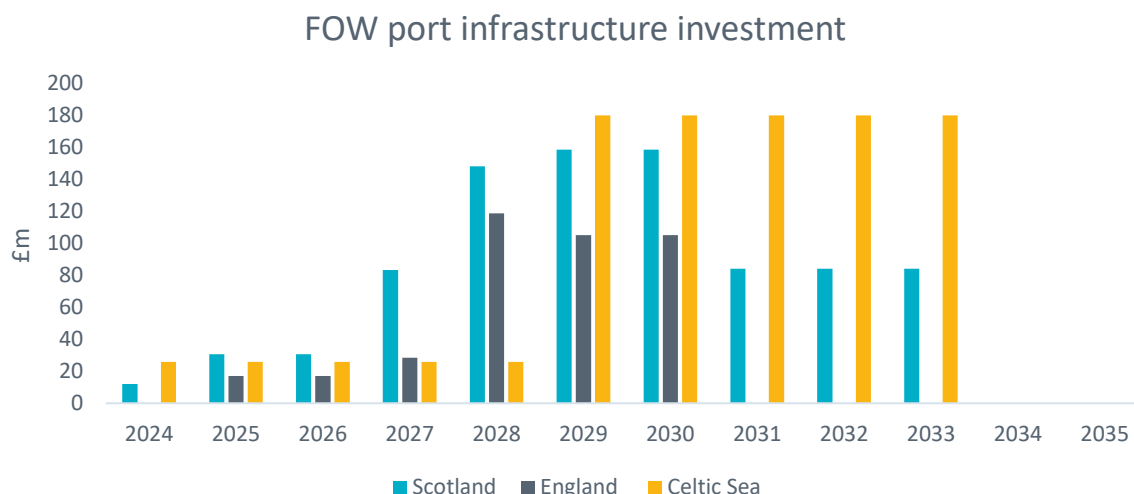


Figure 9: Costs of Required Upgrades

Given port capacities can be exceeded in one high year of deployment, without being reflective of the trend in the preceding and succeeding years, a view of the total capacity of the period in terms of turbine output has been created (Table 10). The figures in the table outline the total number of turbines output in terms of fabricating and marshalling & assembly in the period 2024-2050.

Region	Fabricating	Marshalling & Assembly
England	1,408	1,580
Scotland	1,889	4,436
Celtic Sea	1,125	1,830
Total	4,422	7,846

Table 10: Port Capacities

5.3 Model Outputs

The outputs from the module are based on the assumption that the aforementioned port upgrades have taken place. The charts show whether the necessary deployment can be accommodated within the regional ports. Discussion of the English ports has not been included, as in all scenarios there is very little FOW deployment in the region.

The port module highlights the challenge of creating a sustainable industry for FOW. To facilitate the deployment scenarios, an average annual addition of FOW capacity was calculated for each scenario (Table 11). If all ports are upgraded, there is significant overcapacity in the period modelled, although these upgrades are needed to deploy the projects already in the pipeline for the 2030s. Port capacity drops in the higher deployment scenarios, as there are more turbines requiring O&M in port.

Table 11: Port utilisation

Scenario	2050 cumulative OSW capacity (GW)	Of which is FOW (GW)	Average FOW capacity per year (GW)	Average port marshalling capacity per year (2024 – 2050) (GW)	Port marshalling utilisation
Base Case	100	32	1.24	6.18	20%
Low Ambition	75	20	0.75	6.40	12%
IGP Aligned	115	49	1.90	5.92	32%
High Ambition	125	54	2.08	5.83	36%

5.3.1 Base Case Scenario

In the Base Case Scenario, at a UK level, the capacity for fabricating FOW turbines is exceeded in the early 2030s (Figure 10). This glut of deployment through the early 2030s creates a critical issue seen by the significant lack of utilisation across UK ports after 2037. This results in an overall utilisation rate of 20% across UK ports in the period through to 2050, based on ports' marshalling capacity.

Using the assumptions for port upgrades in this report, there is little time before port upgrades must start across all regions. For Scotland, these must start by 2026 and in the Celtic Sea by 2025.

UK port capacity - Base Case Scenario

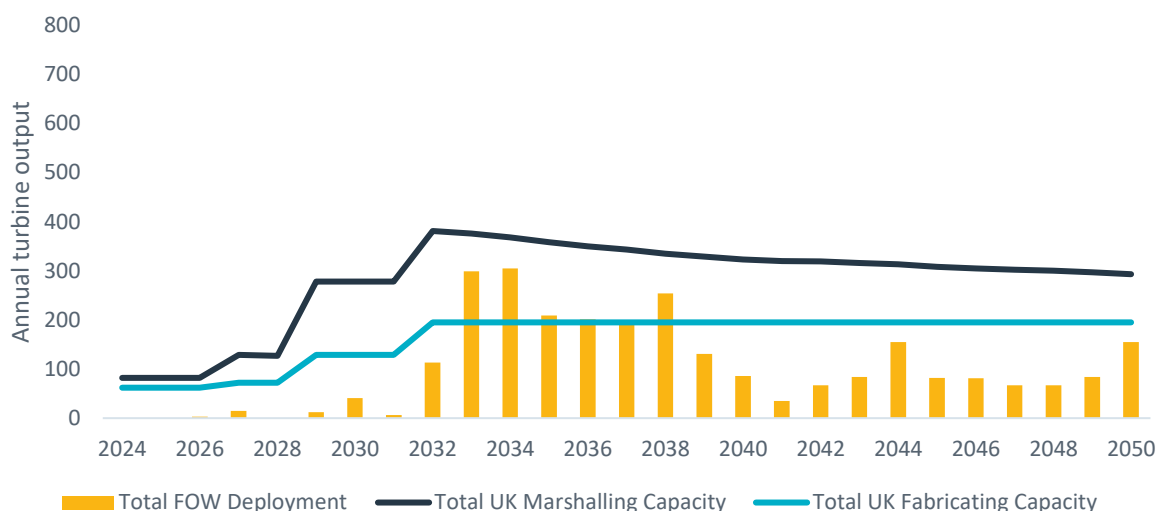


Figure 10: UK Port Capacity – Base Case Scenario

At specific regional levels, fabricating capacity is exceeded massively in the early 2030s in Scotland as ScotWind is built out. Beyond this point, due to minimal FOW deployment, ports are significantly underutilised reducing to no output between 2038-2044.

Scotland port capacity v turbine requirements - Base Case Scenario

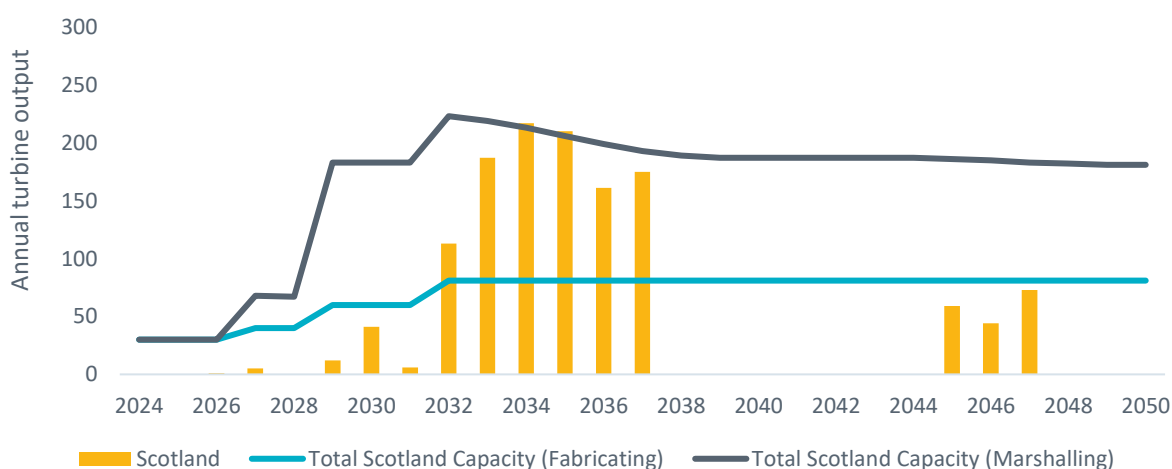


Figure 11: Scotland Port Capacity – Base Case Scenario

In the Celtic Sea, fabricating capacity is exceeded in the early 2030s, however, this is manageable given the low utilisation rate beyond this point.

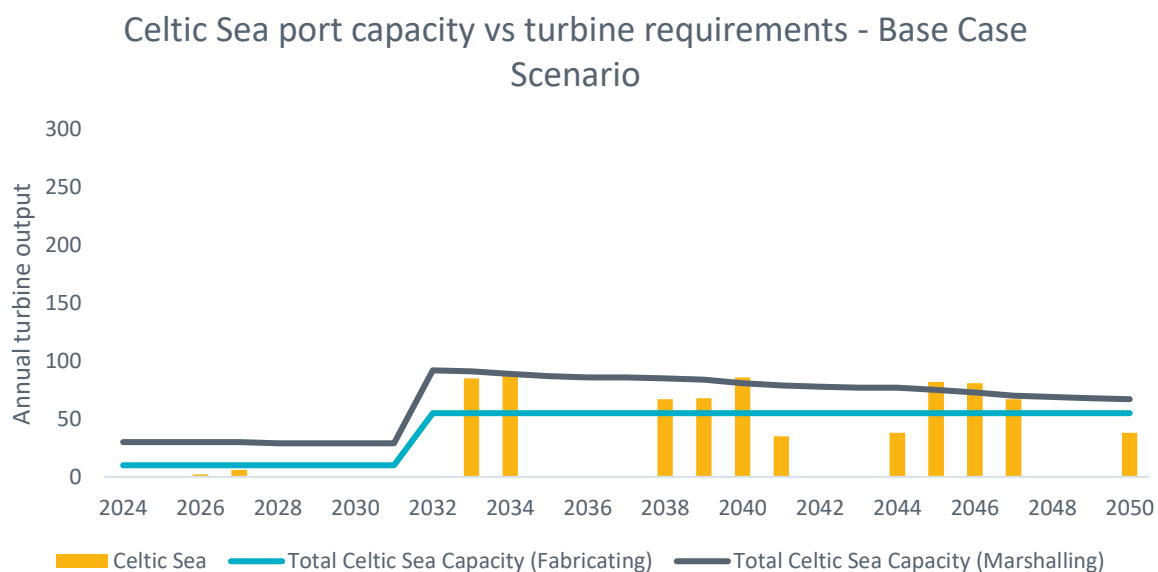


Figure 12: Celtic Sea Port Capacity – Base Case Scenario

6 GRID INFRASTRUCTURE DEVELOPMENT

6.1 Grid Methodology

To model grid infrastructure, an approach was taken to output the approximate costs required to develop and upgrade the grid to accommodate the different levels of deployment in each scenario.

The methodology utilised findings from the Holistic Network Design (HND) publication, to determine a cost of grid upgrade per GW of deployment. This figure was applied to annual deployment additions for each scenario to indicate the cost profile required over time to facilitate each level of deployment. A timing assumption was applied to the costs to account for the period of construction. It should be noted that this period only accounted for the construction process, and omitted time taken for planning and consenting of each new grid connection. It was assumed construction of the relevant grid upgrade would be completed one year before the relevant deployment.

In modelling grid infrastructure development, it was difficult to distinguish grid upgrade requirements between fixed-bottom and FOW, as many transmission connections added to the grid may serve both technologies. Therefore, the outputs account for both fixed-bottom and FOW connecting to the grid. The investment profiles created for each scenario assume grid upgrades commence in 2024.

6.2 Grid Inputs

The HND outlines the necessary grid improvements and financial commitment needed to facilitate 50GW of OSW in the UK by 2030. The report proposes a coordinated design which incorporates the offshore transmission network, the onshore work required to facilitate each connection, and the network needed to transport the electricity around the UK.

The OSW capacity already deployed in the UK, in addition to projects in a late stage of development considered out of scope in the HND as they already have secured grid connections, account for 27GW of capacity. To reach the desired 50GW by 2030, the HND considers the remaining 23GW of capacity made up of 18 existing planned projects.

The HND proposes a figure of £32bn to accommodate the recommended offshore network design. This figure is based on high-level assumptions and could change in future with a more detailed study. Significant investment in the onshore transmission network is also required to facilitate this level of OSW, with the HND outlining a spend of £21.7bn across 94 reinforcement projects. These projects range from minor upgrades to substantial infrastructure developments aimed at transporting electricity from where it is produced to areas of greater demand.

Using a total investment figure of £53.7bn, a cost per GW of OSW deployed was calculated at £2.33bn/GW. This figure was applied to each deployment scenario to work out the required costs for grid development through to 2050. A timing assumption of 3 years to construct each new energy transmission was applied, which was informed by industry sources¹²

The grid development costs were split by region – England, Scotland and the Celtic Sea. Although the exact figures for connecting each project and grid zone are beyond the scope of this study, it was

¹ National Infrastructure Commission, “Delivering net zero, climate resilience and growth”, 2023

² Electricity Networks Commissioner and Energy Systems Catapult, “Companion report findings and recommendations”, 2023

important to split the approximate costs by region, as it allows for a more detailed view of where the required investment is likely to be spent.

In addition, two sensitivities were carried out, one at £2bn/GW and one at £3bn/GW. These sensitivities were included as the exact requirements of future grid development are unclear and will depend on more accurate information relating to future leasing sites/development areas and the potential capacity built in these regions.

6.3 Grid Outputs

Outputs highlight the levels of grid investment required to facilitate different levels of deployment and ensure available grid infrastructure does not constrain it. The variations in cost between regions account for the different frequency and size of leasing rounds in each scenario. The total level of investment from 2024-2050 between scenarios ranges from a minimum of £111bn to deploy 75GW by 2050 to £228bn to deploy 125GW by 2050.

Scotland requires the majority of the overall investment in each scenario. This is to facilitate the buildout of ScotWind and create multiple offshore links from Scotland to the South of England.

Beyond 100GW in the IGP Aligned Scenario and the High Ambition Scenario, the spread of investment evens out to include greater spending in England and the Celtic Sea. This is due to a streamlined project development timeline of 8 years, compared to 11 years in the Base Case Scenario and 14 years in the Low Ambition Scenario, in addition to a greater level of capacity being leased in each round.

6.3.1 Base Case Scenario

A total investment of £170bn is required through to 2050 to facilitate 100GW of OSW. £73bn of this will be spent between 2024-2030, with the remaining £97bn between 2030-2050. The majority of spend will be invested over the coming decade in Scotland's grid infrastructure at a cost of £91bn. This will facilitate the buildout of ScotWind, where a coordinated network design will enable the efficient transfer of electricity from these sites to high-demand areas. £52bn will be invested in upgrading England's grid, and £27bn in the Celtic Sea.

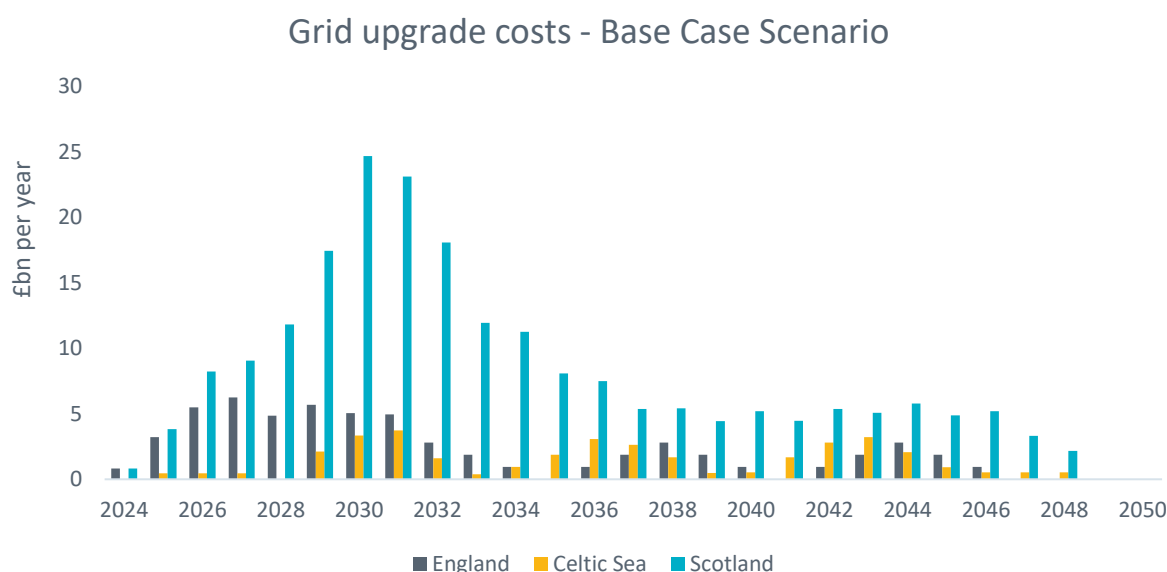


Figure 13: Grid Infrastructure Development Costs - Base Case Scenario

The following sensitivities were run to account for uncertainty in the cost of upgrading the grid (Table 12).

Base Case Scenario - Sensitivities

Base Case Scenario	Cost of grid upgrade (bn/GW)	Total cost of upgrade (bn)
Sensitivity 1	2	146
Sensitivity 2	3	219

Table 12: Base Case Scenario - Sensitivities

7 CFD ALLOCATION ROUNDS

7.1 CfD Methodology

This modelling exercise has taken the approach of estimating the cost of each CfD given the expected LCOE and reference price of energy. In the model, the allocation rounds are run annually for all scenarios. The specific timeline between the lease award, CfD award, and commissioning is outlined in the Consenting Timeframe subchapter.

The model uses a simplified version of CfD budget impact calculation. The calculation can be shown as:

$$\text{Budget impact} = (\text{strike price} - \text{reference price}) \times \text{load factor} \times \text{Capacity} \times (\text{days} \times \text{hours})$$

Equation 1: CfD Budget Impact

The full calculation and definition of the parameters is available on the DESNZ website.³ It includes multipliers for renewable technologies, transmission losses, and delivery year multipliers. These are typically set to 1 or close to 1.

The budget impact cannot be shown as a negative number, which would occur when the strike price is lower than the reference price. In these instances, the budget impact for the project is returned as 0. In practice, a new revenue mechanism may be created to deal with scenarios such as these, for example, if the price of electricity is no longer linked to gas prices and the majority of electricity comes from renewable technologies, there may have to be reform of how the CfD functions.

The model runs CfDs auctions annually with a limit of 75% of capacity being awarded a CfD. Capacity not awarded a CfD is delayed until the next year. As with port marshalling, CfD capacity creates attrition.

7.2 CfD Inputs

The key external input for CfDs in this model is the reference prices. AR6 parameters were released at the start of March 2024. The reference prices set out in this announcement are shown in Table 13.

Table 13: CfD Reference Prices in AR6

Reference Prices					
Year	26/27	27/28	28/29	29/30	30/31
Reference price (2012 prices)	49.92	37.74	30.22	25.81	24.13

This study makes no comment on whether these reference prices are appropriate or not, other than to say they are lower than industry expectations. Given these prices do not extend as far as the

³ [Allocation Framework for the second Allocation Round.pdf \(publishing.service.gov.uk\)](#)

forecast period, the model uses the reference prices listed in DESNZ's Energy and emissions projection 2021 – 2040, and has kept the 2040 price constant to 2050. These prices were then converted to 2012 prices for the CfD calculation.

The Load Factor for the CfD calculation has also been set using the AR6 parameters. This reduced from 63% to 61% in AR6. This is currently higher than capacity factors seen across the UK's currently installed capacity, which for the last 12 months has been 42.2%.⁴ As before, this is not a comment on whether the capacity factor used in AR6 is correct or not, but to highlight it may change significantly and therefore change the outputs of this model.

7.3 CfD Outputs

The outputs from the model show large variations in CfD budget impact from the four scenarios, which is expected given the differences in scale of FOW deployment (Table 14).

Table 14: Budget Impact in Each Scenario

Scenario	Total budget impact (£bn)
Base Case Scenario	6.6
Low Ambition Scenario	5.1
IGP Aligned Scenario	7.6
High Ambition Scenario	8.3

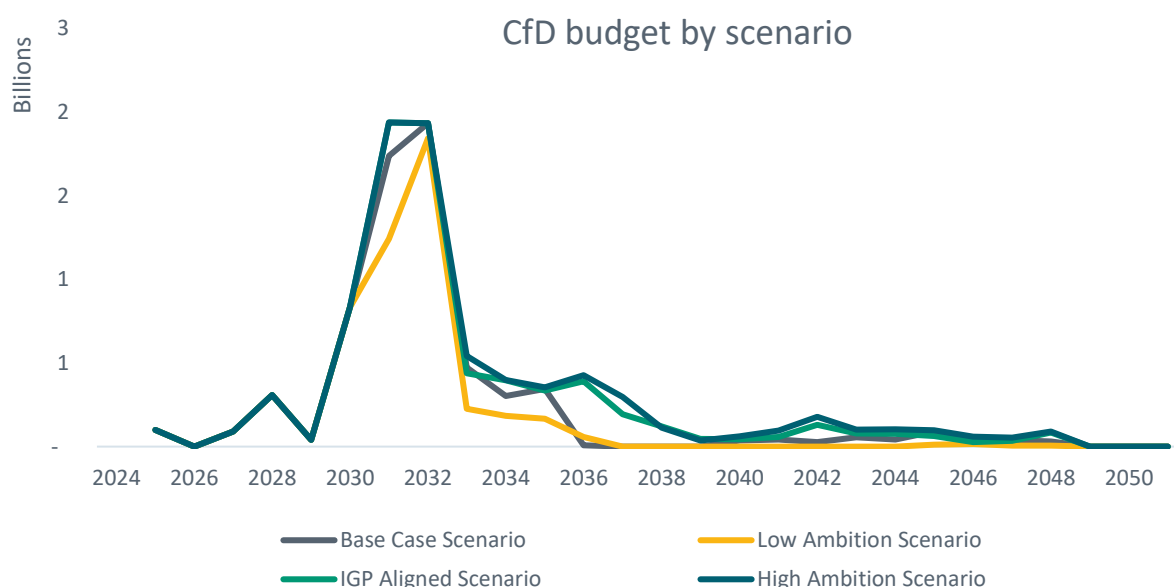


Figure 14: Budget Impact Comparison

The intention of these figures is not to predict outcomes or pot sizes required to clear the capacities in the model but to show the relative difference between the scales of deployment and government support required in the CfD auctions. The model shows no budget impact for the IGP Aligned Scenario and the High Ambition Scenario in 2024, as the time between CfD award and commission is reduced in these scenarios, and therefore projects that will in reality bid into AR6 do not. This is not reflective of the likely short-term outcomes in AR6 (Figure 14).

⁴ [UK offshore wind capacity factors – Energy Numbers](#)

7.3.1 Base Case Scenario

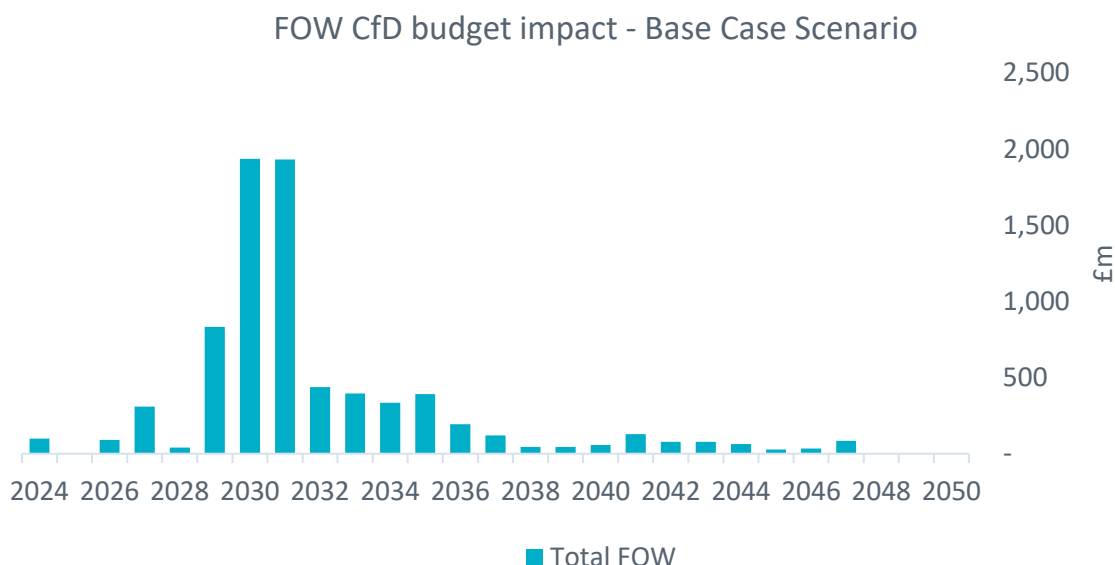


Figure 15: FOW CfD Budget Impact – Base Case Scenario

In the Base Case Scenario, there is a significant increase in the budget impact towards the end of this decade. In 2031, with the budget parameters in this report, a budget of £2bn is needed to clear the capacity. This is the first large-scale FOW project from the future leasing rounds to reach CfD award. The impact is significantly higher due to the scale of deployment (5.4GW) and the relatively high average LCOE (£137/MWh), as cost reductions have not been made by this timeframe (this is linked to work from FOW CRP Project) of the early large projects. For the rest of the modelled period, the LCOEs of projects drop significantly and therefore budget impacts for FOW return to levels seen in the last part of this decade, though still high by today's standards.

8 VESSEL AVAILABILITY

8.1 Methodology

Vessel availability has been modelled using work previously carried out by the FOW CoE. In this work, estimates were created for the time taken for each task of installing a FOW turbine by vessel type. Vessels were split into categories and subcategories within these.

All tasks are grouped by project phase; pre-construction, construction, and O&M. Decommissioning has not been modelled, as the methodology for decommissioning a FOW windfarm is unclear at this point, and the project lifespan for FOW means nearly all projects will not be decommissioned until after the modelled period ends. Tasks are estimated as days per turbine, and these estimates were multiplied by the deployment scenarios.

Metocean data was downloaded for three representative sites, one in each region, to understand what portion of time vessels could operate in. Operational limits for each vessel were taken from previous work completed by the FOW CoE.

Significant uncertainties exist in estimating the time involved for each vessel and or task. As FOW is a novel technology and commercial scale best-practice for tasks has not been established, processes

will be optimised over time. Additionally, new technologies or better designs of substructures will speed up deployment in the future. This is impossible to take into account in this module. Additionally, the same task may take longer due to site characteristics (bathymetry, sea bed characteristics, etc.), ocean conditions, and distance from shore. This model has had to use estimates of averages, which inevitably will mean total vessel days for some sites are over-estimated and others are under-estimated. The bias in the model impacts leasing rounds in different ways.

8.2 Vessel Availability Inputs

The total vessel days for each windfarm phase are:

Table 15: Vessel Days per Windfarm Phase

Vessel Category	Vessel Type	Pre-construction	Construction	O&M	Total
Survey Vessel	Survey Vessel	6.5	6.5	0.5	13.5
Transport Vessels	Semi-submersible Carrier/Barge	0	3.5	0	3.5
	Heavy Lift Cargo Vessel	0	9.5	0	9.5
	Open Deck Carrier (ODC)	0	6	0	6
	Coaster Vessel	0	6	0	6
Cable Lay Vessels	CLV	0	7	0	7
Offshore Construction Vessels (OCV)	OCV with < 200-ton crane capacity	2	6.5	2	10.5
	OCV with 200 - 400 ton crane capacity	0	7.5	0	7.5
	OCV with > 400-ton crane capacity	0	3.5	0	3.5
Anchor Handling Vessels	AHTS with bollard pull capacity <200 ton	0	12	1	13
	AHTS with bollard pull capacity >200 ton	0	10.5	2	12.5
Towing Vessels	Tug	0	4.5	1	5.5
O&M Vessels	SOV	2	3.5	8	13.5
	CTV (from mother SOV)	0	0	2.5	2.5

8.3 Outputs

This section shows the total modelled vessel days. Vessel demand profiles typically fit two patterns.

First, survey vessels, transport vessels, CLVs, and large OCVs see spikes in demand and then falls, this is because their tasks are performed once in each wind farm's life, or are only needed in one phase of the wind farm life cycle. They are only required in the pre-construction and construction phases. Survey vessels have a small demand placed on them in the operational phase, but not enough to change the demand profile.

Second, small OCVs, AHVs, tugs, and O&M vessels see demand rise throughout the period modelled. This is because they are needed in the operational phase of the wind farm and therefore demand is cumulative as new deployment continuously comes online.

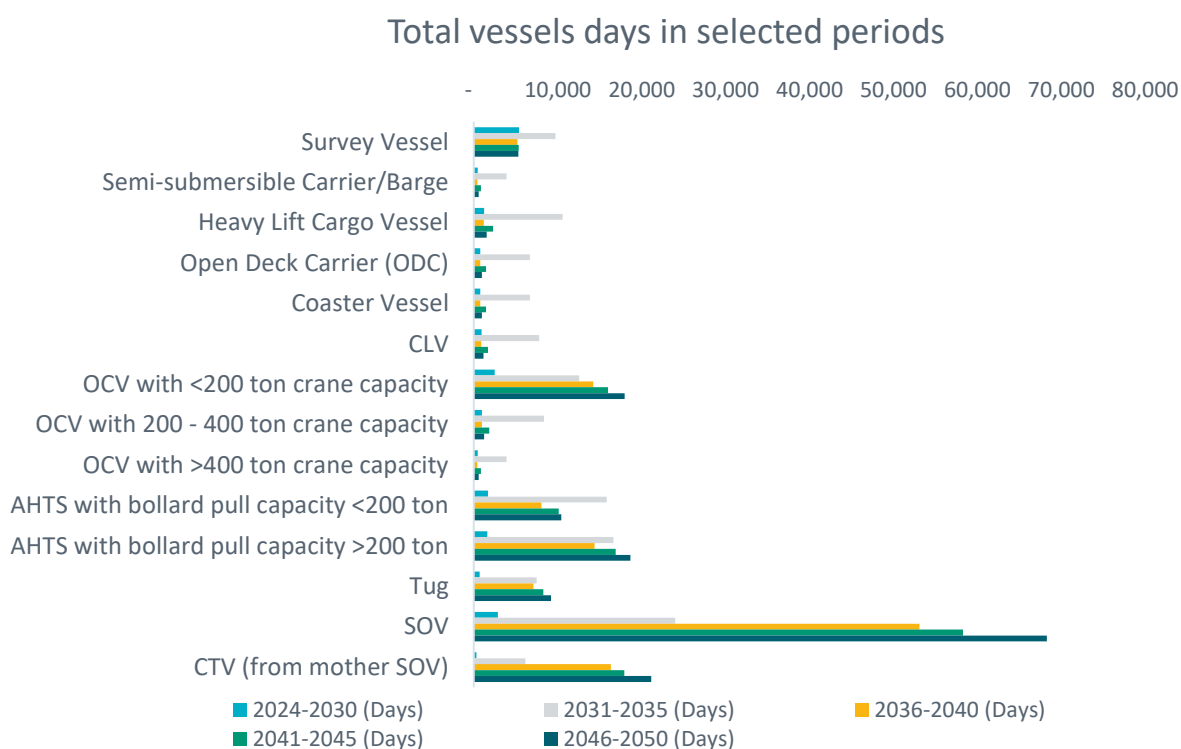
Creating a sustainable industry for vessel operators within the UK requires having consistent demand for all vessels types. With the uneven distribution of deployment in the modelled deployment scenarios this is challenging, particularly in the lower ambition scenarios.

8.3.1 Base Case Scenario

Table 16: Peak Vessel Demand – Base Case Scenario

Vessel Type	Peak vessel demand (no. of vessels)
Survey Vessel	10
Semi-submersible Carrier/Barge	5
Heavy Lift Cargo Vessel	12
Open Deck Carrier (ODC)	7
Coaster Vessel	7
CLV	9
OCV with <200 ton crane capacity	14
OCV with 200 - 400 ton crane capacity	8
OCV with >400 ton crane capacity	4
AHTS with bollard pull capacity <200 ton	15
AHTS with bollard pull capacity >200 ton	17
Tug	13
SOV	56
CTV (from mother SOV)	26

Figure 16: Total Vessel Days in Selected Periods - Base Case Scenario



In the Base Case Scenario, the total vessel days required increase for most vessels over the period shown in Figure 16, in some cases significantly. For vessels only required during the construction phase there is a high demand placed on them between 2031-2035, but significantly less throughout the other periods.

9 SUPPLY CHAIN CAPABILITY AND CAPACITY

9.1 Model Methodology

The supply chain module looks at the demand profile of high-value fixed-bottom and FOW components based on different levels of deployment in each scenario. The model then calculates the supply chain capacity and investment required if all components are to be manufactured in the UK. This approach assumes that any manufacturing facility can cater for both fixed-bottom and FOW. In addition, any existing or planned UK supply chain capacity was included in the analysis, and therefore any future required factories are on top of existing capacity.

The list of components considered includes turbines, blades, nacelles, towers, array cables and export cables. This is a high-level list of components, based primarily on commonality across fixed and floating wind and therefore excludes for example moorings and anchoring systems. Export cable analysis was split by high voltage direct current (HVDC) and high voltage alternating current (HVAC). This is to reflect varying supply chain capabilities and the split between technologies as wind farms are deployed further from shore. Substructures were not considered in this module as they are covered in the port infrastructure development module.

The annual expected production output and required investment for each type of component factory was estimated from industry research, and these figures were utilised to determine the potential output of factories and cost of building one. A sensitivity was applied to the production capability of factories and the investment of each to reflect the potential for larger factories with greater production capability in future years.

9.2 Model Inputs

9.2.1 Technical Assumptions

FOW technical assumptions were informed by input from the FOW CRP Project, in addition to previous project work. An assumption was made to keep the turbine size, and subsequent technical inputs constant, with 18MW turbines used throughout the deployment pipeline. In reality, in addition to 18MW turbines, 15MW turbines are likely to be widely used in the UK too. The use of smaller turbines would result in higher demand across some components in the supply chain. Fixed-bottom technical assumptions were informed from ORE Catapult's in-house cost model. The split between HVAC and HVDC export cables was formulated from 4C's Offshore Wind Farm Database.

The assumptions used to reflect the most likely level of investment and the factory output capacity under current conditions are shown in Table 17.

Table 17: Supply Chain Assumptions - Sensitivity 1

Component	Unit	Annual factory output (per 1 factory)	Required investment per factory (£m)
Blades	#	300	150 – 200
Nacelles	#	250	300 – 400
Towers	#	135	100 - 150
Array cables	km	500	250 – 300
HVDC export cables	km	250	300 – 350
HVAC export cables	km	250	300 - 350

9.2.2 Existing Capacity

The study considered any existing and publicly planned UK supply chain capacity which has or will have the capability to cater for 18MW turbines. Existing capacity was informed through industry research and previous project work.

The UK has two existing blade manufacturing facilities in the Isle of Wight and Hull. One of these facilities has been recently upgraded to cater for next-generation turbines. This module therefore assumes that the UK has one existing facility capable of manufacturing 300 blades per year for 18MW turbines.

Currently, the UK lacks any tower or nacelle manufacturing capability but has extensive experience in manufacturing and exporting array cables. An existing facility has undergone investment to enable the manufacture of both static and dynamic array cables to cater for both fixed-bottom and FOW. This facility has been used in the analysis.

An existing facility is currently undergoing a significant upgrade which will allow for the manufacture of HVAC cable. The upgrade is assumed to be completed in 2024. In 2023, plans for two new facilities were announced which will both have the capability to manufacture HVDC export cables. These facilities are assumed to be operational from 2026.

In addition to the demand for offshore wind export cables, the study also considered the impact of demand from upgrading grid infrastructure in the UK. The HND informed on the estimated number and length of both HVAC and HVDC cables which will be required to upgrade the grid.

Existing facilities and associated production capabilities are shown in Table 18.

Factory	Number	Production capability per year
Blade factory	1	300 blades
Nacelle factory	0	0
Tower factory	0	0
Array cable factory	1	500km
HVDC export cable factory	2	500km
HVAC export cable factory	2	500km

Table 18: Existing and Publicly Announced UK Supply Chain Capacity

9.3 Model Outputs

Table 19 shows the total utilisation of each factory type across the entire deployment scenario timeline. The High Ambition Scenario results in the highest utilisation rate on average across all factory types when compared to the other scenarios. The Low Ambition Scenario sees some high utilisation rates as a result of the existing array cable manufacturing capability for instance. In

addition, the Low Ambition Scenario shows a tower manufacturing factory being utilised 96% of the time which is unrealistic. In reality, an additional factory would be required to meet demand. This is the case for some factories across other scenarios too.

Table 19: Factory utilisation rates

Factory Capability	Base Case	Low Ambition	IGP Aligned	High Ambition
Blade factory	89%	65%	72%	79%
Nacelle factory	71%	52%	87%	95%
Tower factory	66%	96%	80%	88%
Array cable factory	59%	85%	72%	79%
HVDC cable factory	62%	44%	81%	89%
HVAC cable factory	30%	21%	39%	42%

9.3.1 Blades

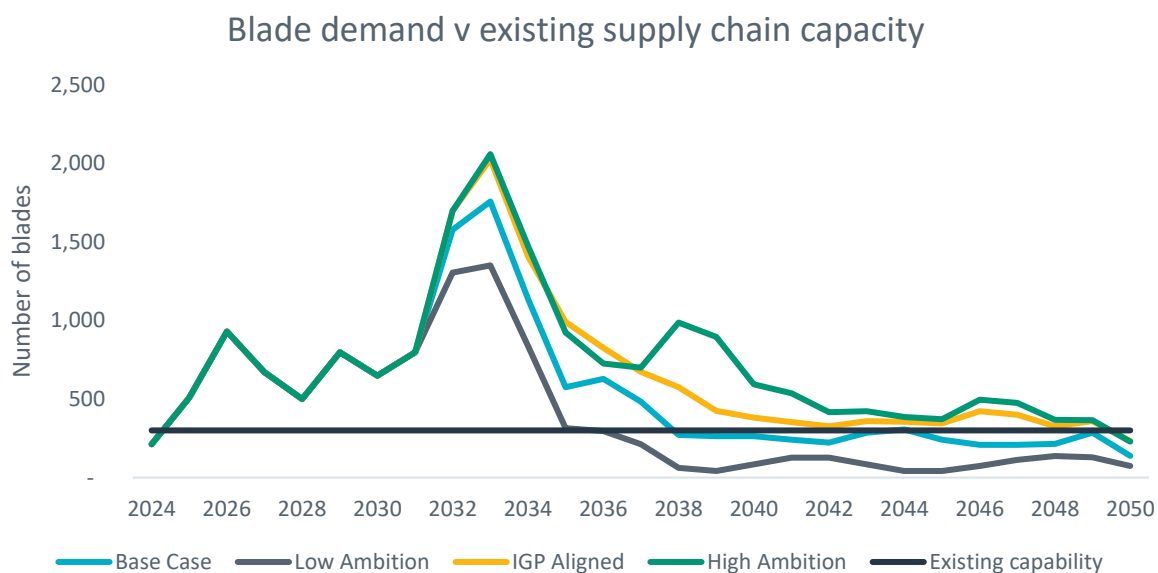


Figure 17: Blade Demand by Scenario against Existing Supply Chain Capacity

The capacity of the existing blade manufacturing facility producing 300 blades per year is not sufficient to meet the total number of blades required through to 2050 in any scenario. At least one further facility is required in each scenario, as shown in Table 20.

The Base Case Scenarios requires an additional facility costing between £150-200m, which, once completed, the facilities will be utilised 89% of the time.

On an annual basis, blade demand peaks in the early 2030s, largely due to the buildout of ScotWind. Even with the additional facilities in operation, careful production management is required during this period to ensure manufacturing constraints do not halt deployment.

Scenario	No. of blade factories required (on top of existing capacity)	Investment required (£m)	Total no. of blade factories	Total factories' utilisation rate
Base Case	1	150 – 200	2	89%
Low Ambition	1	150 – 200	2	65%
IGP Aligned	2	350 – 400	3	72%
High Ambition	2	350 - 400	3	79%

Table 20: Blade Factory Requirements & Utilisation Rates

9.3.2 Nacelles

The UK lacks any nacelle manufacturing capability. The analysis has outlined the potential for a UK nacelle manufacturing facility based on the future demand profile. However, despite high utilisation rates, in accordance with findings from the Industrial Growth Plan (IGP), the study recognises that nacelles will likely be sourced internationally, rather than domestically manufactured.

9.3.3 Towers

The UK has no existing tower manufacturing capability. The number of towers required to facilitate each deployment profile is shown in Figure 18. A minimum of two facilities are required to meet demand in the Base Case Scenario costing between £250-300m. The model has shown only one facility required in the Low Ambition Scenario, however, it is unrealistic to assume a facility can operate 96% of the time. Therefore, two facilities would be required, resulting in much lower utilisation rates.

While developers currently import towers from outside the UK, the high cost of transporting and assembling them creates an opportunity to develop tower manufacturing capability in the UK. The UK has existing experience in steel production which can be further developed. As recognised in the IGP, a tower manufacturing facility would stimulate economic growth and create jobs.

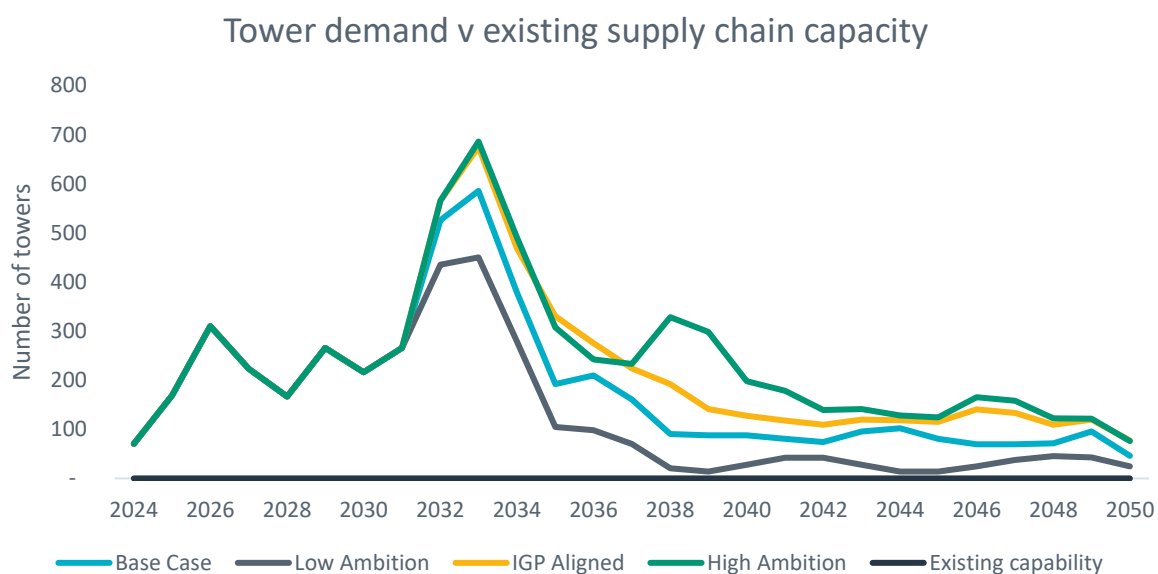


Figure 18: Tower Demand Against Existing Capacity

Scenario	No. of tower factories required (on top of existing capacity)	Investment required (£m)	Total no. of tower factories	Total factories' utilisation rate
Base Case	2	250 – 300	2	66%
Low Ambition	1	100 – 150	1	96%
IGP Aligned	2	250 – 300	2	80%
High Ambition	2	250 – 300	2	88%

Table 21: Tower Factory Requirements & Utilisation Rates

9.3.4 Array cables

The UK has existing expertise in the manufacture of array cables. The analysis has accounted for this with the inclusion of the existing factory which can manufacture both static and dynamic cables for fixed and floating technologies.

The existing factory is sufficient to meet array cable demand in the Low Ambition Scenario, although this results in a high utilisation rate of 85% and the annual output capacity being exceeded in multiple years in the early 2030s. In addition, the analysis has not considered export opportunities. Based on these factors, there could be scope for another factory to help meet demand.

The Base Case, IGP Aligned and High Ambition Scenarios all require an additional manufacturing facility to meet demand. This results in a required investment of £250-300m and utilisation rates of 59%, 72% and 79% respectively, making the case for the High Ambition Scenario.

On an annual basis, demand peaks through the 2030s with the buildout of ScotWind. Factories will require careful production management to deliver the components on time and ensure constraints do not lead to project delays.

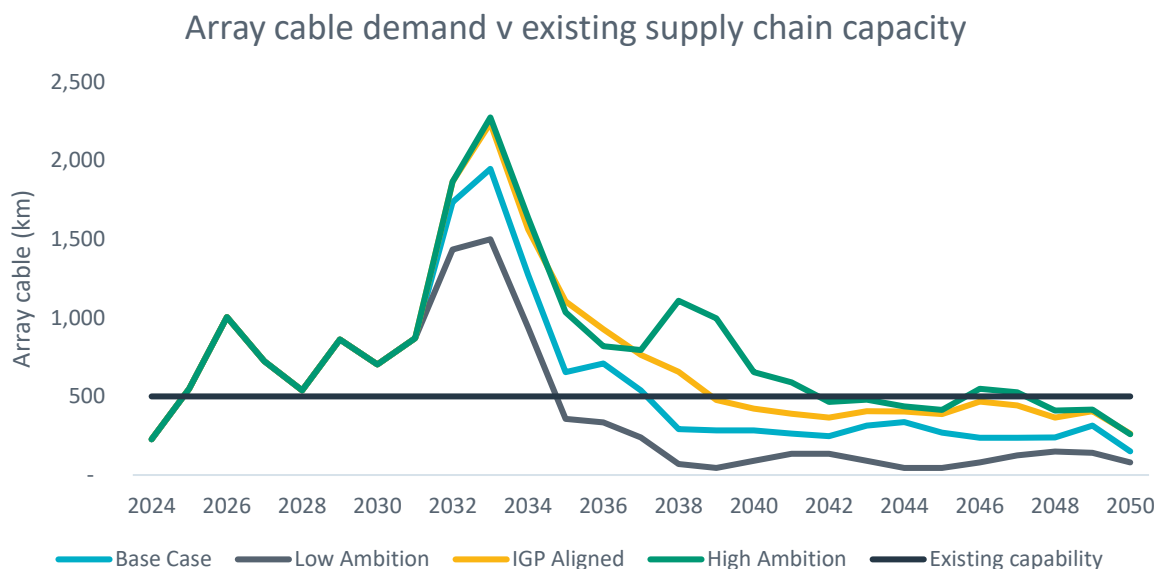


Figure 19: Array Cable Demand Against Existing Capacity

Scenario	No. of array cable factories required (on top of existing capacity)	Investment required (£m)	Total no. of array cable factories	Total factories' utilisation rate
Base Case	1	250 – 300	2	59%
Low Ambition	0	0	1	85%
IGP Aligned	1	250 – 300	2	72%
High Ambition	1	250 – 300	2	79%

Table 22: Array Cable Factory Requirements & Utilisation Rates

9.3.5 Export cables

The existing planned facilities operational from 2026 will be sufficient to meet the demand for HVDC cables across all scenarios. Based on the demand profile shown in Figure 20, both facilities will be utilised 62% of the time in the Base Case Scenario. Prior to 2026, export cable for Dogger Bank A, the UK's first offshore wind farm to be fitted with HVDC technology, was produced in Sweden.

For HVAC cable, the existing capacity in addition to the publicly announced facility (operational from 2026), will more than meet the future demand profile through to 2050, resulting in a maximum utilisation rate in the High Ambition Scenario of 42%.

This analysis highlights demand for cables which connect radially to the closest point on shore for each individual wind farm. In reality, as informed by the HND, the upgraded network will consist of a combination of onshore and offshore radial and coordinated connections which will significantly increase cable demand, particularly for HVDC cable required for longer subsea routes.

Analysis conducted on data from the HND estimates that 107km of additional HVDC cable and 103km of HVAC cable are required per GW of OSW added to the grid. The additional cable length accounts for coordinated connections and connections created to futureproof the grid for coming years.

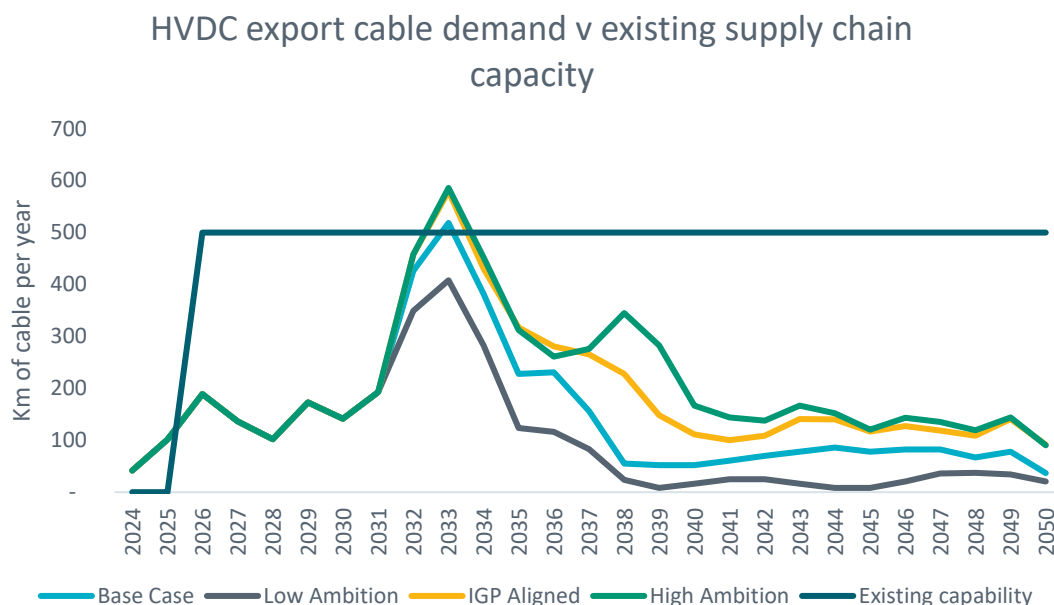


Figure 20: HVDC Cable Demand Against Existing Capacity

Upgrading the grid will significantly increase utilisation rates and could place strain on existing cable manufacturing facilities. With careful production management, the capacity of the existing and publicly planned HVAC facilities should be sufficient to meet demand, however HVDC facilities may be placed under greater strain, potentially resulting in the requirement for a further facility.

Attracting supply chain investment will depend on the future demand profile of components and ensuring infrastructure will be utilised enough to provide a steady revenue stream for investors. The High Ambition scenario results in factories being utilised significantly more than the Low Ambition scenario for instance. Findings like these outline the importance of building the business case for OSW through ambitious deployment targets which will help to attract supply chain investment.

10 WORKFORCE

10.1 Methodology

This module models the expected workforce in terms of total FTEs required for each deployment scenarios and the occupations this creates. It does not look at the skills required. This work only shows OSW industry FTEs as many employees will work across both technologies, particularly back office staff, and FTEs specific to FOW are difficult to tease out.

This module draws largely on the work completed by OWIC, in their Offshore Wind Skills Intelligence Report 2023. This report presents the total workforce in 2022 as 32,257. To establish this number, OWIC surveyed the industry and received over 10,000 job records from 81 companies. This was then extrapolated to understand the full workforce, with OWIC estimating that 104,401 people would be employed by 2030. They assumed that all projects in the pipeline at the time were completed, leading to the deployment of 51GW in 2030.

This report multiplies the FTE/GW ratios created from the OWIC report by the deployment scenarios to understand the total FTEs required.

10.2 Inputs

In Table 23 the relationship, in OWICs report, between FTEs and deployment is shown. The deployment for 2022 comes from ORE's database, and the years between 2022 and 2030 are a linear line between the start and final years of OWIC's projection. The average FTEs/GW is 2,337 over this period. For modelling purposes, the FTE/GW ratios created in this table are used for the respective years in the modelling. From 2030 to 2050, 2,000FTEs/GW is used. This number seeks to incorporate several forces pulling in different directions:

- Increased deployment of FOW, in the early stages will see overall FTEs/GW increase as there will be high inefficiencies in tasks.
- Increased deployment of FOW will increase learning rates and therefore efficiencies will increase.
- Companies will look to take on staff to decommission fixed-bottom projects in the back end of this project. Decommissioning will be a relatively inefficient process in the early stages.
- Macroeconomic trends (e.g. AI) drive efficiencies in the roles across organisations.

Table 23: FTEs/GW

Year	OWIC workforce projections	Deployment in OWIC report (MW)	FTEs/deployment
2022	32,257	13,715	2,352
2023	43,374	18,376	2,360
2024	58,774	23,036	2,551
2025	72,689	27,697	2,624
2026	72,789	32,358	2,250
2027	88,509	37,018	2,391
2028	95,123	41,679	2,282
2029	100,947	46,339	2,178
2030	104,401	51,000	2,047

10.3 Outputs

There is a difference of 100,000 FTEs between the Low Ambition Scenario and the High Ambition Scenario in 2050, with the Base Case Scenario falling in the middle (Table 24).

Table 24: Total FTEs by Scenario

Deployment scenario	2050
Base Case Scenario	198,000
Low Ambition Scenario	152,000
IGP Aligned Scenario	236,000
High Ambition Scenario	256,000

The workforce growth over time is consistent with deployment (Figure 21). The plateau in the Base Case Scenario is the same one as in the deployment figures. Table 25 shows a breakdown of the roles.

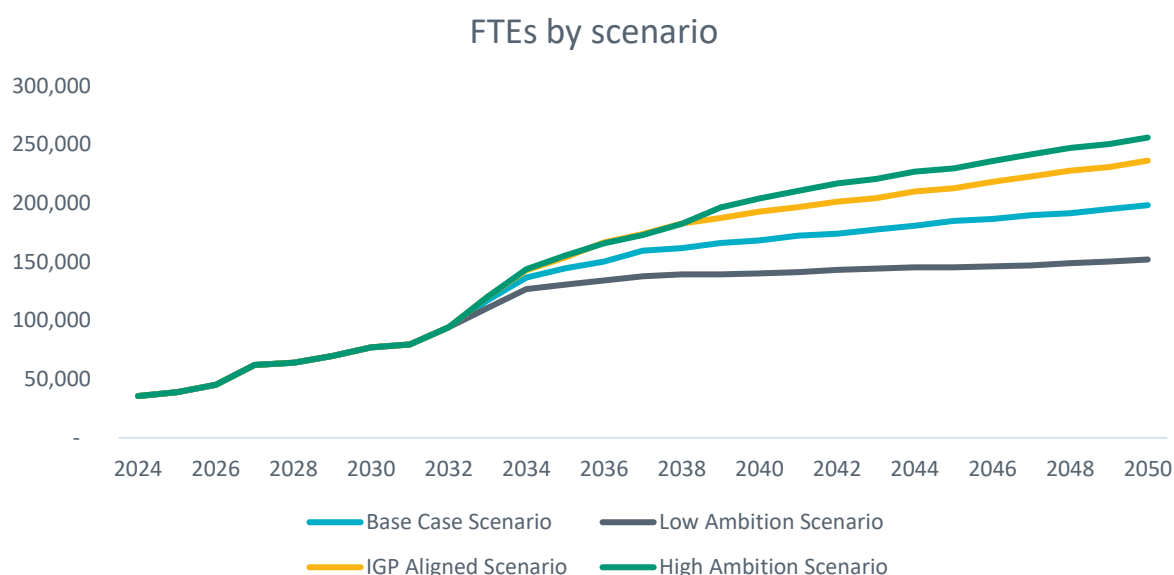


Figure 21: Total FTEs by Scenario

Table 25: Occupations in Selected Years – Base Case Scenario

Workforce split by role type	2030	2035	2040	2045	2050
Managers, directors and senior officials	5,814	8,050	12,261	14,369	17,089
Professional occupations	27,531	38,121	58,059	68,041	80,921
Associate professional & technical occupations	13,509	18,705	28,489	33,387	39,707
Administrative and secretarial occupations	3,334	4,617	7,032	8,241	9,801
Skilled trades occupations	28,386	39,305	59,863	70,155	83,435
Caring, leisure, and other service occupations	940	1,302	1,983	2,324	2,764
Sales and customer service occupations	5,985	8,287	12,622	14,792	17,592

11 DEPLOYMENT SCENARIOS

The deployment trajectories of each scenario are shown in the following figures, outlining both the combined fixed-bottom and FOW cumulative pipeline, in addition to the FOW pipeline broken down by region.

In Table 26, the final deployment figures for each scenario are shown. Key findings are:

- England has a lot of remaining potential for fixed-bottom wind
- The Celtic Sea has very little room for fixed-bottom wind.
- In all scenarios England does not see any FOW commissioned, though in the IGP Aligned Scenario and the High Ambition Scenario projects are leased and would expect to be commissioned shortly after the modelled period.
- Between 70 and 80GW of fixed-bottom wind is approximately what is feasible, in cost terms, before FOW is required to reach larger targets.
- In none of the scenarios presented are the 2030 OSW targets met.

Table 26: Final OSW Deployment Figures by Scenario

	Base Case Scenario (MW)	Low Ambition Scenario (MW)	IGP Aligned Scenario (MW)	High Ambition Scenario (MW)
Fixed-bottom	2050			
England	44,713	38,317	47,611	51,211
Celtic Sea	2,676	1,826	2,271	2,687
Scotland	19,659	16,246	18,990	20,114
Total fixed-bottom	67,048	56,389	68,872	74,012
FOW	2050			
England	58	58	58	58
Celtic Sea	8,608	3,382	13,303	12,451
Scotland	23,450	16,181	35,930	41,469
Total FOW	32,116	19,621	49,291	53,978

11.1 Base Case Scenario

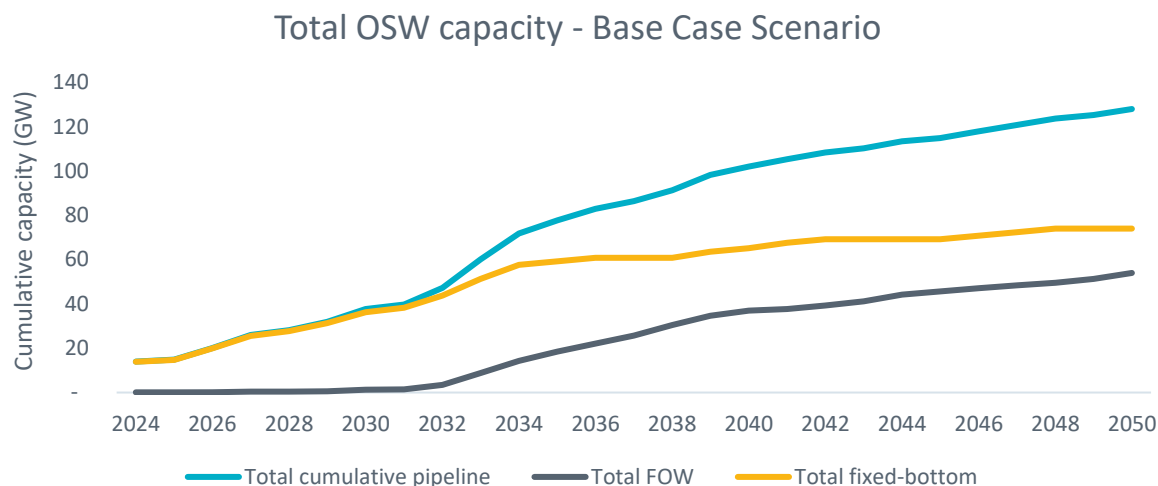


Figure 22: Base Case Deployment Scenario

Figure 22 shows the Base Case deployment scenario. In this scenario, there is a big ramp-up of deployment in the early 2030s as ScotWind projects come online. Using the commissioning dates from the EnergyPulse database, creating a sustainable industry is difficult with this level of deployment, as a big portion will be delivered in a very short space of time, and therefore less is needed through the rest of the years.

There is some levelling off of FOW deployment after the ScotWind and Celtic Sea Leasing rounds come online which is due to cheaper fixed-bottom space being leased before FOW. Given this deployment target sees 100GW deployed, there is a big risk a region may miss out on the activity due to others being first movers.

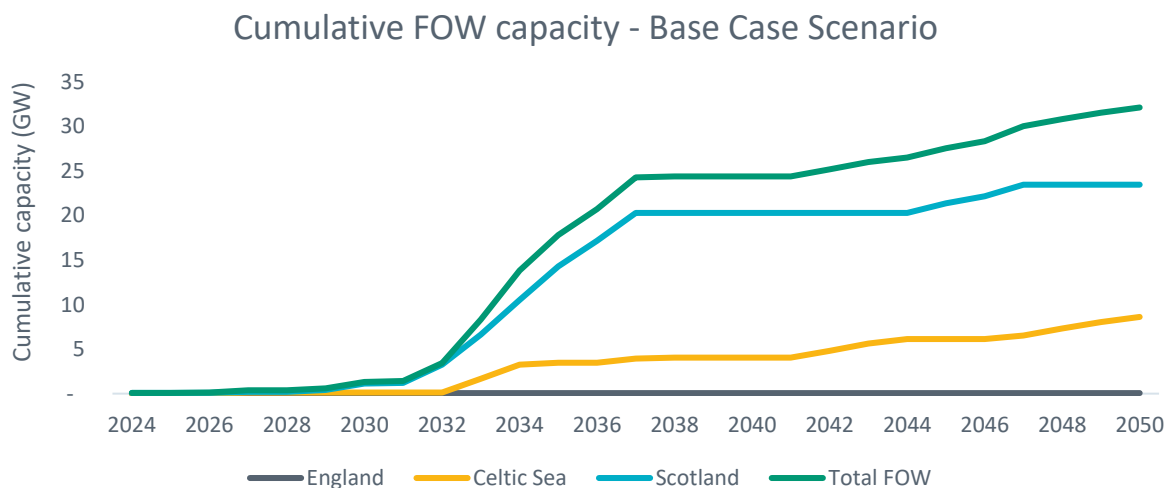


Figure 23: FOW Deployment by Region - Base Case Scenario

ScotWind is set to drive a significant deployment of FOW. The Celtic Sea sees deployment pick up in the 2040s. This is structural in the model, as the Celtic Sea Project Development Zones will likely be leased this year or next. The next leasing round in the model is in 2030 and therefore projects are not commissioned until 2041.

12 KEY ENABLING ACTIONS AND DEPLOYMENT SCENARIOS

Findings from this report reiterate the need for action to alleviate existing barriers and enable the UK to meet its ambitious OSW and Net Zero targets. The following section delivers a set of key enabling actions necessary to achieve this. In all scenarios, the overriding goal is to create a sustainable and investable industry. This requires *steady* market growth. This is a challenge in the lower ambition scenarios, as, with the existing leasing rounds the UK's path to 2050 is largely locked in, the majority of projects will be delivered before 2040. This is not sustainable or attractive for investors, as the supply chain will not have the pipeline after the 2030s to justify investing in the industry. Enabling actions listed below will seek to smooth out deployment so there is less of a glut of projects in the early 2030s and create a steady amount of deployment per year.

The table below will outline what actions need to be taken to reach each deployment scenario.

	Base Case Scenario (100GW)	Low Ambition Scenario (75GW)	IGP Aligned Scenario (115GW)	High Ambition Scenario (125GW)
Leasing	With the existing pipeline (built and in development) reaching 82GW and the current project development timeline of 11 years, 18GW of new projects must be leased by 2039. This equates to 1.4GW per year, from 2026. If leasing rounds are run every 6 years for each home nation (Scotland, England, Wales (Celtic Sea)), each leasing round must see 2.5GW commissioned. The key to creating a sustainable industry is appropriately sized and frequent leasing rounds that allow for a consistent pipeline. Large and infrequent leasing rounds are difficult to manage for the supply chain as they require significant capacity for specific years but create low utilisation rates.	With the existing pipeline (projects built and in development) reaching 73GW and a development timeline of 14 years, 2GW of new projects must be leased by 2036. For new leasing rounds commencing in 2026, this equates to approximately 180MW per year. If leasing rounds are run every 8 years for each home nation (Scotland, England, Wales (Celtic Sea)), each leasing round must see 400MW commissioned. This scenario does not allow for a sustainable industry after the 2030s, if even 50% of the current pipeline is delivered on time.	A development timeline of 8 years, 28GW of new projects must be leased by 2042 to reach 115GW by 2050. This incorporates the existing pipeline of 87GW (including projects both built and in development). This equates to approximately 1.7GW per year from 2026. If the leasing rounds are run every 6 years for each home nation (Scotland, England, Wales (Celtic Sea)), each leasing round must see 3.5GW commissioned. This level of deployment after the 2030s is more conducive to creating a sustainable industry, particularly once decommissioning, and repowering are considered.	A development timeline of 8 years, will require 38GW of new projects to be leased by 2042 to reach 125GW by 2030. This includes the existing pipeline of 87GW (both built projects and in development). This equates to approximately 2.2GW per year from 2026. If leasing rounds are run every 6 years for each home nation (Scotland, England, Wales (Celtic Sea)), each leasing round must see 4.75GW commissioned. This level of deployment allows, combined with decommissioning and repowering of sites, creates activity in the future and a steady pipeline of projects for developers, ports, vessel operators, etc.

	Base Case Scenario (100GW)	Low Ambition Scenario (75GW)	IGP Aligned Scenario (115GW)	High Ambition Scenario (125GW)
Project development and consenting	An 11-year project development timeline, including 3 years to gain consent, representing the typical business-as-usual timeline seen in the industry today. It will be critical to ensure consenting timelines don't slip further as more OSW is deployed. Faster consenting will allow for a smoother deployment profile.	A 14-year project development timeline, including 4 years to gain consent. This assumes action is not taken to streamline the consenting process, and the timeline slips further.	An 8-year project development timeline, including 1.5 years to gain consent. In this scenario, action has been taken to reduce the consenting process timeline. It will be crucial to ensure this consenting timeframe is maintained as the buildout of OSW increases.	An 8-year project development timeline, including 1.5 years to gain consent. In this scenario, action has been taken to reduce the consenting process timeline. It will be crucial to ensure this consenting timeframe is maintained as the buildout of OSW increases.
CfD	Large budgets will be required to reach these deployment figures, as there will be significant deployment levels and relatively high strike prices. To award all the FOW ScotWind projects a CfD, £5.4bn is required between 2030 and 2038.	Significant commitment from the Government is required while projects LCOEs are still high. Given there is little deployment beyond the 2030s in this scenario, there will be little to no impact on the CfD budget. To award all the FOW ScotWind projects a CfD, £4.3bn is required between 2030 and 2038.	Significant commitment from the Government is required while projects LCOEs are still high. The deployment in later decades will require less subsidies/revenue support due to the market price being set more by renewables than today. To award all the FOW ScotWind projects a CfD, £6.3bn is required between 2030 and 2038.	Significant commitment from the Government is required while projects LCOEs are still high. The deployment in later decades will require less subsidies/revenue support due to the market price being set more by renewables than today. To award all the FOW ScotWind projects a CfD, £6.6bn is required between 2030 and 2038.
Port infrastructure	Port utilisation is low over the modelled period. Decisions over which, and how many ports need to be upgraded must be made. Upgrading fewer ports will mean less deployment capacity per year, but will allow the upgraded ports to have a more sustainable business model. An investment of £873m across 6 Scottish ports will enable the desired buildout of 24GW of FOW in Scotland. The assumptions in this model suggest it will take 8 years to fully complete Scotland's port upgrades. Therefore, to meet the high demands on port capacity created by early ScotWind projects, the preliminaries must start in 2026. With	Port utilisation is very low, and upgrading all ports is likely not justifiable. An investment of £873m across 6 Scottish ports will enable the desired buildout of 16GW of FOW in Scotland. The assumptions in this model suggest it will take 8 years to fully complete Scotland's port upgrades. Therefore, to meet the high demands on port capacity created by early ScotWind projects, the preliminaries must start in 2026. With major CAPEX starting in 2030 or 2031, at the latest.	With higher port utilisation upgrading all ports available is more justifiable. Particularly once other activities are taken into consideration. The assumptions in this model suggest it will take 8 years to fully complete Scotland's port upgrades. To meet the high demands on port capacity created by early ScotWind projects, the preliminaries must start in 2026. With major CAPEX starting in 2030 or 2031, at the latest. 2 ports in the Celtic Sea region were identified as suitable for	This scenario sees the highest port utilisation. An investment of £873m into 6 Scottish ports will enable the desired buildout of 41GW of FOW in Scotland. The assumptions in this model suggest it will take 8 years to fully complete Scotland's port upgrades. To meet the high demands on port capacity created by early ScotWind projects, the preliminaries must start in 2026. With major CAPEX starting in 2030 or 2031, at the latest. 2 ports in the Celtic Sea region were identified as suitable for FOW

	Base Case Scenario (100GW)	Low Ambition Scenario (75GW)	IGP Aligned Scenario (115GW)	High Ambition Scenario (125GW)
	major CAPEX starting in 2030 or 2031, at the latest. 2 ports in the Celtic Sea region were identified as suitable for FOW deployment and will require an investment of £1.027bn. To allow the first Celtic Sea projects to come online in 2033, the preliminaries must start in 2025. With major CAPEX starting in 2030 at the latest. If ScotWind projects are pushed back, then, depending on which ports are chosen for deployment, there would be a moderate drop in investment required to facilitate yearly capacity.	2 ports in the Celtic Sea region were identified as suitable for FOW deployment and will require an investment of £1.027bn. To allow the first Celtic Sea projects to come online in 2033, the preliminaries must start in 2025. With major CAPEX starting in 2030 at the latest. If ScotWind projects are pushed back, then, depending on which ports are chosen for deployment, there would be a significant drop in investment required to facilitate yearly capacity	FOW deployment and will require an investment of £1.027bn. To allow the first Celtic Sea projects to come online in 2033, the preliminaries must start in 2025. With major CAPEX starting in 2030 at the latest. If ScotWind projects are pushed back, then, depending on which ports are chosen for deployment, there would be a moderate drop in investment required to facilitate yearly capacity	deployment and will require an investment of £1.027bn. To allow the first Celtic Sea projects to come online in 2033, the preliminaries must start in 2025. With major CAPEX starting in 2030 at the latest.
Grid Infrastructure	To reach 100GW, the grid must be able to accommodate an additional 73GW, requiring an investment of £170bn. The majority of this spend must be made in the early 2030s, particularly in Scotland to support the delivery of ScotWind. £7.1bn of grid investment will need to be secured and deployed by 2028 to enable the first 2GW of ScotWind projects. The development of grid infrastructure must be supported by ongoing work to reduce the overall timeline for connecting to the electricity network to 7 years, down from a current timeline of 12-14 years. Under this timeline, consents for 2030 must be secured by 2027.	To reach 75GW, the grid must be able to accommodate an additional 48GW, requiring an investment of £111bn. Given the existing pipeline will come online in the 2030s, the milestones are the same as the base case scenario.	To reach 115GW, the grid must be able to accommodate an additional 88GW, requiring an investment of £205bn. Given the existing pipeline will come online in the 2030s, the milestones are the same as the base case scenario.	To reach 125GW, the grid must be able to accommodate an additional 98GW, requiring an investment of £228bn. Given the existing pipeline will come online in the 2030s, the milestones are the same as the base case scenario.
Vessel availability	Installation and construction vessel demand peaks in the early 2030s and	Vessel demand is lowest in this scenario resulting in a greater	Vessel demand follows a similar trajectory to the Base Case	Vessel demand is highest in this scenario with an estimated 93 SOVs

	Base Case Scenario (100GW)	Low Ambition Scenario (75GW)	IGP Aligned Scenario (115GW)	High Ambition Scenario (125GW)
	then reduces significantly. Service vessel demand grows as the OSW fleet increases, reaching a peak in 2050 with a requirement of 56 SOVS for instance. Creating a sustainable industry for vessel operators is dependent on the outcome of other actions required to reach deployment targets.	reliance on shorter term leases and higher vessel day rates. Creating a sustainable industry for vessel operators, is dependent on the outcome of other actions required to reach deployment targets.	Scenario, however there is greater demand in later decades due to increased deployment. In particular, there is a requirement for 20 offshore construction vessels with <200 ton crane capacity by 2048.	required by 2050. This is to account for a greater buildup of FOW compared to other scenarios. Creating a sustainable industry for vessel operators, is dependent on the outcome of other actions required to reach deployment targets.
Supply chain capability and capacity (The study did not consider the impact of constraints from the global supply chain and therefore operates on the assumption that components can be sourced internationally if sufficient investment into developing the domestic supply chain is not materialised.)	To create a sustainable, investable industry for the supply chain there must be enough demand within the UK, different companies will take different views of what justifies a factory investment. Component demand from this scenario creates some justification for investment in UK factories. For instance, an additional blade factory, on top of existing capacity, would be utilised 89% of the time. As part of the Offshore Wind Sector Deal, the UK has pledged to reach 60% UK content in OSW farms by 2030. To support this ambition, an overall investment of £650m will be required to enhance blade and cable manufacturing capabilities and develop a tower manufacturing facility. Substructures are considered in the port infrastructure constraint.	This scenario is unlikely to generate enough demand to justify investment in UK factories. As part of the Offshore Wind Sector Deal, the UK has pledged to reach 60% UK content in offshore wind farms by 2030. To support this ambition, an overall investment of £460m will be required to enhance blade and cable manufacturing capabilities and develop a tower manufacturing facility. Substructures are considered in the port infrastructure constraint.	The higher level of demand will create a stronger case of investment in the UK. For instance, a new tower manufacturing facility would be utilised 80% of the time in this scenario. As part of the Offshore Wind Sector Deal, the UK has pledged to reach 60% UK content in offshore wind farms by 2030. To support this ambition, an overall investment of £650m will be required to enhance blade and cable manufacturing capabilities and develop a tower manufacturing facility. Substructures are considered in the port infrastructure constraint.	This scenario creates high utilisation of most factory types. In particular, a tower manufacturing factory would be utilised 88% of the time with this level of deployment. As part of the Offshore Wind Sector Deal, the UK has pledged to reach 60% UK content in offshore wind farms by 2030. To support this ambition, an overall investment of £750m will be required to enhance blade and cable manufacturing capabilities and develop a tower manufacturing facility. Substructures are considered in the port infrastructure constraint.
Workforce	The Base Case Scenario assumes a total workforce of 199,000 FTEs will be required by 2050 to facilitate the level of deployment.	This scenario assumes a total workforce of 151,000 FTEs will be required by 2050 to facilitate the level of deployment.	This scenario assumes a total workforce of 231,000 FTEs will be required by 2050 to facilitate the level of deployment.	This scenario assumes a total workforce of 251,000 FTEs will be required by 2050 to facilitate the level of deployment.

Table 27: Key Enabling Actions by Deployment Scenario

13 CONCLUSION

This report has presented four deployment scenarios for UK offshore wind and has outlined the enabling actions required for these to be met. These deployment scenarios are not forecasts and there is no prediction as to which one is most likely to be realised.

Addressing these enabling actions will take considerable resources, time, and political capital, however, they create the conditions necessary for the UK to reach its long-term Net Zero targets and reap the benefits of the growth of a globally burgeoning industry. Some of these actions are much more urgent than others, and some – such as grid and port investment – are not optional if FOW is to be realised in the UK. Tough decisions must be made soon in terms of overall level of ambition and whether the UK wants to capture as much value as possible in the supply chain or reach these targets as quickly and cheaply as possible. Currently, these are incompatible goals, given the readiness of the UK supply chain and ports.

In the short-term, effort should be made to accelerate development timelines of existing projects and address barriers to deployment. Ongoing collaboration between industry and government is required to reform and streamline the consenting regime, in addition to significant financial commitments to support the CfD scheme and ensure a route to market for projects.

This report is designed to allow decision makers to understand the requirements of the ambitions and targets for the FOW industry. The ultimate goal is to create a sustainable and investable industry for all key stakeholders, and that will require a fundamental rethink of how the industry is approached. Currently there is c82GW of projects in the pipeline (with around 24GW of FOW), and just under 15GW already built, with most set to be delivered prior to 2037. If the goal is to reach 100GW of offshore wind, then only 18GW of new projects need to be leased (provided all current projects are built). However, if there is appetite to go beyond this and install more than 100GW of OSW, leading to greater energy security and export opportunities, then significant new seabed areas should be made available for development. Either way, the project pipeline needs to be considerably smoother to prevent overbuilding of supply chain capacity and underutilisation once all these offshore wind projects are built.

Support for our offshore and floating wind pipeline needs to be provided in the context of a holistic plan for each region of the UK. Awarding further leases and then subsequently considering the infrastructure and supply chain required will result in delays to deployment and a suboptimal industry. If plans and support for grid upgrades, supply chain and port investments can be put in place, then mid- and long-term targets will be easier to achieve and result in an increase in UK and regional spend, economic prosperity and job creation.

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