, Jeannine Dunne
and Aoife Kelly, Gavin & Doherty
Geosolutions Ltd.

Foras na Mara
Marine Institute

Disclaimer

Cover Images

Available in PDF only

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Design Flexibility in ORE Development/Consenting and Planning

Foras na Mara
Marine Institute

Client	**The Marine Institute**
Document Ref.	24010-REP-001-00
Project Title	Design Flexibility in ORE Development
Date	01/11/2024

Project Title:	Design Flexibility in ORE Development
Report Title:	Design Flexibility in ORE Development/Consenting and Planning
Document Reference:	24010-REP-001-00

Client:	The Marine Institute
Ultimate Client:	Marine Institute
Confidentiality	Open Access (agreed by GDG 11-Feb-25)

REVISION HISTORY

Rev	Date	Reason for Issue	Originator	Checker	Reviewer	Approver
00	01/11/2024	Final Report Submission to MI.	GB	AK	MAA	DOS/JD

DISCLAIMER

TABLE OF CONTENTS

List of Tables

List of Figures

List of Abbreviations

AA	Appropriate Assessment
ABP	An Bord Pleanála
AR	Allocation Round
BEIS	The Department for Business, Energy and Industrial Strategy
BoE	Bureau of Energy
BOEM	Bureau of Ocean Energy Management
CA	Competent Authority
CFD	Contracts for Difference
CFR	Code of Federal regulations
CIP	Copenhagen Infrastructure Partners
COP	Construction and Operations Plan
DCO	Development Consent Order
DEA	Danish Energy Authority
DESNZ	The Department for Energy Security and Net Zero
DHLGH	The Department of Housing, Local Government and Heritage
DMAP	Designated Maritime Area Plan
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Reports
EIS	Environmental Impact Study
EPA	Environmental Protection Agency
EPAct	The Energy Policy Act of 2005
ES	Environmental Statement
EU	European Union
ExA	Examining Authority
FDR	Facility Design Report
FEED	Front-End Engineering Design
FEIS	Final Environmental Impact Statement
GDG	Gavin and Doherty Geosolutions Ltd.
GWEC	Global Wind Energy Council
HRA	Habitats Regulations Assessment
ICOL	Inch Cape Offshore Limited
IRENA	International Renewable Energy Agency
JR	Judicial Review
LoD	Limit of Deviation
LAT	Lowest Astronomical Tide
MAC	Maritime Area Consent
MAP	Maritime Area Planning
MARA	Maritime Area Regulatory Authority
MD-LOT	Marine Scotland Licensing Operations Team
MI	Marine Institute
ML	Most Likely

mLAT	Meters Above Lowest Astronomical Tide
mHAT	Meters Above Highest Astronomical Tide
MOEA	Ministry of Economic Affairs
NNG	Neart Na Gaoithe
NSIP	Nationally Significant Infrastructure Projects
NTS	Non-technical Summary
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
OEM	Original Equipment Manufacturer
ORE	Offshore Renewable Energy
ORESS	Offshore Renewable Energy Support Scheme
OSP	Offshore Substation Platform
OSS	Offshore Substation
OW	Offshore Wind
OWF	Offshore Wind Farm
PA2008	Planning Act 2008
PDE	Project Design Envelope
PDR	Planning and Development Regulations 2001
PPA	Power Purchase Agreement
PTS	Permanent Threshold Shift
RED	Renewable Energy Directive
RSPB	Royal Society for the Protection of Birds
RVO	Netherlands Enterprise Agency
SAP	Site Assessment Plan
SEA	Strategic Environmental Assessment
SEAI	Sustainable Energy Authority of Ireland
SEIS	Supplementary Environmental Information Statement
SID	Strategic Infrastructure Development
SLV	Seascape, Landscape and Visual
SNH	Scottish Natural Heritage
SOP	Statutory Objective Period
T&I	Transport and Installation
TPC	Taiwan Power Company
UXO	Unexploded Ordnance
WC	Worst Case
WFD	Water Framework Directive
WFSD	Wind Farm Site Decision
WTG	Wind Turbine Generator

EXECUTIVE SUMMARY

When developing an offshore wind farm, between initial project scoping, the submission of a planning application, and construction, there will be several iterations of project design as more detailed information is gathered on the site, as technology advances, and as engagement with the supply chain increases and suitable components and suppliers are identified. As project development progresses, however, projects will be required to prepare and submit their planning applications. Final design parameters will not be available at the time of application submission due to the long lead times between the preparation and submission of a planning application and the eventual construction of an offshore wind farm, as well as the phased nature of site investigation and design strategies employed by projects. Projects will therefore require flexibility in their consented design envelope, to account for details that are not finalised at the time of planning application submission.

There is a balance to be struck between providing developers with the necessary design flexibility to ensure projects can proceed to construction, while also ensuring that An Bord Pleanála, as the Competent Authority, can conduct thorough environmental impact assessment of proposed projects.

To inform understanding on this topic, and to assist Government in making informed decisions on how design flexibility should be accommodated for in consenting offshore wind farms in Ireland, Gavin and Doherty Geosolutions Limited (GDG) was awarded funding to undertake research on this subject under the Marine Institute's Research for Policy Awards 2023.

In this piece of work, GDG has investigated the need for design flexibility in offshore wind development and consenting and identified the key design parameters in need of flexibility, as well as the drivers for this need. While different projects will have different requirements for flexibility, the drivers are generally the same, including the phased nature of site investigation (and therefore availability of detailed site-specific information to inform detailed design activities), lengthy consenting timelines, rapid technological advancements, and supply chain constraints.

GDG has also investigated if and how design flexibility has been addressed in other jurisdictions. This review found that some degree of design flexibility in consenting for offshore wind is a key part of the development processes in the countries assessed; England and Wales, Scotland, Denmark, the Netherlands, the USA and Taiwan. While the markets operate differently, it was found that there are a few key principles followed by all that are discussed in this report. In addition, GDG has reviewed several case studies of projects which have been consented internationally using a design envelope, to show how the approaches have worked in practice. These projects have provided several important learnings on the value of accommodating flexibility in offshore wind consenting, as well as having robust processes in place for varying or altering consents.

Finally, this work has looked at the Irish case more specifically. Through the Planning and Development Act 2000 (as amended), the Planning and Development Regulations 2001, the Maritime Area Planning Act 2021, and the Planning and Development, Maritime and Valuation (Amendment) Act 2022, provisions have been made for An Bord Pleanála to allow for flexibility in consenting of offshore wind projects. The degree of flexibility allowed will depend on how An Bord Pleanála interprets this.

From interviews with Phase One projects on their engagements with An Bord Pleanála in relation to design flexibility to date, and from reviews of planning applications submitted by some of the Phase One projects, it is clear that An Bord Pleanála has attempted to give the Phase One projects some flexibility in consenting. From interviews however, there is an opinion that the more limited level of flexibility which An Bord Pleanála is willing to accommodate is sub-optimal and forcing projects to make assumptions in consent applications and EIA that may make it more likely that variations to consent will be needed. This could have serious implications to development timelines for the projects should they require material alterations to their consents.

Based on these findings, GDG recommends the following actions:

- **Workshop:** A collaborative workshop should be held between GDG, the Marine Institute, the Department of Housing, Local Government and Heritage, An Bord Pleanála, and an industry representative such as Wind Energy Ireland to discuss in more detail how the Phase One approach to design flexibility has worked, and what could be improved going forwards, without prejudice to any existing or future planning applications for these projects.
- **Detailed Study:** Jurisdictions of interest from this review should be studied in more detail for learnings which can be applied to Ireland. The Danish approach in particular could be of interest to the Irish government.
- **Legal Review:** While GDG believes the main reason for a more limited level of flexibility in consenting for offshore wind development in Ireland is the Derryadd decision and the impact of this, it should be confirmed with An Bord Pleanála if this is the case. If it is, a thorough legal review of this case should be undertaken to clarify its implications on design flexibility and whether concerns are legally justified.
- **Process Clarity:** It should be ensured there is clarity in the exact process for accommodating design flexibility in offshore wind development, as discussions with project developers have noted some inconsistencies between what is set out in the Planning and Development Act 2000, and what was then applied by An Bord Pleanála, particularly in relation to the number of project options that could be included.
- **Process for altering/varying consent:** It should be ensured that robust processes are in place for altering or varying consents for offshore wind development, which is clearly set out for developers. This has been shown to be an important requirement even in jurisdictions with high level of design flexibility in consenting, and given the relatively limited flexibility being accommodated here, consent variations could be seen as more likely to be required for Irish projects.

These recommendations aim to improve the consenting process for offshore wind projects in Ireland, ensuring it remains flexible and efficient, and best placed to assess the large volume of projects expected to pass through the system in the coming years.

1 INTRODUCTION

GDG was awarded funding to complete this scope of work under the Marine Institute's (MI) Research for Policy Awards 2023. The relevant work package is Design Flexibility in ORE (Offshore Renewable Energy) Development/Consenting and Planning.

1.1 BACKGROUND TO PROJECT INCLUDING OBJECTIVES AND PROPOSED LEARNING OUTCOMES

The primary aim of this work is to undertake a review of the implementation of flexible design provisions for real world ORE developments in consenting and regulatory regimes globally, and from this review to make recommendations for how flexible design provisions could be implemented under the Irish regulatory structure. The focus of this work will be offshore wind (OW), given its relevance to Ireland, current offshore wind targets and the nascent nature of other offshore renewables worldwide.

The structure of the report is as follows:

1. Introductory discussion on the need for flexibility in design for OW **(Section 2).**
2. Overview of approach to project scoping and Environmental Impact Assessment (EIA) used by the OW industry **(Section 3)**, including discussion on EIA Scoping, EIA, and assessment of realistic worst-case scenarios.
3. A review of OW fixed bottom turbine technology and the expected technology evolution over the next 10 years **(Section 4).**
4. A review of how design flexibility has been accommodated in other jurisdictions **(Section 5).**
5. Case studies of relevant OW developments internationally that have used a flexible approach to development (**Section 6).**
6. Examination of flexibility in Irish regulatory decision making and suitability for ORE decision making **(Section 7)**, including summary of interviews undertaken with several Phase One project developers.
7. Summary and Recommendations **(Section 7.4)**

This work aims to assist Government in making informed decision on ORE development policy and statutory guidelines for OW development, at this important time for the industry in Ireland.

2 INTRODUCTION TO DESIGN FLEXIBILITY FOR OFFSHORE WIND

When developing an OWF, between the initial project scoping, the submission of a planning application for the project, and construction of the project, it is a certainty that there will be several iterations of the project design as further information is gathered on the site including on the environmental receptors, metocean environment, geotechnical conditions, other marine uses, etc. and as technology advances and potential suitable options are identified and assessed.

In July 2023, the Department of Housing, Local Government and Heritage (DHLGH) acknowledged in 'Circular MPP 01/2023 - An Opinion on Design Flexibility for Maritime Development' [1] that the final details of a proposed development may be unconfirmed at the time of submitting a planning application to the An Bord Pleanála (ABP), including, but not limited to, foundation type, exact turbine tip height and turbine blade size.

Generally, through initial project scoping, a project will prepare a high-level Project Design Envelope (PDE) which outlines the key design parameters and assumptions for the project, such as the array area, the anticipated project capacity range, the maximum and minimum number of turbines, the maximum and minimum blade tip height and rotor diameter, the potential foundation types that could be deployed on site and relevant dimensions for these etc.

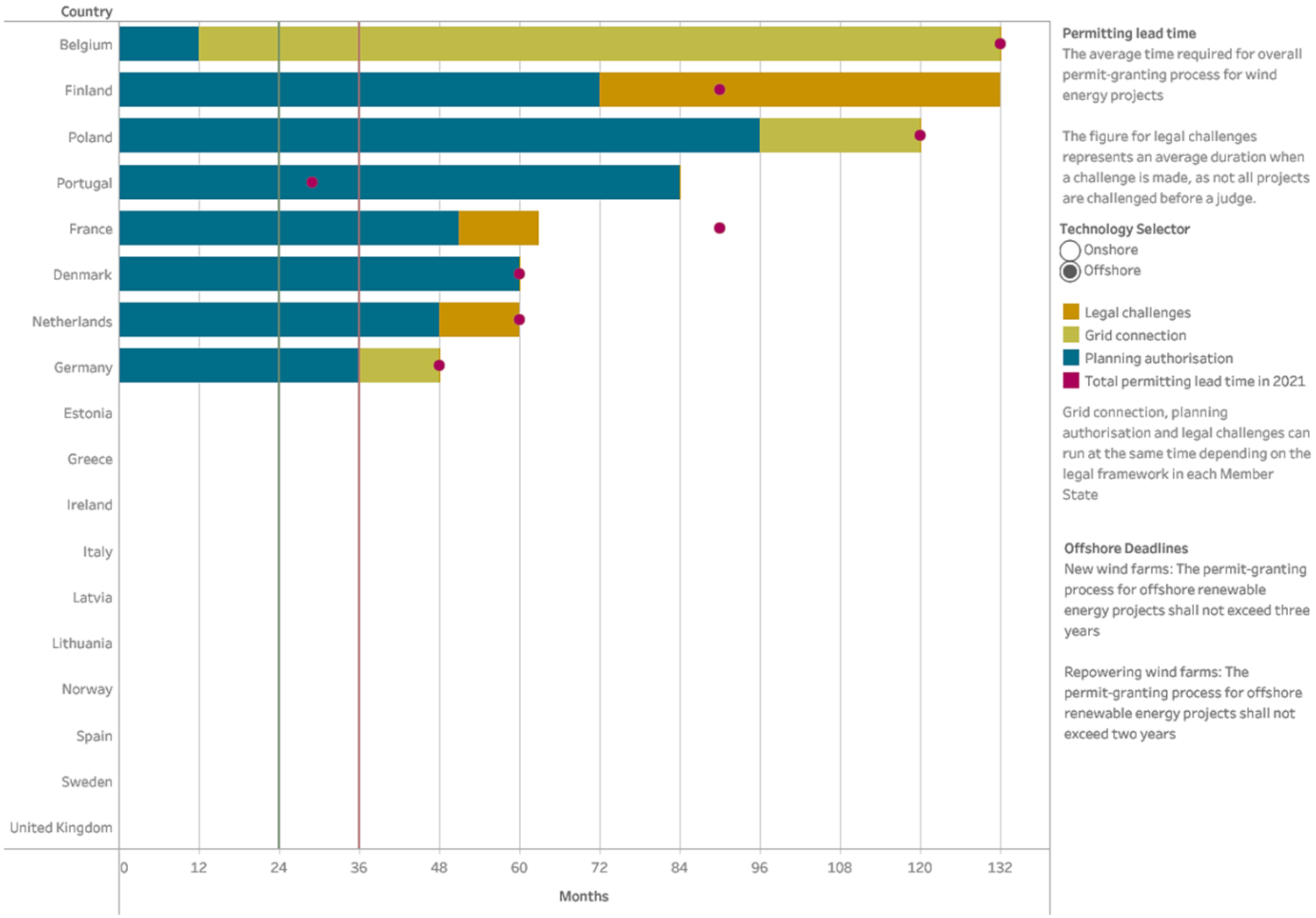
This initial PDE outlines the design parameters that should be taken forward into discussions with stakeholders, for consideration in future studies and into early-stage environmental assessments (e.g. EIA Scoping). As more consultation and assessment are undertaken, and more data becomes available in relation to site conditions and available and suitable technology, this PDE will be refined to give more certainty on the PDE for the project to be assessed in EIA.

Given the long lead times between the preparation and submission of a planning application and the eventual construction of an OW farm, and the phased site investigation and design strategies employed by projects, final design parameters will not be available at the time of application submission in almost all cases.

Figure 2-1 shows WindEurope analysis of permitting times for offshore renewables in Europe, broken down by time for planning authorisation, grid connection, and legal challenges. In the countries assessed, which include the most mature markets for OW in Europe, overall permitting times range from 48 months (Germany) to 132 months (Belgium). When considering just planning consent, times range from 12 months (Belgium) to 96 months (Poland). Under the new Renewable Energy Directive (RED III) [2], which entered into force in November 2023 and is currently being transposed by Member States, the permit-granting procedure for ORE projects in renewables acceleration areas shall not exceed two years, or three years for offshore renewable energy projects outside renewables acceleration areas. This should hopefully see permitting times improve for offshore renewables in Europe, but permitting remains a bottleneck for the industry that is proving difficult to solve, and drastic improvements in permitting durations are not expected.

According to the International Renewable Energy Agency (IRENA) and the Global Wind Energy Council (GWEC) 'Permitting is a key bottleneck for OW – highlighted by manufacturers, developers and investors, and seen in every region of the world, and with projects of every size. Overcoming this bottleneck would have a transformative effect on the rapid rollout of offshore wind' [3]. GWEC says that typically, OWFs globally take up to nine years to move from early development stage to full commissioning. The bulk of this time is spent in the permitting and consenting stage, with projects then generally being constructed very quickly, typically in two years, depending on project size [4].

Figure 2-1: WindEurope assessment of OW energy permitting lead times [5]



Ireland has no history of consenting OWFs of scale to point towards. Phase One projects in Ireland have begun submitting their planning applications this year (in line with the requirements of their Maritime Area Consents (MACs)), and these projects will be the first developments of this scale to be assessed and consented by ABP.

Experience with the consenting of onshore renewables can be looked at. For wind farms, those with a capacity of more than 50MW or with more than 25 turbines apply to ABP for planning consent and the applications are processed through the Strategic Infrastructure Development (SID) Process, along with other larger infrastructure projects such as thermal power stations, transport infrastructure, wastewater treatment plants etc. SIDs are developments which are of strategic economic or social importance to Ireland, the region or local areas.

ABP has a statutory objective period (SOP) for SID decisions of 18 weeks from the last day for making submissions or observations on the application, the conclusion of any oral hearing on the application or the provision by the applicant of any information requested under a 'Request for Information'. Based on its 2020 annual report [6], compliance in 2020 for SID cases was 17%, compared to 73% for all planning cases. In 2022 [7], compliance with the relevant SOP for SID cases was at 6%. According to reports, not a single wind farm was granted planning permission anywhere in the State in 2023 [8]. This demonstrates that permitting of onshore wind has proved difficult and time-consuming to date.

Although the Planning and Development Act 2024 [9] proposes the introduction of statutory mandatory timelines for all consent processes, with a headline time limit of 48 weeks to be imposed on the consenting authority to decide SID cases, it remains to be seen how long consenting of OWF projects in Ireland will take. ABP (or An Coimisiún Pleanála, as ABP will be renamed according to the new Act) will also be able to agree a longer time limit with the applicant, but this revised period must be published on its website. This is to provide for certain large scale SIDs which may be more complex in nature, which can be expected to include OWFs.

This uncertainty on consenting timelines further necessitates a degree of design flexibility at planning application stage, as applicants wish to submit their planning applications as early in the process as is practical, to avoid delays to overall project timeline. Any flexibility must be facilitated while keeping in place the appropriate safeguards for environmental assessment and public consultation.

While ideally, a project would have as much flexibility as required, for ABP to carry out a robust assessment of the application, including an assessment of the likely environmental impact, there should not be an excessive number of options or range of parameters, and applications must always be of a high standard, with details finalised where possible/practical.

This means there is a balance to be struck, between allowing a developer flexibility in design so they can accommodate the newest and most efficient technology and installation methods and the most up to date site knowledge, but also ensuring sufficient clarity is available on design parameters so that a fit-for-purpose assessment of environmental impacts can be undertaken by ABP as the Competent Authority (CA).

If sufficient flexibility is not facilitated, developers may be required to build projects using inefficient designs and outdated technology to stay within their consented envelopes or may be required to seek variations to their consents, opening up the consenting process again. On the very extreme end, projects may be shelved due to project economics no longer being viable with the use of outdated technology. But above all else ABP must be confident that it has enough detail provided that will allow it to make an informed decision on project consent.

This work aims to provide recommendations on how this balance can be found, and how an appropriate level of flexibility can be accommodated for in the development of OW in Ireland.

2.1 THE NEED FOR DESIGN FLEXIBILITY IN OW DEVELOPMENT

The primary reasons necessitating design flexibility in OW development are discussed below. Technological advancement is a key point for consideration, but by no means the only one.

2.1.1 OW TECHNOLOGY IS CONTINUOUSLY ADVANCING:

OW is now a mature industry globally, but technological progression is still being made by the industry continuously, and significant developments can be made in the time between a consent application being prepared and submitted, and consent being granted and construction beginning. This progression can relate to turbine size and capacity (See Section 4), but also to other aspects such as foundation type, export cable or offshore substation (OSS) design, construction methods etc.

An example showing the benefit here relates to wind turbines generators (WTGs). Codling Wind Park estimated in its EIA scoping report from 2020 that as much as 140 WTGs could be needed to reach its target capacity of 1300MW [10]. Originally, when the project was conceived, it was envisaged that up to 440 WTGs could be required for the 2 project phases. Advances in wind turbine technology in the past number of years (combined with a more detailed understanding of the wind farm site), means the project will now need only 60 - 75 turbines [11]. This use of fewer, larger capacity turbines, reduces the potential environmental impacts of construction and operation, while also improving the economics of the project etc.

While Codling Wind Park has been able to narrow down this range in advance of submitting its planning application, and this may be seen as an extreme example due to length of time the project has been under development, this demonstrates the huge impact advances in turbine technology can have on a project and its impact on the receiving environment.

Design flexibility in consenting processes can ensure the newest, most efficient technologies can be used in the project and benefits like above can be realised – otherwise developers may be locked into old, inefficient technology, and chose to build this, rather than to reopen the consenting process again by seeking a consent variation.

2.1.2 CONSENTING TIMELINES ARE A HUGE BOTTLENECK FOR THE OW INDUSTRY:

The need for flexibility in design and consent is exacerbated by the long and uncertain consenting timelines for OWFs. As shown in Figure 2-1: , planning timelines for OW in Europe can range from 12 months (Belgium) to 96 months (Poland), on average. This does not include time for grid connection or legal challenges.

The key points here are not only that timelines for consenting can be long, but they are also uncertain. This increases the uncertainty for projects on what technology will be available at the time of construction, and the potential for significant technological improvements to be made between submitting a consent application and moving to construction. It also encourages projects to submit planning applications as early as is practical, which can increase the time between consent application submission and commercial operation date even further.

Another consideration regarding the consenting process and timelines is the complexity of Ireland's judicial review (JR) system and the likelihood that legal challenges taken against developers may slow developments significantly. There are concerns that the increase in JR cases related to OW will create further delays, with recommendations that gaps in legislation are addressed sufficiently and that adequate resources are allocated to MARA and ABP [12]. JR has been an issue in other markets such as the UK also, as discussed in Section 6. The Inch Cape project in Scotland submitted a new planning application after it was delayed by an unsuccessful JR.

Again, this further strengthens the need for a degree of flexibility in OW consenting.

2.1.3 THE SUPPLY CHAIN FOR OW IS LIMITED AND STRETCHED

Europe has the most mature OW supply chain, from turbine nacelles through to key components and raw materials. More recently, China has become the world's leading WTG manufacturing base, but also the largest production hub for key components and raw materials [4]. The EU Commission recently announced it is launching an inquiry into Chinese suppliers of WTGs, under the new Foreign Subsidies Regulation, with Chinese WTGs being offered in Europe at up to 50% lower prices than Europe-made turbines, and deferred payments also being offered [13], so how this develops and its impact on the European supply chain, will be interesting to monitor.

That said, the supply chain for OW is limited, and in demand from a global market with huge targets. In the last number of years, the supply chain has faced pressures from factors such as inflation, difficulty in access to raw materials, high commodity prices, competition from non-European manufacturers, permitting delays and a lack of a clear pipeline for projects.

According to WindEurope, projects may need to wait 3 - 4 years in some cases for offshore foundations [14]. The availability of cable and installation vessels is also expected to become an issue in the short-term, with lead times of 3-4 years for wind turbine installation vessels also not unusual. Turbine manufacturers are reporting huge losses [15], and major developers are even cancelling projects due to supply chain challenges, amongst other things [16]

Ireland has a very limited supply chain for OW, particular in relation to major components. Projects will be at the mercy of global markets and will not be in a position to procure and place firm orders for foundations, WTGs, inter array cables, export cables, T&I contractors etc. until consent has been granted, detailed design has been completed and the project nears financial close. There is no guarantee on the availability of particular components or installation vessels to suit project schedules, therefore potential supply chain constraints require flexibility in consenting both in terms of foundation or turbine types, and also construction methods and timing.

2.1.4 DETAILED SITE INFORMATION WILL NOT BE AVAILABLE AT TIME OF CONSENT APPLICATION, AND DETAILED DESIGN WILL NOT BE COMPLETE:

Project site investigation strategies will vary project to project, but all projects will carry out site investigation works in a phased manner to manage costs and avoid unnecessarily detailed surveys at an early stage (Figure 2-2). Site investigations are required at the wind farm location and at the proposed onshore and offshore cable route and the onshore substation site.

At the early stages of project initiation, desktop studies will provide sufficient level of detail to gain a very high-level understanding of site metocean conditions, potential export cable routes, expected ground conditions etc, and a conceptual ground model may be devised from this information and a survey strategy prepared.

The project will then need more site-specific data to characterise the site, and this will require preliminary geophysical, geotechnical, metocean and environmental surveys. Preliminary site investigation surveys early in the project development programme are designed to give an overview of the receiving environment with the aim of developing a first stage ground model. At this stage, projects will be able to prepare conceptual project layouts, narrow down foundation type options, define preliminary export cable routes etc, but site knowledge will not be sufficient to finalise any design parameters. Around this time, projects will also need to finalise and submit planning applications to the relevant consenting authorities to be processed, prior to more detailed site information becoming available.

After planning consent applications are submitted, further geotechnical and geophysical surveys are often completed pre- and post-consent and pre-construction to determine WTGs locations, foundation design and cable routes [17]. At this stage the project will continue with its site investigation works in a more detailed and targeted manner, with a view to informing final design.

This phased approach to site investigation is also followed to line up with the staged process to project design. Generally, for an OWF or other major infrastructure projects, the stages of design will be broadly as follows [18]:

[1] **The feasibility study** is the first phase of any project. The stage of the project is used to determine whether the project is viable and economically feasible. Not only is technical and economic feasibility evaluated, but also legal, planning, and operational feasibility, as well as an assessment of the project's environmental, social, economic and political impacts. The study can be based mainly off desktop studies, or some preliminary site investigation data.

[2] **The Conceptual Design stage** starts after a positive outcome of the feasibility study once it is established that the project is viable. This marks the start of the design process, with the design the updated and refined as more detail becomes available. Survey data will be used to inform this stage and the stages that follow.

[3] **The pre-FEED (Front-End Engineering Design) stage** is the final part of conceptual engineering, where the selected concept will be defined and detailed further to come to a "design basis" for FEED. By the end of pre-FEED, key design decisions have been made, risks are clear and mitigated where needed, there is a clear approach for the execution phase, and cost estimates are more precise.

[4] **The FEED stage follows**, where based on the pre-FEED deliverables, a FEED Package can be prepared. The FEED Package forms the basis for contract bidding for the 'Execution' phase

[5] **Detailed design** can then be completed, where the design will be refined using all available site information, to enable procurement and construction.

This approach to project development and site investigation strategy is a primary reason why projects will not have sufficient certainty on design at planning submission stage.

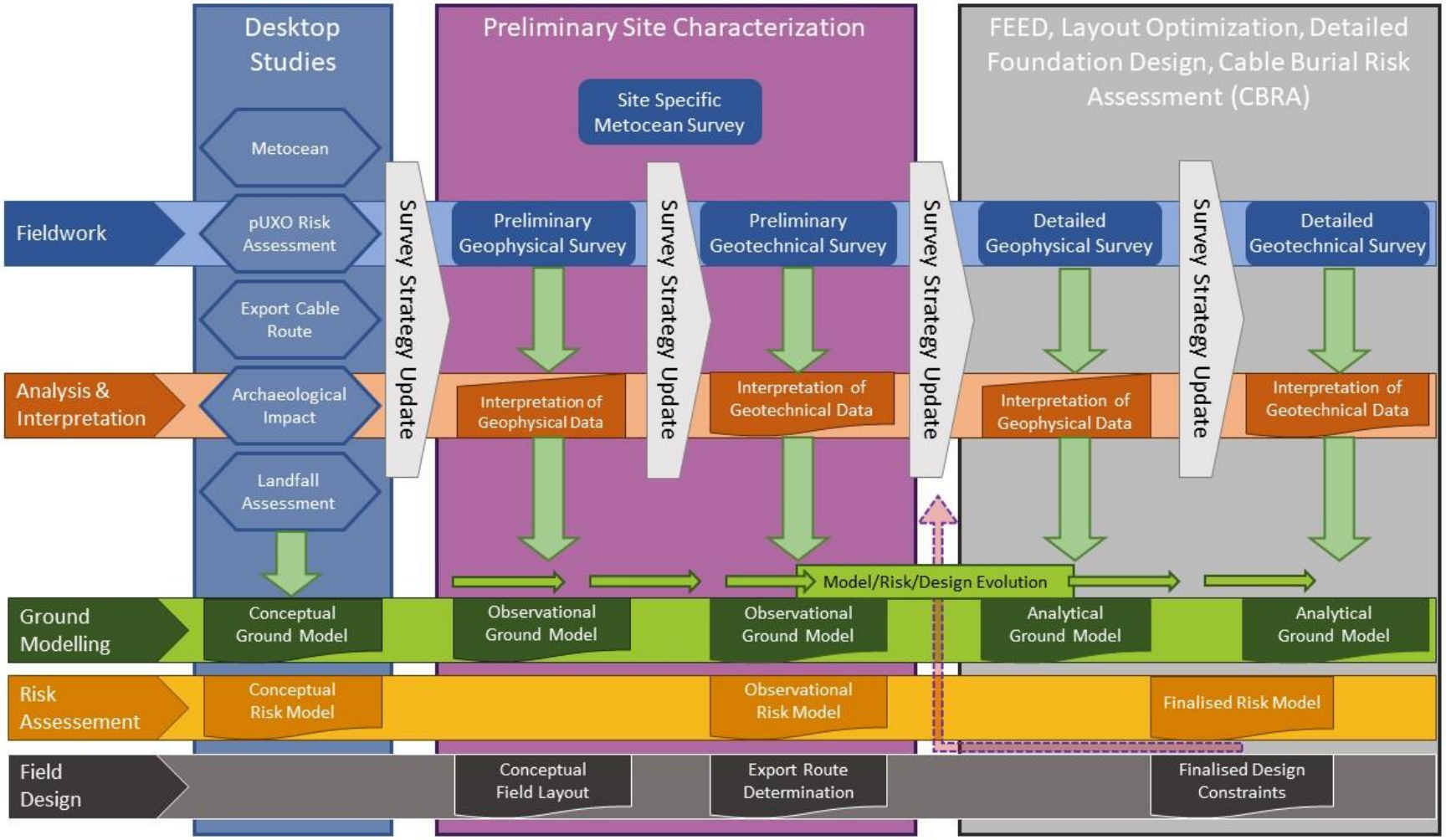


Figure 2-2: Illustration of Survey, Site Investigation, and initial design stage ground model update map (GDG)

2.1.5 External Factors can effect projects, and Decisions needs to be made to manage costs

A host of stakeholders and different factors impact OW projects – including those discussed above, and other external factors like market and environmental conditions, finances, and policy and legislation.

Projects will need to adjust to these factors, and make decisions to maintain the viability of the project, and manage costs. Incorporating flexibility into the consenting process helps projects to do just that, ensuring they can move forward with development, and at the lowest cost, and avoid projects being unnecessarily shelved or abandoned.

2.2 The Key Parameters in Need of Flexibility

OWFs are complex projects with a host of parameters feeding into design and consenting applications. Depending on the project and its circumstances, different parameters may be more in need of flexibility than others.

Table 2-1 shows a real project PDE example from the Neart Na Gaoithe (NNG) OW farm Environmental Statement (ES) (Chapter 6, The Approach to Environmental Impact Assessment) [19]. This includes a number of parameters involved in an OW development that may require design flexibility. This list is not exhaustive, and not all of these parameters need to be strictly defined in the project consent, but is used for information purposes. This envelope allows for turbines ranging from 3.6MW (175m tip height) to 7MW (197m tip height), so allows for a high level of flexibility. The full Rochdale Envelope is used in the preliminary assessment of each receptor, but only those parameters that would have an effect on the given topic are assessed.

Table 2-1: Example PDE using Rochdale Envelope from Nearh Na Gaoithe ES [19]

Project design element	Parameter	Turbine capacity			
		3.6MW	4.1MW	6MW	7MW
Turbines					
Turbines	Number at 450MW capacity	125	109	75	64
	Maximum rotor tip height (m)(LAT)	175	171.25	175.5	197
	Max turbine spacing (m)	1320	1249	1330	1805
	Min turbine spacing (m) (approx)	480	450	484	656
	Position of WTGs (coordinates / shapefiles)	Indicative Layout A		Indicative Layout B	
Jacket foundations					
Jacket foundations	Jacket leg spacing at seabed level (m x m)	15x15 - 25x25	15x15 - 25x25	20x20 - 30x30	25x25 - 35x35
	Foundation diameter (m) (piles)	2.5-3.5	2.5-3.5	2.5-3.5	2.5-3.5
	Foundation bed penetration depth (m) (piling)	15-40	15-40	20-50	20-50
	Foundation installation duration (per foundation) (hours)	Piling (62-180 hours for 4 piles), jacket installation (12-24 hours). This includes time for setting up and changing equipment between piling locations.			
	Total seabed occupied by substation	100-250m^2			
Gravity base foundations					
Gravity Base Foundations	Size of foundation footprint (m2)	300-700	300-700	490-1600	490-1600
	Quantity of material dredged	Average of 1500m^3 dredged per foundation. Approximately 190,000	Average of 1500m^3 dredged per foundation. Approximately 160,000	Average of 4000m^3 dredged per foundation. Approximately 320,000 m^3 of material dredged over entire site	

		m^3 of material dredged over entire site.	m^3 of material dredged over entire site		
	Installation duration (per foundation)	Seabed levelling and gravel bed placement 8-14 days. Foundation placement and filling 4-7 days scour protection placement 7-14 days			
	Gravel bed	Minimum 530m^3 per foundation, maximum 1850m^3 per foundation.			
	Foundation diameter (m) (piles)	20-30	20-30	25-45	25-45
	Turbine Foundation Scour Protection and footprint size	Gravel bed extends 2-4m outside full foundation perimeter. Scour protection extends 5-8m outside foundation perimeter			
Cables					
Inter-array cables	Number of cables (no)	Indicative 85-140km of cable			
Export cables	Number of cables (no)	2	2	2	2
	Cable Corridor width (m)	500m either side of cable route centre line. Burial depth 1-3m			

While above is a long list of potential parameters that may require flexibility, there are a few key ones that have been identified by GDG's design team as particularly in need of flexibility generally, and often subject to change at a late stage as more site information becomes available and on-site conditions are full established.

Some of the key parameters in need of flexibility are noted below. It can be seen that they are all very related, and a change in one parameter can cause a change in another.

- **Foundation type and dimensions**: final choice will be based on detailed understanding of ground conditions, water depth, environmental conditions, and WTG size.
- **WTG Model**: not known at time of consent application. Chosen based on yield analyses and engagement with supply chain on availability, cost, performance, suitability to site etc.
- **Hub height:** Optimized to suit the final layout, generally to maximise energy yield/minimise wake losses.
- **Elevation of top of blade:** dependent on final turbine choice, rotor diameter and hub height. Also influenced by final foundation choice.
- **Elevation of bottom of blade:** dependent on final turbine choice, rotor diameter and hub height. Minimum blade clearance requirements also generally apply to prevent / lower risk of collisions with birds. Also influenced by final foundation choice.
- **Rotor diameter:** dependent on final turbine choice. Influence by blade clearance requirements.
- **Installation / Construction methods:** installation method will be chosen primarily based on technology type and ground conditions. For example, a monopile foundation can be drilled, driven, or use drive-drill-drive for installation. The ground conditions and rock type on site will influence this, as well as the availability of suitable hammers and / or drills for installation. A gravity-based foundation would not require drilling or driving, but would require seabed preparation and rock dumping etc.
- **Exact WTG and OSS layout:** Wind farm layout is subject to change based on: Prevailing wind direction; Distance from adjacent WTGs; Geological and bathymetric conditions; Physical and spatial constraints; foundation choice etc.

Nonetheless, each project will have specific requirements, and may need more flexibility on particular parameters for site-specific reasons. Project PDEs are shown and discussed further in Section 6.

3 OVERVIEW OF APPROACH TO PROJECT SCOPING AND EIA USED BY THE INDUSTRY

The use of PDEs in EIA is the key area of design flexibility which needs to be careful understood and considered, to ensure potential impacts are properly described and considered by the applicant, and assessed by the CA. EIA is an iterative tool for examining and assessing the impacts and effects of the construction, operation, and decommissioning stages of a development on the environment.

EIA is required under the EU's EIA Directive (2011/92/EU as amended by 2014/52/EU) (The Directive).

The purpose of an EIA is to carry out an independent assessment of the 'likely significant effects' of a project, both adverse and beneficial. It is a systematic and evidence-based process and comprises the following broad stages:

- Screening to determine whether or not an EIA is required;
- Scoping of issues to be considered within the EIA;
- Collection of baseline data, through surveys, consultation, and desk-based studies, to describe and characterise the existing environmental conditions, as a basis for the impact assessment process;
- Identification and assessment of potential environmental impacts and conclusions on the likely significance of impacts identified;
- Identification of mitigation measures and monitoring, or management strategies that can be applied, to avoid, reduce, or remove identified adverse impacts and the subsequent assessment of residual impact significance.

Screening is the first stage of the EIA process, whereby a decision is made on whether an EIA is required. The decision-making process then proceeds by examining the relevant legislation which transposes the Directive (e.g. Planning and Development Acts and associated secondary legislation, Maritime Area Planning (MAP) Act 2021 etc.) paying particular attention to the nature and scale of the project in the context of Annex I and Annex II of the EIA Directive. If this process does not provide a clear screening outcome, then the nature and extent of the project, site and the types of potential effects are examined. The totality of the project is considered, including off-site and secondary projects as well as indirect, secondary, transboundary and cumulative impacts.

In Irish legislation, Annexes I and II are broadly transposed by way of the Planning and Development Regulations 2001, as amended, in Schedule 5 Parts 1 and 2, with national thresholds added to many of the Part 2 classes of development. Part 1 developments meeting or exceeding the thresholds set out therein require mandatory EIA and, as such, there is no screening determination required. Part 1 sub-threshold developments require screening in cases where the same class of development is not listed in Part 2 with a lower mandatory threshold. For Part 2 developments, in cases where national thresholds are met or exceeded, or where no threshold is set, there is mandatory EIA; again, there is no screening determination required.

Figure 3-1 below sets out the EIA process as described by the EPA in its guidance [20]. This is the overall process that Irish OW projects will be expected to broadly follow in their EIARs (Environmental Impact Assessment Reports). While the guidance does not explicitly mention the use of a design or Rochdale envelope, it does state that:

Where provision of full details of the construction and/or operation of a project is not practicable in an EIAR, the extent of environmental effects of the project should be set out so that the CA has sufficient information about the context, for their assessment and decision. To do this, a description of the project should be provided to enable the worst-case effects of the project to be described in an EIAR. The detailed design can then vary without rendering the EIA process inadequate… Notwithstanding any allowance for omission of full details of a proposal from the EIAR, the EIAR must contain adequate information to enable assessment of all likely significant effects. The more detailed the proposal is at the time of the consent application, the easier it will be to ensure compliance with the legislation.

This approach is consistent with the Rochdale envelope approach as it has been applied in other jurisdictions (See Section 5).

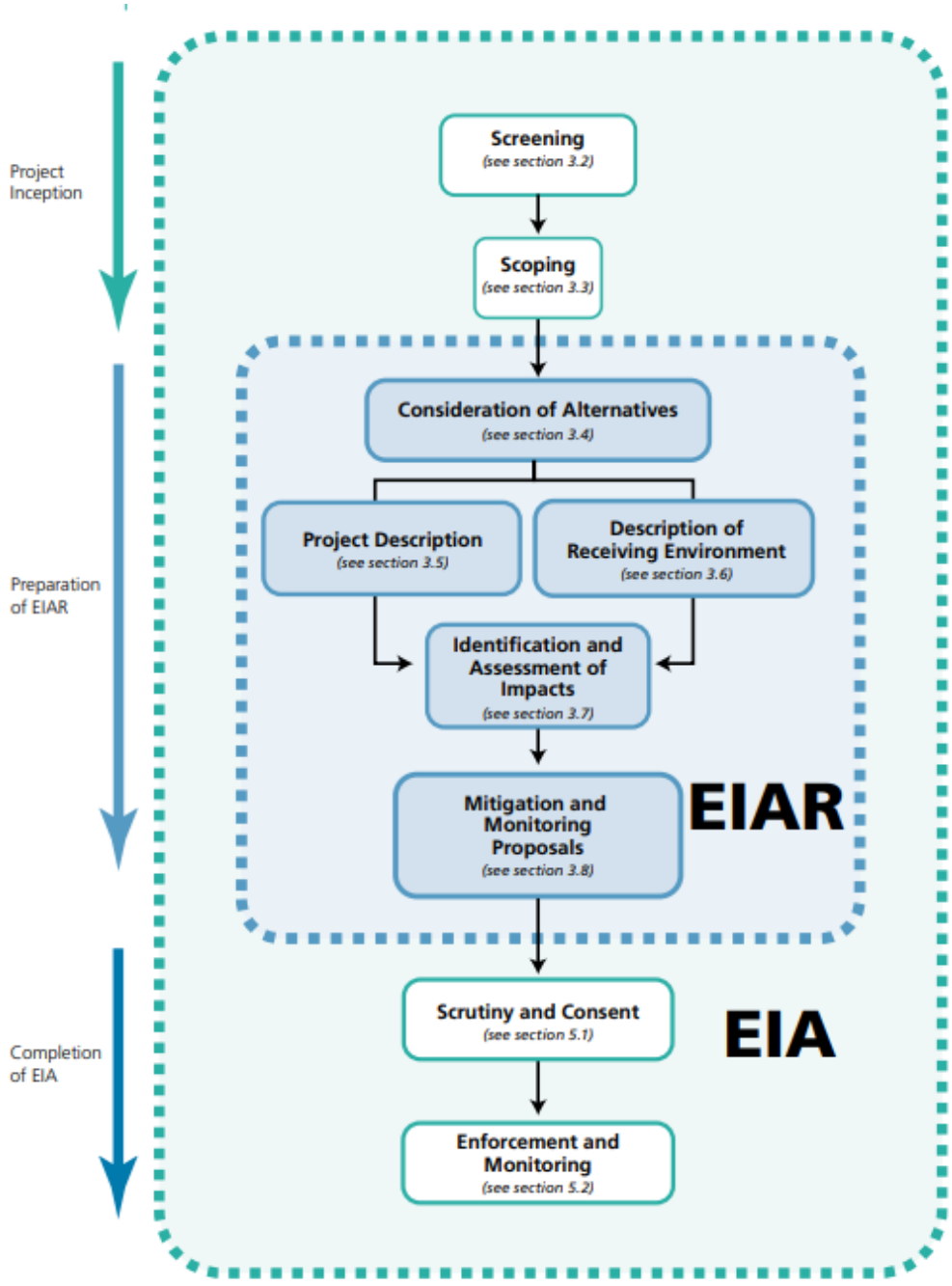


Figure 3-1: EIA process as described by the EPA

3.1 EIA SCOPING

Scoping is a key stage of the EIA process. Scoping is conducted at an early stage in the process to ensure that the environmental studies required are undertaken in a sufficiently timely manner to provide all the relevant information on a proposed project.

EIA Scoping Reports are used to inform stakeholders about the key environmental issues, the key elements of the Project and alternatives within the Project. They also aim to generate comments from stakeholders and to provide the consultees (which can be Statutory and Non-Statutory) with an opportunity to provide feedback, particularly on the approach to assessment and survey methodologies as well as any data collected/presented. This can be particularly useful for establishing the worst case (WC) scenarios to be taken forward to EIA.

EIA Scoping Reports also includes what methods have been and/or will be used to gather and assess that information.

Generally, EIA Scoping Reports describe:

- the key elements of the proposed development
- the baseline conditions and sensitivities of the receiving environment likely to be affected by the Project
- the gaps in baseline knowledge and the studies and assessments proposed to address those gaps
- The potential impacts throughout the construction, operational and decommissioning phase of the Project
- outline of the proposed approach and structure to the forthcoming EIAR.

Refinement of the approach to assessment will then be carried out while the EIAR is prepared. If information emerges after the initial scoping stages indicating that additional issues should be considered, then these will also be included.

An example Table of Contents for an EIA Scoping Report is shown below in Table 3-1:

Table 3-1: EIA Scoping Report structure overview

Chapter	Brief Description
Introduction	Describing the project background and the benefits of the proposed development. This chapter also details the current status and consent process for the proposed development.
Proposed Programme	A timeline with key dates for the proposed development as well as any relevant details
Stakeholder Engagement and Consultation	This chapter contains a description of the applicant's approach to the consultation at every stage, including pre-scoping consultation, technical consultation, community and public consultation and planned scoping consultation
Policy, Planning and Legislative Content	The local need for the proposed development is outlined here. As well as this, a non-exhaustive list of relevant EU and Irish legislation is included in terms of how it is relates to the project. Irish relevant examples include NMPF, National Development Plan, Climate Action Plan and numerous EU directives
Site selection and assessment of alternatives	This chapter will present a summary of the alternatives assessment process. The EIAR will provide further detail on the alternatives assessment including how the design, sites, routes and locations have evolved over time.
Detailed description of the proposed development	This chapter sets out an overview of The Proposed Development, including its main component infrastructure. This chapter also sets out a general description of the activities typically involved in the Construction, Operation and Maintenance and decommissioning Phases of an OWF.
Environmental Impact Assessment Methodology	This section sets out the proposed approach to the EIAR to be prepared to support the consent application.
Wider Scheme Aspect Chapter	This chapter details other mitigating factors such as population and human health in the area, seascape, landscape and visual impacts, climate and major accidents and/or disasters that are relevant to the proposed development.
Offshore topic specific chapters	This chapter relates to only offshore specific issues such as marine geology, oceanography and physical processes, Marine water quality, underwater noise and vibration, Benthic, epibenthic and intertidal ecology, marine mammals and marine turtles, offshore ornithology, offshore bats, fish and shellfish, commercial fisheries, shipping and navigation, marine archaeology and cultural heritage, aviation and radar, coastal and marine infrastructure and other users, offshore air quality and offshore airborne noise
Onshore Topic Specific Chapters	This chapter relates to only onshore specific issues such as air quality, noise and vibration, land, soils and hydrogeology, surface water, including flood risk, biodiversity, archaeology and cultural heritage, roads and traffic and material assets
Interaction of effects and summary of transboundary effects and monitoring and mitigation measures	This section presents an overview of the proposed approach to be taken in the preparation of the EIAR that will support the Development Permission application in relation to the following: • Interaction of Effects • Summary of Cumulative and Transboundary Effects; and • Monitoring and Mitigation Measures

EIA Scoping reports completed for most of the Phase One OWFs (which also adopt a design develop approach) can be found online: Dublin Array [21], the North Irish Sea Array (NISA) [22], Oriel Wind Farm [23], Arklow Bank Wind Park Phase 2 [24], Codling Wind Park [10].

Many other examples can also be found following a similar approach (i.e. scoping using a design envelop approach) e.g. Berwick Bank [25], Shelmalere OWF [26], Neart na Gaoithe OWF [27] etc.

3.2 EIA Reporting Approach

The next step in this process is the EIAR which documents the effects that the proposed developments may have on the surrounding environment, usually for both onshore and offshore aspects of the project, where both are being considered under the same planning application. This report is undertaken by or on behalf of the developer and informs the EIA procedure.

Section 72 of the EPA Act 1992 is the basis for the contents required in the EIAR. These guidelines have been revised to include the transposition of the amending EIA Directive (2014/52/EU) and also encapsulate precedent from EU and Irish case law. An EIAR will often be accompanied by an EIAR Non-Technical Summary (NTS). The purpose of this document is to describe the proposed development in non-technical language so as to make the information more easily accessible to the wider public.

EIARs for windfarms in other jurisdictions can be found online, e.g. [28], [29]. For Irish examples, recent planning applications for Phase One projects, which were submitted in May and June 2024, can now also be viewed e.g. [30], [31].

Throughout an Offshore EIA Scoping Report (and subsequent Offshore EIAR), the Design Envelope approach may be used to allow meaningful assessments of the Proposed Development to proceed, whilst still allowing reasonable flexibility for future project design decisions.

Once the EIAR has been completed and distributed to relevant stakeholders, the last stages of the EIA process are undertaken. These last steps aid the developer in presenting information to the CA and finalising the EIA process. The penultimate stage involves Scrutiny and Consent of the EIAR.

3.2.1 Realistic Worst Case Scenario Approach for EIA

The use of a Rochdale Envelope / Design Envelope approach facilitates defining a 'realistic worst case' (RWC) scenario in the EIAR that the CA can account for in assessing environmental impacts of a project – this is one of the key principles of the approach as it has been applied to date.

In most jurisdictions, if the project's final as-built technical and engineering parameters fall within the limits of the envelope established within the EIA, then flexibility is permissible under the consent granted, subject to any conditions that may be applied to the consent. If consent is granted on the assessed maximum parameters of a development, any parameters equal to or less than those assessed is permitted to be constructed.

The RWC scenario assumes that one or other of the parameters will have a more significant adverse effect than the alternative. Where a range is provided, i.e., blade tip heights, the most detrimental is assessed in each case.

An important point to be made here is that the most significant impact / WC scenario will be different for each receptor type. Understanding the cause and effect specific to each receptor leads to the definition of the appropriate Rochdale parameter for that receptor and, therefore, identifies the RWC. Taking the RWC scenario, it can be assumed if no significant impact is demonstrated at the RWC, then no significant impact is likely for any scenario.

The word 'realistic' is important here. The parameters assessed in the EIAR should not be a combination of the maximum design parameters for each component. For example, generally the project would not assess both the maximum number of turbines and the parameters related to the largest turbine type within the envelope, as this is not a feasible scenario. Assessment based on the maximum number of turbines would usually assume the smallest turbine type, and vice versa. Some of the design parameters cannot co-exist e.g. the largest turbine and the largest number of turbines may exceed the project capacity.

This approach avoids assessments being overly conservative. Assumptions around this should be set out clearly in the EIAR, so assessment can be undertaken by the CA with certainty.

From the parameters outlined in the EIA, including information relating to construction methods and schedules, vessel movements and decommissioning information, individual WC scenarios can be developed for each receptor resulting in a tailored Rochdale Envelope. The full Rochdale Envelope is used in the preliminary assessment of each receptor, but only those parameters that would have an effect on the given topic are assessed. For example, when considering visual impacts, the volume of material dredged would not need to be considered, or when considering impacts on marine mammals, turbine tip height need not be considered etc.

Once the Rochdale Envelope has been developed for each receptor, it is checked to ensure the assessment covers all aspects of the design that could be constructed, while avoiding an unrealistic project.

Ultimately, a clear picture of the realistic worst case development scenario is constructed specific to each individual receptor. The full EIA then draws together the conclusions of the individual chapter assessments to provide a clear and concise summation of the potential impacts [19].

An important part of this is the scoping stage, which can be used to screen out certain impacts, and consult with relevant stakeholders to establish what the WC scenario for a particular receptor is.

To demonstrate this, we can look at the Inch Cape EIAR [32] (a project which is reviewed in greater detail in Section 6.1). The project's EIAR (Chapter 7 – Description of the Development) notes that the assessments within each technical chapter are based upon the design parameters which represent the WC for the receptor under consideration. As each individual impact assessment is based on the WC parameters specific to their topics, the EIAR concludes that the overall impact assessment represents the worst-case scenario for the Development.

We can then look to the individual technical chapters for a description of the worst-case scenario for each different receptor. This is described for a selection of receptors in Table 3-2 from the Inch Cape EIAR.

The summary of effects EIAR Chapter draws together these conclusions, and identifies all the mitigation measures, that have both been embedded into the design (and taken into account in the baseline assessment), and those additional mitigation measures that have been proposed to reduce the environmental effects of the Development on those receptors assessed.

It is the responsibility of the developer/applicant to ensure the approach to identifying RWC scenarios for each receptor and assessing same is clearly set out in a way that allows the CA to undertake its assessment.

Table 3-2: Overview of WC scenario assumptions for different receptors in the Inch Cape EIAR (focus on array area impacts) [32]

EIAR Chapter / Receptor	Potential Impact	Worst Case Scenario Discussion and Design Envelope Scenario Assessed
Ornithology	Displacement and Barrier effect	The methods used to determine impacts from displacement and barrier effects are not influenced by WTG density or by the dimensions of the WTGs. **The assessment was based upon a maximum extent of the Development Area (150 km^2) plus a two km buffer.**
	Collision risk	Considered: • 72 WTGs, with a max mean hub height above LAT of 119 m and a max rotor diameter of 167 m. • 40 WTGs, with a max mean hub height above LAT of 155.5 m and a max rotor diameter of 250 m. Of these, the **40 WTG design represented the WC for two of the three receptors for which collision risk impacts were considered to have the potential to cause significant effects** (i.e. gannet and kittiwake
	Residual Effects (Ornithology)	The assessment identified no ecologically significant residual impacts for the Development, either alone or cumulatively, for any ornithological receptor (i.e**. no moderate/major or major impacts were concluded**).
Marine Mammals	Pile driving noise	Ground model study revealed that up to 20% of the site may require higher blow energies to drive the pin piles to the required depth. Thus, the most likely blow energy profile represents the soft start and ramp up to full power required to drive the pile into the sediment across 80% of the site, while **the WC represents the increased blow energy required to drive the pile within the remaining 20% of the site.** Guidance received from Marine Scotland and SNH (in meetings) confirmed that a most likely (ML) scenario (for pile driving noise) should be considered in the impact assessment for marine mammals, contextualised with a description of a WC scenario and how frequently WC is likely to be encountered. **The assessment for the Development was undertaken upon the WC scenario, with the caveat that this situation across the whole site is not credible.** The assessment also provided the impact assessment for the most likely scenario to contextualise the more likely scale of effects from driving the piles.
	Displacement/ PTS from piling	**Max blow energy (kJ)** Most probable blow energies (80% of locations): 1080

EIAR Chapter / Receptor	Potential Impact	Worst Case Scenario Discussion and Design Envelope Scenario Assessed
	(pin piles)	Highest expected blow energy (20% of locations): 2160 **Total piling duration (hours/ pin pile)** Most probable blow energies (80% of locations): 2.5 Highest expected blow energy (20% of locations): 2.6 **Total number of pin piles** Most probable blow energies (80% of locations): 244 Highest expected blow energy (20% of locations): 60
	Displacement/ PTS from piling (monopiles)	**Max blow energy (kJ)** Most probable blow energies (80% of locations): 2250 Highest expected blow energy (20% of locations): 4500 **Total piling duration (hours/ monopile)** Most probable blow energies (80% of locations): 4 Highest expected blow energy (20% of locations): 6 **Total number of monopiles** Most probable blow energies (80% of locations): 59 Highest expected blow energy (20% of locations): 15
	Residual Effects (Marine Mammals)	The residual effects of displacement and PTS on all marine mammal species from piling at the development area was predicted to be of **minor significance**.
Seascape, Landscape and Visual (SLV) Impacts	Impacts Scoping	Design Envelope being considered at Scoping stage was 48 turbines of up to 301m to blade tip (the lowest number of turbines likely at the tallest height) and 72 turbines of 215m to tip (the greatest number of turbines at the lowest height considered). **SNH agreed that on initial review of the preliminary wirelines for both scenarios sent to SNH, it was likely that the WC scenario for Inch Cape would be the tallest turbines** as this created the greatest visual presence and result in a greater difference between Inch Cape and NNG and Seagreen.

EIAR Chapter / Receptor	Potential Impact	Worst Case Scenario Discussion and Design Envelope Scenario Assessed
		The maximum blade tip height was reduced from 301m at scoping to 291m in the application. **Accordingly, the SLV Impact Assessment took account of 40 of the tallest proposed turbines (291m) with the consented NNG and Seagreen OWFs.**
	Operational Phase - Physical presence of WTGs and OSPs may affect seascape and/or landscape character, landscape designations and visual amenity.	40 WTGs 291 m to blade tip and 166 m to hub height, and up to two OSPs of 100 m x 100 m and up to 70 m height.
	Residual Effects (Visual Impacts)	Analysis of visibility data showed that at a distance of around 35km, which is the furthest distance at which **significant effects** are predicted for high sensitivity landscape or visual receptors, visibility of the WTGs is likely to occur for on average, just under 40% of the year.
Socio Economic Impact		In order to follow EIA Regulations, **the socio-economic assessment was based on the minimum generating capacity considered for the Development which was 560MW** e.g. in terms of economic impacts this would be considered the lowest or the WCS. associated with the Development).
	Residual Effects (Socio Economic Impact)	For one of the eight catchment areas within the Economic Study Area, **significant beneficial effects were assessed** as being likely to occur during the construction phase only, these being in the labour market catchment area around the Cromarty Firth.
Shipping and Navigation	Operational Phase - Increased vessel to vessel collision risk and the creation of vessel to structure allision risk	It was considered that the **WC scenario would represent the greatest number of WTGs being considered (72) and the installation of the maximum number of OSPs (2) all on the largest jacket foundation (30 x 30m for WTGs, 100 x 100m for OSPs)** (i.e. maximum loss of navigable sea area), all located within the Development Area. This assumes that there will be increased potential for allisions and collisions when there are more and larger structures in place.
	Residual Effects (Shipping and Navigation)	All construction and decommissioning phase impacts were scoped out. Impacts associated with the Development Area were assessed as being of **moderate significance to commercial vessels, moderate significance to commercial fishing vessels, and minor/moderate significance to recreational vessels**. Following the application of further mitigation, the impacts were assessed as being of minor significance to commercial vessels, minor significance to commercial fishing vessels and negligible/minor significance to recreational vessels.

Table 3-2 shows how different relevant parameters and WCSs were identified for different receptors in the Inch Cape EIA. All of this is then summarised in the final chapter of the EIA report – Summary of Effects – which presents a summary of the key findings of the assessment of the environmental effects of the Development, alone and cumulatively with other relevant projects. The predicted residual environmental impacts of the proposals are reported for each receptor assessed, taking account of the potential for significant positive and negative environmental effects, and mitigation which has been committed to by the project.

The EIA for the Hollandse Kust Noord project provides another example [33].

The WCS for different receptors is found by researching and comparing several WCS as alternatives in the EIA. The parameters defined in the WCS are then named and described, such as the maximum number of turbines, maximum upper and lower limit of the rotor, maximum rotor surface area, characteristics of the foundation method, etc. An example table showing worst- and best-case scenarios for Birds and Bats, Underwater life and Shipping is shown below in Table 3-3.

Table 3-3: showing worst- and best-case scenarios for Birds and Bats, Underwater life and Shipping from the Hollandse Kust Noord EIA sumary [33]

Environmental aspect	Bandwidth	
	Alternative (Worst case)	*Alternative (Best case)*
Birds and bats	95 x 8MW turbines Lowest tip point 25m, rotor diameter 142 m	76 x 10MW turbines Lowest tip point 30 m, rotor diameter 221 m
Underwater life	76 x 10MW turbines Pile driving energy: 3,000kJ 1 turbine location per day	95 x 8MW turbines Pile driving energy: 1,000 kJ 1 turbine location per day
Shipping	95 x 8MW turbines Jacket foundation with 15m diameter	76 x 10MW turbines Monopile foundation with 10 m diameter

In all, this approach should enable the CA to understand the primary impacts of the project on each receptor assessed, any mitigation measures proposed, and the overall potential impacts of the project, which should enable the CA to make an informed decision on whether to grant the project consent or not.

3.3 SCRUTINY AND CONSENT

Following the submission of the EIAR to the CA, the public must be notified that an EIAR is being or has been submitted with a consent application. There may be additional requirements such as a discussion between the applicant and the CA on the details of the design in the case of larger developments.

The EIAR will be assessed to ensure that it is compatible with the EU Directive and transposing legislation. If a requirement is not met, an explanation from the developer will be requested. The involvement of competent experts in the preparation of the EIAR will be checked. A consultation with the public and certain authorities will be undertaken to seek their observations on submissions. These observations must be considered in the determination process.

Once the CA has assessed the report and application, there can be three outcomes;

- The CA can request further information from the developer if what has been provided in the EIAR is not sufficient
- The CA can grant the consent with conditions. These conditions are to ensure that mitigation and monitoring measures are adhered to and can be augmented or modified.
- The CA can refuse the consent and may point to evidence contained in the EIAR that show the applicant has not conformed to official standards or that there is uncertainty about environmental interactions.

The guidelines to the requirements in making a decision on the granting of the consent are contained in Article 8a of the Directive. There requirements relate to reasoned conclusion, conditions, mitigation measures and monitoring and must be transposed into the relevant legislation. There must also be provisions for appeals and challenges to the consent [34].

3.4 MONITORING AND ENFORCEMENT

Once approval has been granted, the developer must comply with specific mitigation measures and monitoring measures contained in the EIAR in addition to the conditions attached to the consent by the CA (Figure 3-2). Conditions or triggers may be activated at different times in the development, i.e., during construction, operation or decommissioning.

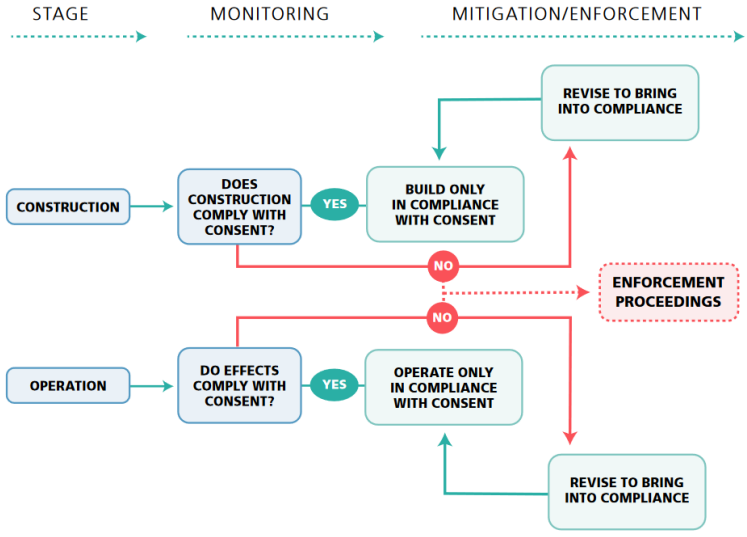


Figure 3-2: The Monitoring, Mitigation and Enforcement Process as described by the EPA

4 10 YEAR FIXED OFFSHORE WIND TECHNOLOGICAL OUTLOOK

One key driver for the need for flexibility in consenting is the continuous development of WTG technology for OW. To inform understanding on this, a review of WTG technology installed to date and expected in future is undertaken in this Section.

4.1 GLOBAL OVERVIEW

According to WindEurope [14], the average rated capacity of grid connected offshore WTG in Europe was 9.7MW in 2023, up from 8MW in 2022. The largest turbine size installed was the GE Haliade-X 13MW in the Dogger Bank Phase A project in the UK, while the largest turbine connected to the grid was an 11MW turbine in the Netherlands.

The Haliade-X platform was the industry's first 12+MW offshore WTG to operate. The turbine is available in a range of power ratings covering 12-14.7MW capacity, 220m rotor, a 107m blade, and up to a height of 260m [35]. Figure 4-1 below shows the scale of this turbine model.

The lowest average offshore turbine power rating connected to the grid in 2023 was in France (7.3MW), as the permits for the projects were granted more than 10 years ago, and the project consents only permitted this maximum size of WTG. This is an example of slow permitting and lack of flexibility leading to the installation of outdated equipment. The average power rating of OW turbine ordered in 2023, according to a WindEurope review of disclosed wind turbine orders, was 14.9MW (compared to 12.2MW in 2022). These turbines will be installed over the next few years and will continue the trend of growing power ratings for installed turbines.

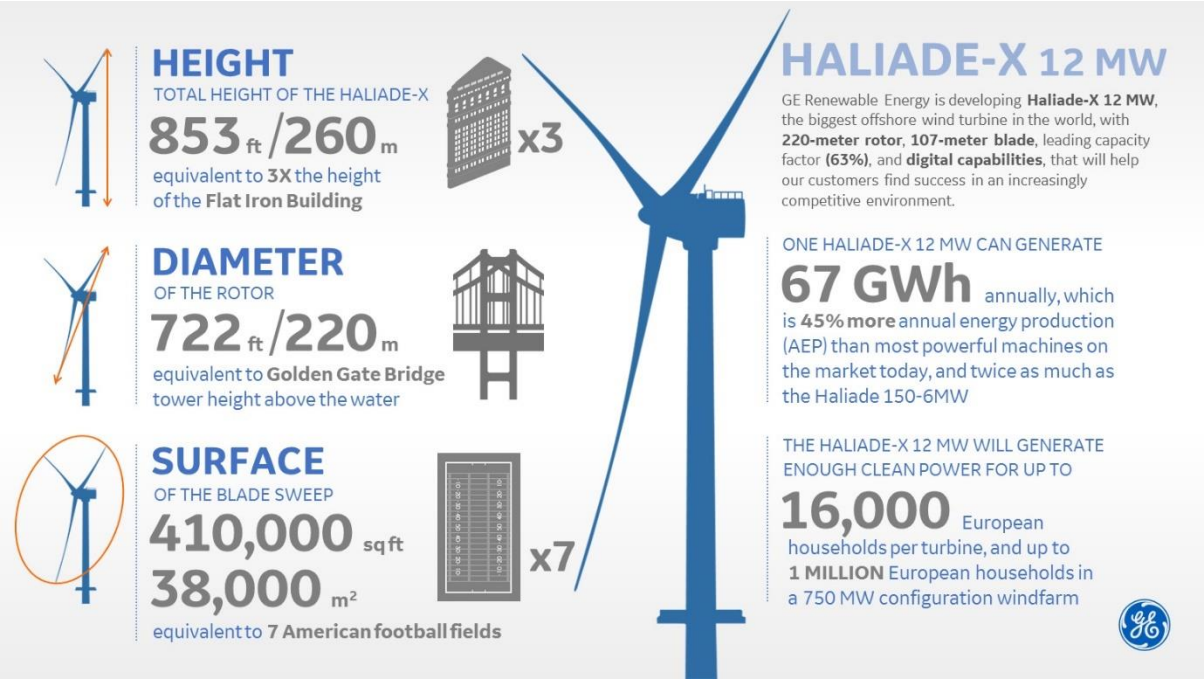


Figure 4-1: GE's Haliade-X OWF turbine infographic [36]

Figure 4-2 below from WindEurope shows the number of offshore turbines installed in 2023 and their average power rating. Over the period of 2014 to 2023, the average power rating of installed offshore WTG in Europe has risen from 3.8GW to 9.7GW.

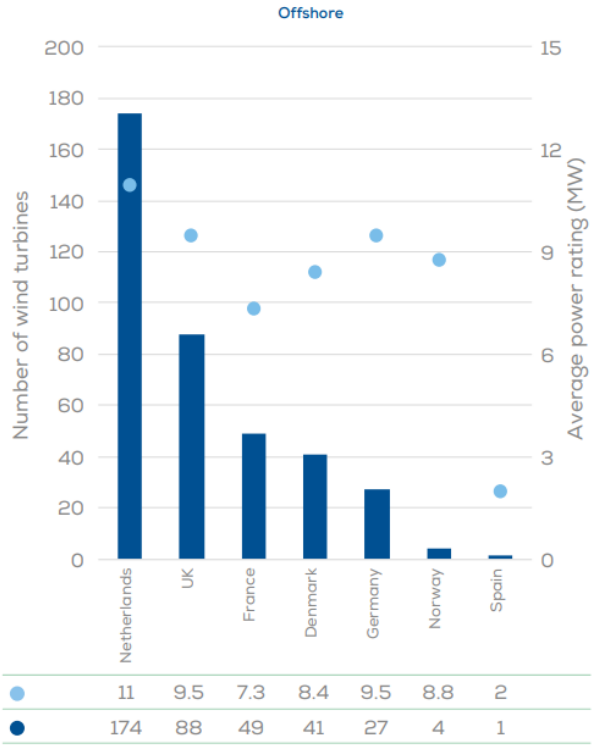


Figure 4-2: Number of turbines installed in 2023 and their average power rating [14]

Chinese WTG manufacturers are leading the charge towards larger machines. In October 2023, Chinese WTG manufacturer MingYang Smart Energy announced a new OW turbine model with a rated capacity of 22MW – the MySE 22MW. This turbine is set for development between 2024 and 2025, and would be the most powerful in the world, and is expected to include a rotor diameter of over 300m [37]. MingYang has also commissioned a 16MW turbine in China, and is developing an 18MW platform. In October 2024, China's Dongfang Electric Corporation announced a 26MW turbine with a hub height of 185m, and a designed rotor diameter exceeding 310m [38].

To aid this assessment, GDG has also undertaken a review of the TGS ForeSEE Global OW database, downloaded on 17 June 2024 [39]. GDG has access to this data under licence. The assessment was based on a review of fixed-bottom projects globally (currently installed and future pipeline), with relevant figures presented below (Figure 4-3 - Figure 4-5).

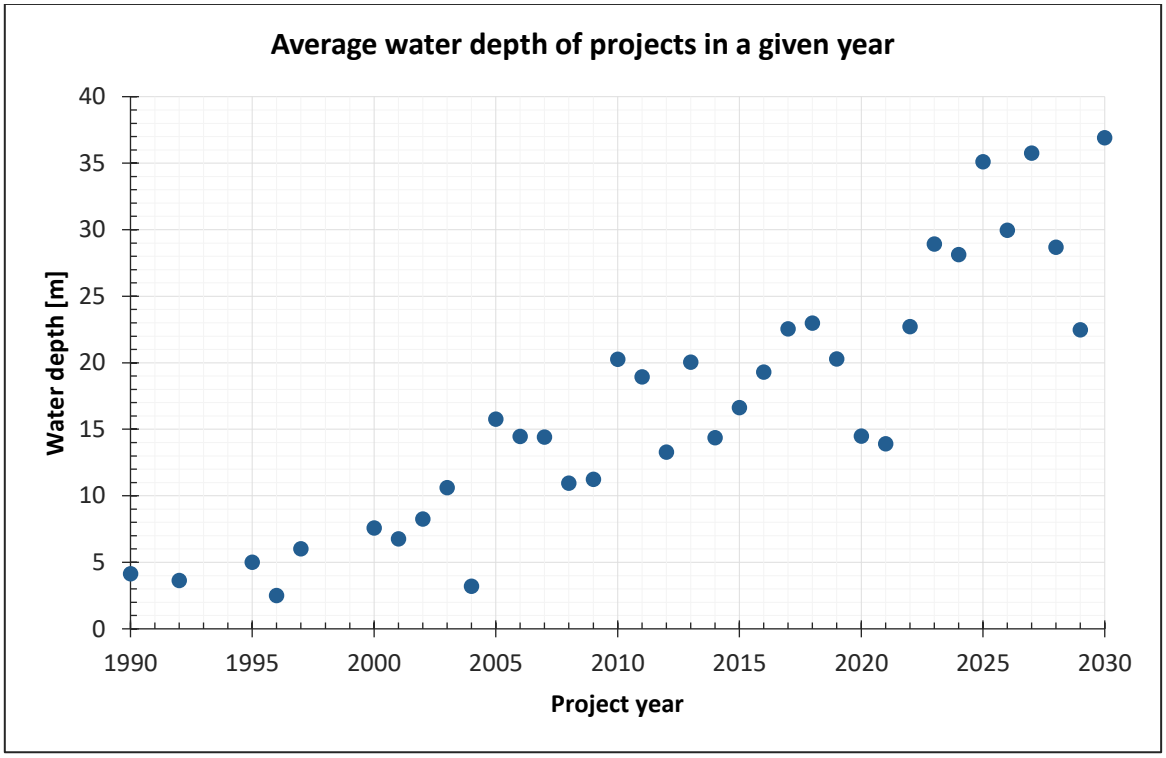


Figure 4-3: Average water depth of projects in a given year

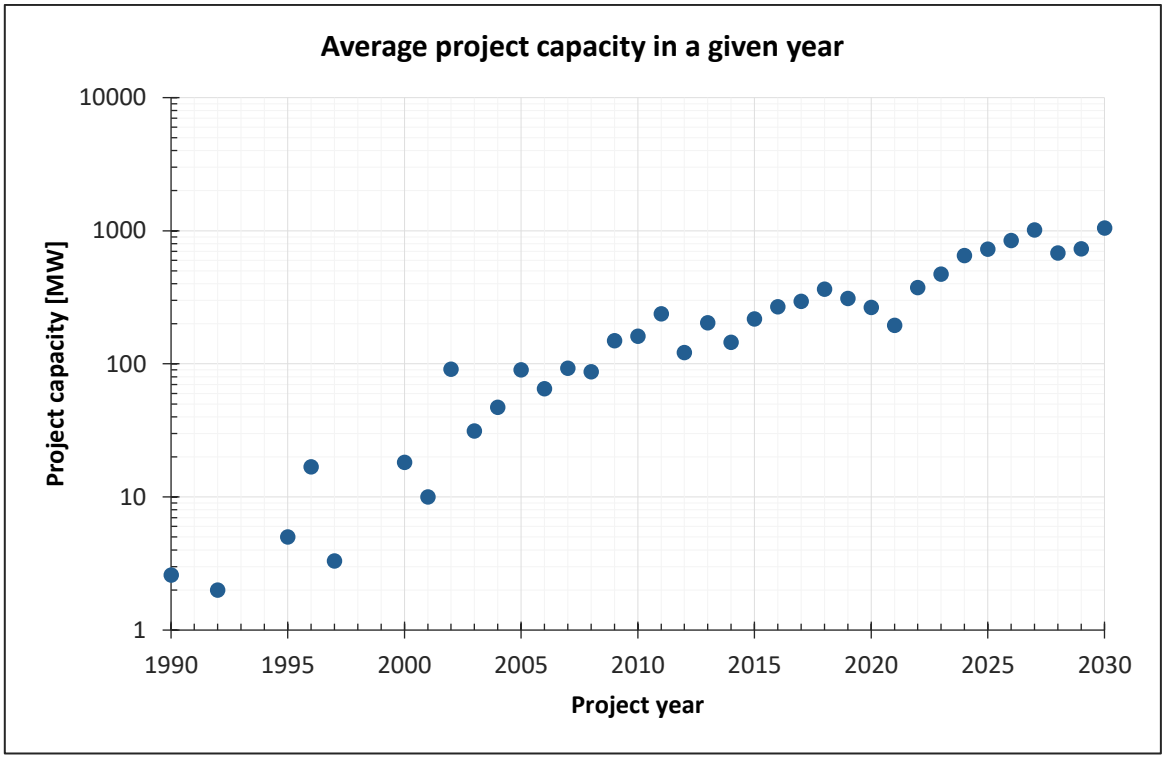


Figure 4-4: Average project capacity in a given year

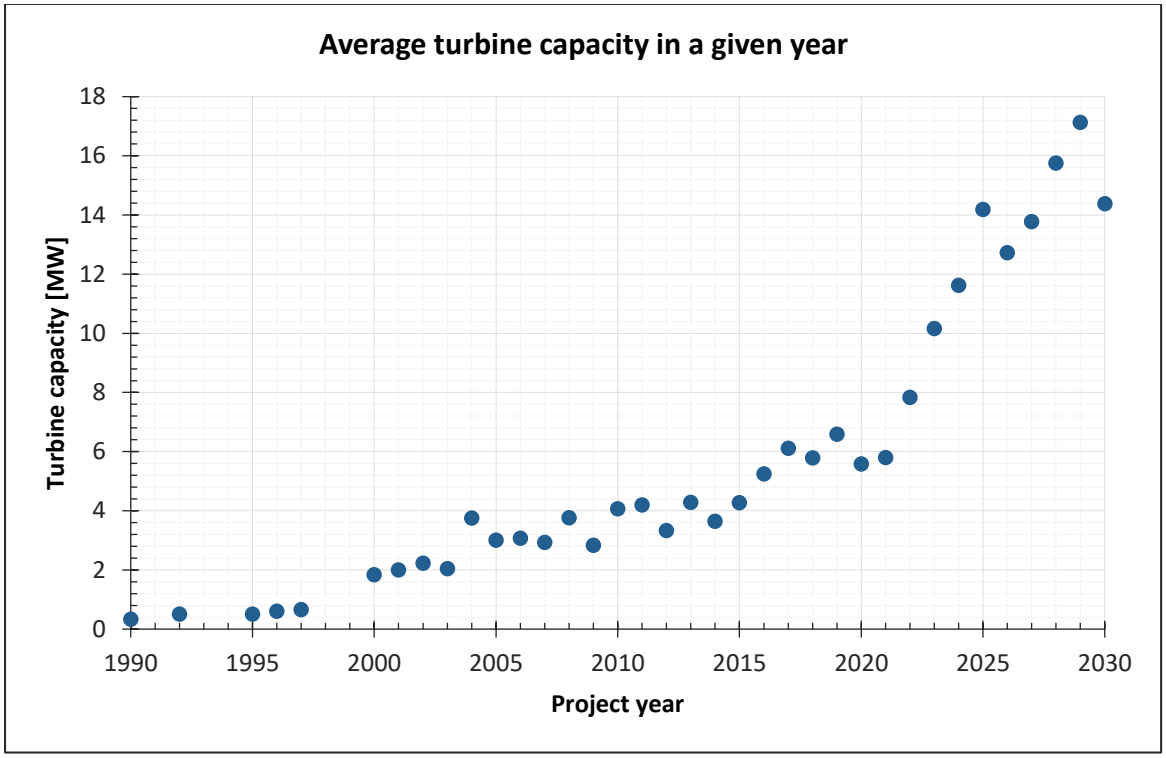


Figure 4-5: Average WTG capacity in a given year

The general trend across the database is building larger projects with more powerful WTGs in deeper water as the time goes on, however this appears to only be the case up to roughly 55 m of water depth and projects up to 2-3 GW. This is likely because in case of depth in excess of 55 m, the industry is expecting to be using floating foundations and the logistics involved with projects larger than the 3 GW mark would likely be above the scope of what is possible with the current capacity of staging ports, and manufacturing and construction technology.

Turbine sizes are expected to grow over time, with growth accelerating in the upcoming 5 years, but potentially plateauing afterwards when sizes of around 20MW are reached. This will depend on the available manufacturing and installation technology.

4.2 ISSUES CAUSED BY THE WTG 'ARMS RACE'

However, the race for bigger turbines has been cited as an issue for the industry, and the trend of ever-increasing turbine sizes cannot continue forever.

Energy analyst Wood Mackenzie has called for a cap on the size of OW turbines as the push for bigger turbines has placed unsustainable pressure on supply chains, with vessels, factories and ports unable to keep up with the demands to manufacture and install such large infrastructure. They note that while larger turbines were key to lowering the costs of OW initially, the larger sizes have now rendered some elements of the supply chain obsolete [40].

GE also scrapped plans to produce an 18MW turbine earlier this year, and is set to focus on rolling out smaller variants of the Haliade-X [41].

NedZero, the trade association for wind energy in the Netherlands, has called for the introduction of a maximum wind turbine tip height cap of 1,000 feet (~ 305m) combined with a tip clearance of 25 meters for a period of (at least) 10 years. This means that the maximum turbine dimensions would be set for at least a decade. They are calling this cap the North Seas Standard, and asking for it to be adopted by as many countries as possible [42].

Wind energy expert and pioneer Henrik Stiesdal has stated that the "arms race" to ever more powerful machines could undermine the benefits of mass industrialisation [43], which has been key to the huge build out of OW at large scale and lower cost seen over the last decade or more.

Developments will need to be monitored to establish how the trend emerges, with the expectation being that the current trend of increasing turbine sizes will continue for a time, but cannot continue as it has indefinitely.

Table 4-1 below summarises potential design parameters for future WTG model sizes which could be expected to enter the market, from a range of 14MW up to 24MW. This is based on an in-house GDG database of currently available, prototype and concept offshore turbines in the industry which has been analysed and extrapolated out to 24MW.

Table 4-1: Summary of potential WTG parameters

Turbine Output:	14MW	16MW	18MW	20MW	24MW
Rotor Diameter (m)	225	240	255	270	295
Swept Area (m2)	39,761	45,239	51,071	57,255	70,686
Maximum Blade Tip Height (mLAT)	251	266	281	296	321
Hub Height (mLAT)	139	146	154	161	174
Minimum Blade Tip Height (mLAT)	26	26	26	26	26

4.3 IRISH DISCUSSION

For Ireland, the best information available on future turbine sizes can be taken from the recent planning applications submitted by the NISA [44], Arklow Bank [45], Oriel and Codling Wind Park [46] projects.

NISA has looked for consent for 2 discrete project options:

- **Project Option 1:** 49 WTGs with 250m rotor diameter (290m tip height, 165m hub height , and 40m blade tip clearance)
- **Project Option 2:** 35 WTGs with 276m rotor diameter (311m* or 316m** tip height, 178m hub height, 40m* or 35m** blade tip clearance)

* When located outside the aviation restricted zone

** When located inside the aviation restricted zone

Similarly, the Arklow Bank project presents 2 project options in its EIAR.

- **Project Option 1:** 56 WTGs with 236m rotor diameter (273m tip height, 155m hub height , and 37m blade tip clearance)
- **Project Option 2:** 47 WTGs with 250m rotor diameter 287m tip height, 162m hub height, 37m blade tip clearance).

Codling Wind Park noted it is seeking 'limited flexibility' on the size and number of WTGs to be installed, with two layout options proposed in its EIAR:

- **WTG Layout Option A:** 75 WTGs with a rotor diameter of 250 m (287.72mLAT tip height, 162.72mLAT hub height)
- **WTG Layout Option B:** 60 WTGs with a rotor diameter of 276 m (313.72mLAT tip height, 175.72mLAT hub height)

Importantly, the NISA application notes that the options it describes do not refer directly to capacities of individual WTGs, but rather their number and physical dimensions, as in recent years, the capacity of WTGs has become more flexible and may be different depending on the environmental conditions at a particular site. The environmental assessments presented in the report were therefore linked to the specific physical design parameters such as blade tip height, rotor diameter, and height of nacelle, rather than WTG capacity. This is the same approach taken by Arklow Bank and Codling.

Reviewing Table 4-1 above and the dimension outlined in the project EIARs, WTG capacities of approximately 16-21MW could be expected for the projects, but as noted, this will need to be assessed closer to commissioning.

For Oriel wind farm [47], the EIAR notes that the project has a preferred wind turbine model of 15MW and the wind turbine rotor diameter is fixed at 236m. The wind turbine hub height will vary within the range 145-152m above Lowest Astronomical Tide (mLAT) across the wind farm site due to the specific height of each foundation.

It should be noted here that the projects have sought a relatively low degree of flexibility in consenting for their projects, and have looked to consent options rather than PDEs. This can be attributed to the pre-application consultations undertaken by the projects with ABP, and the level of flexibility which ABP was willing to accommodate. This is discussed further in Section 7.4.

For future developments (Phase 2 and beyond), Irish projects can be expected to generally follow the global trend discussed above. Improvements in Irish port infrastructure will be required to enable projects with WTGs of this scale to be built from Irish ports.

Longer term, Ireland is expected to transition more towards floating wind, but there is still good potential for fixed bottom wind development in Ireland post Phase 2. Table 4-2 below from the Sustainable Energy Authority of Ireland's (SEAI) ORE Technology Roadmap shows SEAI scenario modelling which predicts 6 – 10 GW of fixed bottom OW by 2050, and up to 40GW of floating OW by 2050. As fixed bottom technology develops, it is also expected to move to deeper waters, so this 10GW may be viewed as a conservative assumption. In the report, the SEAI states the Ireland's technical potential for fixed OW is likely to be significantly higher than 10 GW, but in practice higher than 10GW may be harder to achieve when available area, and cumulative impacts are considered. How this will develop will depend on the relative development of the two technologies in the coming years.

Large scale floating wind projects can be expected to use turbines of a similar scale to fixed-bottom. The largest floating project installed to date, Hywind Tampen, has 11 x 8.6MW turbines installed. The project was installed in 2022 and fully commissioned in 2023, so this is in line with the average offshore WTG size connected to the grid in Europe at that time (9.7MW in 2023, up from 8MW in 2022).

Table 4-2: Scenario modelling for the SEAI Report outlining modelled capacities for fixed bottom and floating wind out to 2050 [48]

Scenario	Technology	Total capacity installed by end 2030 (GW	Total capacity installed by end 2040 (GW)	Total capacity installed by end 2050 (GW)
Scenario 1 - Decarbonising through OW	Fixed OW	3.2	5.5	6
	Floating OW	0	1	3.3
Scenario 2 - Delivery of 37 GW ambition	Fixed OW	3.2	10	10
	Floating OW	0	7	27
Scenario 3 - Stretch wind target	Fixed OW	3.3	10	10
	Floating OW	0	13	40
Scenario 4 - Meeting 37 GW ambition with wind and wave	Fixed OW	3.3	5.5	10
	Floating OW	0	6.3	24

5 FLEXIBILITY PROVISIONS IN OTHER JURISDICTIONS

5.1 THE ROCHDALE ENVELOPE IN EUROPE

The need for design flexibility in planning applications for OW is an issue that has been addressed in other jurisdictions already. In other European jurisdictions, to enable projects to accommodate these uncertainties, EIA for OW development has been based on the established principle of the Design Envelope or the PDE, as discussed earlier in this report. Different terms for this approach are used in different jurisdictions, e.g. The Rochdale Envelope in the UK, Box Models in parts of Europe, Bandwidth in the Netherlands etc. Generally, however, the principle remains the same, as set out below.

The origin of this approach, coming from the UK, is set out in the following paragraphs (adapted from the cases of R v Rochdale Metropolitan Borough Council ex p Milne (2000) and R v Rochdale Metropolitan Borough Council ex p TEW (1999)) (Rochdale Envelope). These cases dealt with outline planning applications for a proposed business park in Rochdale.

This Rochdale Envelope approach is based on identifying the WC from within the realistic and likely options that might be developed. The approach allows developers to identify in their permit application a reasonable range of potential project design parameters for certain key components of a development. The permitting agency then uses the PDE approach to assess potential impacts on key resources (e.g., marine mammals, fish, benthic habitats, commercial fisheries), focusing on the development options with the potential for the WC in terms of potential environmental impact.

The Design Envelope, therefore, sets out a series of design options for the project and it contains a reasoned minimum and maximum extent for a number of key design parameters. The final, detailed design will lie within the minimum and maximum extent of the consents sought. This is consistent with the assessment of the 'WCS' as envisaged within the Guidelines on the information to be contained in EIAR as published by the Environmental Protection Agency in May 2022 [20].

The detailed design of the project, following consent award, can therefore vary within the PDE which has been assessed and consented, and can be further refined as engineering design details become available, without rendering the supporting EIA inadequate. By retaining flexibility in the design parameters considered in the application, the Design Envelope approach aims to ensure that the final project design can be accommodated within the existing consents, reducing the need for any potential future variations to those consents.

The European Commission's view is that the Design Envelope approach is not inconsistent with the EIA and Habitats Directives. The EU Commission's publication Guidance document on wind energy developments and EU nature legislation (2020) [49] endorses the use of a design envelope approach and sets out how the flexibility provided is compatible with the requirements of Environmental Impact Assessment (EIA) (Directive 2011/92/EU [50] as amended by Directive 2014/52/EU [51]) and the Habitats Directive (Directive 99/43/EEC [52]). An excerpt from the guidance document shown below [emphasis added]:

The design envelope approach provides flexibility during the design and pre-planning phase of offshore wind energy projects and allows a degree of freedom to optimise wind turbine parameters prior to construction. It is a proven and acceptable approach to consenting where there is uncertainty in the final design of a project, and there is an established procedure for ensuring robust assessment of significant effects [49].

Increasing flexibility in adapting technology specifications in the timeframe between permit application and construction of projects aids greatly in speeding up development timelines, as noted by the EU Commission [53]. The Commission's 2024 Commission Staff working document accompanying the commission recommendation on speeding up permit-granting for renewable energy notes that '*More flexibility, i.e. allowing developers to apply for a range of technological parameters or to notify changes in a fast manner after the permit is issued to allow updating the permit while limiting the review of the authorities to the changes that are strictly necessary, helps in deploying the most efficient technologies in a faster manner, without necessarily entailing a greater environmental impact.'*

Without flexibility, the length of permit-granting procedures or delays in permit-granting can lead to sub-optimal technology installation in cases where project developers are obliged to implement the exact technological specifications of their initial permit application, even though the proposed changes may not always be meaningful or necessary from the environmental point of view.

However, to date it appears that the Irish Government / ABP is not entirely comfortable with the Rochdale Envelope approach to assessment and any degree of flexibility under MAP Act 2021 is likely to be more defined with a relatively narrow range of acceptable parameters for the various technical aspects, agreed through engagement with ABP as part of the pre-application process and/or set out in Secondary Legislation under MAP.

A review of how this approach has been accommodated in various jurisdictions is given below.

5.2 ENGLAND AND WALES

OW projects of more than 100MW installed capacity in England and Wales[1] are defined as nationally significant infrastructure projects (NSIP) and are examined by the Planning Inspectorate. The Secretary of State for the Department for Energy Security and Net Zero (DESNZ) (formerly the Department for Business, Energy and Industrial Strategy (BEIS))[2] grants or refuses consent based on a recommendation made by the Planning Inspectorate.

To permit a project, a Development Consent Order (DCO) is granted under the Planning Act 2008 (as amended) which incorporates a number of consents, including a marine licence and onshore consents. In Wales the marine licence is determined by Natural Resources Wales. A section 36 consent was previously needed to obtain authorisation for an OW project to be constructed, but since 1 March 2010, section 36 consents have no longer been required for offshore operating stations with a capacity greater than 100MW where development consent is required, and is granted, under the Planning Act 2008.

A 2018 advice note is available from the Planning Inspectorate (Nationally Significant Infrastructure Projects (NSIP) - Advice Note Nine: Rochdale Envelope [54]) which explains the use of the Rochdale Envelope applicable to the EIA process set out in The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations). The advice note was prepared as a number of applicants had sought advice on the degree of flexibility that would be appropriate for applications for development consent. This Advice Note explains the use of the 'Rochdale Envelope' approach under the Planning Act 2008 (PA2008).

It states that the approach is needed where the nature of the Proposed Development is such that some project details such as precise dimensions of structures cannot be confirmed when the

[1] The proposed approach to facilitating flexibility in Northern Ireland has not been considered in this assessment as no offshore wind projects have been built in the jurisdiction.
[2] BEIS existed until February 2023 when it was split to form the Department for Business and Trade, DESNZ and the Department for Science, Innovation and Technology.

application is submitted. It is up to applicants to choose whether or not flexibility is need in their application for development consent and if it is, then they must ensure:

- that the approach is explained clearly for the purpose of consultation and publicity at the Pre-application stage;
- that the ES explains fully how the flexibility sought has been taken into account in the assessments and why it is required; and
- that there is consistency across the application documents including any other relevant environmental assessments (e.g Habitats Regulations Assessment (HRA) or Water Framework Directive (WFD) assessment).

Key points the advice note makes on the approach based on the judgement made in the original case are that:

- the assessment should be based on cautious 'worst case' approach which will then feed through into mitigation measures envisaged
- the level of information provided should be sufficient information to enable the likely significant effects on the environment to be assessed
- the need for flexibility should not be abused
- the DCO[3] application documents should explain the need for and the timescales associated with the flexibility sought and this should be established within clearly defined parameters
- the DCO must not permit the Proposed Development to extend beyond the 'clearly defined parameters' which have been requested and assessed
- the more detailed the DCO application is, the easier it will be to ensure compliance with the Regulations.
- The Applicant should ensure they have assessed the range of possible effects implicit in the flexibility provided by the DCO

The process in England and Wales places a duty upon applicants to engage meaningfully with affected communities, local authorities and other statutory consultees over their proposals at Pre-application stage – this is an important part of the process, and there are statutory requirements for consultation under the PA2008.

The note also advises on the EIA and ES. The EIA process in England and Wales consists of:

- the preparation of an ES or updated ES, as appropriate, by the Applicant;
- the carrying out of any consultation, publication and notification as required under the Regulations or, as necessary, any other enactment in respect of EIA development; and
- the steps that are required to be undertaken by the Secretary of State or by the relevant authority under the Regulations.

[3] The means of obtaining permission to construct and maintain developments categorised as NSIPs in the UK

The request for a scoping opinion is typically the first formal procedural step in the DCO process, at which time details of the proposed development will most likely not be finalised so will need to be left open. Details the note suggests may not be finalised in relation to OWFs are:

- type and number of turbines;
- foundation type;
- location of the export cable route;
- location of the landfall point;
- the definitive location of any onshore substation;
- location of the grid connection point;
- construction methods and timing; or
- re-powering.

If it is not possible to include all details of the proposed development in the ES, the ES must explain why and how parameters have been established for assessment. If flexibility is sought it will be necessary for the ES to include information taking into account the variations applicable to the Proposed Development. The ES should explain the reasons that lead to the uncertainty to characteristics of the Proposed Development in order to justify the flexibility sought, and worst-case scenario(s) should be established for assessment.

The potential cumulative impacts with other developments will also need to be carefully identified such that the likely significant effects can be shown to have been identified and assessed against the baseline position.

The environmental information in relation to the proposed development will then be examined by the Examining Authority (ExA), to ensure likely significant effects talking account of any proposed mitigation measures, have been adequately assessed. The parameters within the DCO should not be so wide ranging as to represent an effectively different Proposed Development from that which was consulted on and assessed in the ES. The parameters used for the assessment need to be clearly defined in the DOC and ES.

During the examination of an application, if it comes to light that the ES should contain further information for example to assess variations associated with flexibility within the DCO application, consideration of the application would be suspended pending receipt of that further information (Regulation 20 of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017).

The note stresses that implementation of the Rochdale Envelope approach should only be used where necessary and is not a blanket opportunity to allow for insufficient detail in the assessment.

In England and Wales (and Scotland), a phased approach has also been undertaken when developing/expanding/extending or altering OW developments. Three types of general approaches were identified by the Bureau of Ocean Energy Management (BOEM) in its study of phasing in the UK [55]:

- **Incremental:** Smaller projects are consented through separate applications and form a large single project once built in stages (e.g. Gunfleet Sands (I,II and III))
- **Grampian:** A phasing approach whereby development of subsequent phases is only allowed once a certain action has been undertaken (i.e., monitoring of a potentially impact species) (e.g. London Array).

- **Zonal:** A large multi-gigawatt development zone which is developed across a series of individual projects. Each individual project also has two or more phases of construction, discussed further below in relation to the Hornsea development (e.g. Hornsea Project Two).

BOEM notes that this phased approach is very useful for providing developers with flexibility to develop lease areas and projects in an efficient manner. It notes this method is of particular use for developing or emerging markets where the supply chain does not have experience with developing projects of scale. This could be a method worth considering in Ireland, particularly for future large scale floating developments. Again, this approach is not possible without allowance for a PDE with a good deal of flexibility that can consent a wide enough envelope to allow the different project Phases to be developed using the most modern and efficient technology, even though they may be built a few years apart.

The Planning Act recognises the need for design flexibility for OW development, and it also allows developers to apply to have changes made to development consent orders. Schedule 6 to the 2008 Act and the Infrastructure Planning (Changes to, and Revocation of, Development Consent Orders) Regulations 2011 set out a procedure for making such changes [56].

5.3 SCOTLAND

Marine Scotland is a directorate of the Scottish Government and is responsible for managing Scotland's seas. Within Marine Scotland, the Marine Directorate - Licensing Operations Team (MD-LOT) is the regulator responsible for the assessment of Marine licence and section 36 consent applications, ensuring compliance with relevant legislation and the issue of all marine related permissions (including section 36 Consent and deemed planning permission, Marine Licences, European Protected Species licences and basking shark licences, which are handled simultaneously where requested). MD-LOT operates a one-stop-shop approach to consenting and licensing, however Applicants also need to obtain a lease from Crown Estate Scotland for the use of all sea areas in Scottish waters [57].

Section 36 of the Electricity Act 1989 ("the 1989 Act") applies to proposals for the construction, extension or operation of any offshore generating station whose capacity exceeds 1MW within Scottish territorial waters or the Scottish Renewable Energy Zone. Offshore generating stations also require a marine licence under the Marine (Scotland) Act 2010 (between 0 and 12 nm) or under the Marine and Coastal Access Act 2009 (between 12 and 200 nm) [58].

Offshore projects with 50MW+ capacity also require planning permission from the local authority for the works onshore, however, Scottish Ministers (through Marine Scotland) can direct that planning permission be deemed to be granted at the same time as a Section 36 Consent, under a statutory provision in the Growth and Infrastructure Act 2013 amending section 57 of the Town and County Planning (Scotland) Act 1997 [59]. Planning authorities are statutory consultees for section 36 consents, so are consulted on the process.

The design envelope approach for developing OW in Scotland also falls under section 36 of the Electricity Act, 1989 [60], with useful guidance available from Marine Scotland and the Energy Consents Unit on how the design envelope assessment approach may be applied in the context of applications received for generating stations under section 36 of the Electricity Act [61].

Section 36 applications in Scotland must comply with the legislative requirements set out in: The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 and The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017, which transpose the requirements of the 2014 amendment (2014/52/EU) to the EIA Directive. Section 36 consent and marine licence application will require an EIA Report where they are found to meet or exceed the

threshold for Schedule 2 works, or are located in a sensitive area. MD-LOT can screen a project and provide a screening opinion on whether EIA is required.

The design envelope guidance was prepared on foot of enquiries by applicants for discussions on what degree of flexibility would be seen as appropriate. It acknowledges that *'in some instances, the nature of the proposed development and evolving technology mean that some aspects of the final project are yet to be settled in precise detail at the time that the application is submitted (such as the precise location of certain types of infrastructure, the foundation type, the size of certain structures or the turbine model)'*, and that the design envelope approach can be used to enable a degree of flexibility and address uncertainties.

The guidance is very clear in its instruction that the envelope only be used when necessary and discourages it being used as a tool to submit insufficient information to obtain a consent. Through the design envelope approach, the application can set out parameters for the proposal including the maximum extents of the proposal and can assess on that basis what the likely WC effects of the proposal may be. The detailed design of the project can then vary within this 'envelope' to ensure that the project as-constructed has been properly assessed. The approach taken must be sufficient to enable a proper assessment of effects in the context of the receiving environment [61].

Developers are free to seek a scoping opinion under the EIA Regulations from Scottish Ministers to inform what level of detail needs to be included in the EIA, where design flexibility may be discussed. Pre-application consultation with the public as early as is practical is also considered good practice. The applicant is encouraged to make every effort to limit the variations and parameters applicable to the proposed development across all documentation in order to simplify the assessment and provide assurance that the proposed development when constructed, would not result in significant environmental effects beyond those identified and assessed in the EIA report. [61]

Where the Rochdale envelope approach is followed, the guidance states the assessments should:

- be undertaken based on the relevant design parameters applicable to the characteristics of the proposed development included in the application documents; and
- for each of the different receptors, establish those parameters likely to result in the maximum adverse effect (the WC scenario) and be undertaken accordingly to determine significance.
- clearly identify the characteristics of the proposed development that are yet to be finalised – while ensuring the project description is not too wide that it is insufficiently complete to comply with the EIA regulations requirements.
- explain why the characteristics remain uncertain, to justify the flexibility sought.
- ensure that the approach taken in the assessment is not overly complex, as this may impede the understanding of the assessment.
- ensure that the assessment of the WC scenario(s) addresses impacts which may not be significant on their own but could become significant when they inter-relate with other impacts
- ensure that the potential cumulative impacts with other developments are carefully identified

2019 guidance is also available from Scottish Government on Applications for variation of section 36 consents [58] in Scotland.

A variation is needed to obtain authorisation for a generating station to be constructed, extended, or operated in a way that would not be consistent with the existing consent. The 1989 Act did not contain any provisions for section 36 consents to be varied until 2013, when Section 20 of the Growth and Infrastructure Act 2013 inserted section 36C in the 1989 Act, to provide for variations.

The guidance highlights the need for an efficient variation process, noting that after consent is granted, if the developer's plans change for whatever reason, they may be unable to proceed with the project if the consent cannot be varied/amended, even when the proposed change would make the project more efficient or environmentally beneficial.

The variation process is not deemed appropriate to authorise any change in a project that would make it fundamentally or substantially different in terms of scale or nature from what was originally consented – changes of this scale require a new application. Examples the Guidance gives of changes that would be appropriate to seek a variation for are changes to turbine dimensions, changes to the consented operational life, and changes to time-limits on commencement of development.

The guidance sets out two broad categories of cases for which Scottish Ministers may consider it appropriate to exercise the power in section 36C – namely, to enable:

a) The construction of either a generating station or of an extension to a generating station in a different manner or using different components to that set out in the existing consent; or

b) The operation of a generating station (whether or not it is already operational) in a manner, or for a period of time, that is different from that specified in the existing consent.

Pre-application discussions between the developer and MD-LOT are advised to discuss the proposed changes and whether a consent variation is appropriate. The pre-application discussion should also explore the likely environmental effects of the proposed variation and whether it may constitute EIA development, and the likely scope of information that would require to be submitted with any future application.

If MD-LOT considers the proposed variation application would constitute EIA development, they will recommend that the developer submits a request for a scoping opinion from Scottish Ministers to inform the content of an EIA report to accompany the future application. A scoping opinion request should be accompanied by a scoping report, which should be submitted in line with the requirements as set out in regulation 12 of the EIA Regulations.

Prior to The Electricity Works (EIA) (Scotland) Amendment Regulations 2017, the EIA Regulations required that an EIA was to be carried out in respect of any variation to a section 36 consent, even if the variation itself would have no additional environmental effects. Now, the amendments mean that in situations where the proposed variation is unlikely to have significant environmental effects, no EIA Report or process would be required in respect of the variation application. In determining whether there would be significant adverse effects, consideration needs to be given both to the effects of the change itself, and to the overall or cumulative impact of the proposed variation. Where an EIA report is required then it must include the main respects in which the likely significant effects of the proposed varied development would differ from those described in the EIA report or environmental statement prepared in connection with the section 36 consent.

Guidance from Scottish Government is that the need for EIA should be screened out for variation applications where the intensification of existing environmental effects would be so small as to be clearly insubstantial. This would be on the basis that these proposed variations are not considered to be "schedule 2 development".

EIA would only be required where (i) the proposed variation introduces a new significant effect, or (ii) the proposed variation may increase or intensify an existing effect, such that the effect would now be likely to be significant for the "proposed varied development". When granting a variation, Scottish ministers can grant this as a new planning permission with new time limits for implementation, or a varied consent with the original time limits.

All ORE developments require a marine licence in addition to a section 36 consent. Marine licences are issued at the same time as a section 36 consent. In relation to a variation application for a section 36 consent, if consent is granted for the variation application, the Scottish Ministers will consider exercising their discretion to vary the marine licences granted in respect of the development. The Scottish Ministers would consider the variation of the marine licences in terms of section 72 (3) (d) of the Marine and Coastal Access Act 2009 and section 30(3)(d) of the Marine (Scotland) Act 2010 to ensure that the marine licence and consent granted under section 36 of the 1989 Act are consistent.

Similarly, regarding planning permission, when varying a consent under section 36C, Scottish Ministers can make a direction under section 57(2) and/or (2ZA) of the Town and Country Planning (Scotland) Act 1997 that they consider to be appropriate, including varying an existing section 57 direction or deeming it to be granted afresh.

5.4 DENMARK

In Denmark, the Danish Energy Authority (DEA) plans and issues permits for OW projects, acting as a One Stop Shop. The Danish Act on the Promotion of Renewable Energy defines the rules and competences within the DEA as well as the requirements and procedures for issuing licences for developing OW power [62]. The primary consents issued to projects in Denmark are:

[1] Permission for preliminary investigations:

[2] License to construct an OW power project

[3] License to produce electricity from the OW power project

The process for EIA has evolved in Denmark as the industry has matured since the construction of the world's first OWF (Vindeby) in 1992, and the Denmark's first OW tenders in 2005 for Horns Rev II (209.3MW) and Rødsand II (207MW) projects.

The DEA adjusted the tender framework in 2009 for the 400MW Anholt OWF by:

- including the EIA in the tender material provided to the bidders;
- narrowing down the award criterion to the price only;
- adding a risk of penalty in order to reduce the risk of withdrawal of the winner

The Anholt tender was won by Orsted (then DONG Energy), who commissioned the 400MW project in 2013.

Since the Anholt project tender in 2010, the final and complete EIA for the project was completed before the tender award, with the EIA based on a project description that took into account the WCS regarding each specific potential environmental impact, using a Rochdale Envelope approach where project descriptions were not based on the actual final specifics of the project, rather they contained a range of the final project specifications such as number, height and size of turbines etc.

[63] sets out the method used for the EIA of the Anholt OWF, completed in 2009 by Ramboll for Energinet, the Danish national transmission system operator for electricity and natural gas. It states that the assessment of the environmental impacts from the construction, operation and decommissioning of the project would be based on:

- Description of the project with 2 park layouts;
- 2 types of foundation (mono pile and gravitation);
- 2 size of wind turbines (2.3MW and 5MW);
- WC for the studied area;

- Description of the existing environment/baseline;
- Methodology for environmental impact assessment;

The documents also state that 'as the wind park project is dealing with a "undefined" project design e.g. layout, choice of foundation, number of mills etc., impacts are difficult to predict with certainty and some level of uncertainty in assessing the resultant impacts is inevitable.' Predictions and assessments are therefore made by evaluating the WCS, with any material areas of uncertainty stated, and a conservative view of the likely impacts taken.

The EIA was completed in 2009, construction for the project began in 2011, with commissioning in 2013. The project consists of 111 3.6MW turbines (2.3 – 5MW assessed), using monopile foundations.

According to the DEA, this model was successfully applied in all tenders for OWFs located far from shore but faced criticisms from residents living close to nearshore OWFs (less than 8km from shore). The residents were unhappy with the lack of certainty around the final layout of the project at tender award stage. This is an example of the parameters for design flexibility being too wide causing issues with projects, and the criticism caused a change in approach from the DEA.

For more recent projects, the DEA has updated its approach. More survey work is completed prior to bids, to increase understanding of any high-risk environmental factors. All the results and data from the studies and surveys are made available to stakeholders.

After tender award, the winner will receive a licence to survey the site, and the winner of the tender then completes the EIA of the OWF, OSS and export cables to the landfall, meaning that the EIA is now undertaken after the specifications for the project have been decided [64]. This process still allows for flexibility however, as the DEA states that the winner of the tender can decide on the specifications and dimensions within the given frame that will suit best its business model for the project.

For a more recent example, the Vesterhav Nord tender took place in 2016, for a 176MW, 21 turbine project, which was commissioned in 2024 by Vattenfall. In 2015 a report was produced to determine the environmental impacts for the WC location of a wind farm within the concession area for Vesterhav Nord.

After receiving a number of appeals, the Danish Energy Board of Appeal decided that for Vesterhav Syd (neighbouring project in the same tender), an assessment should be made covering the specific offshore project and not just a WCS [65], which resulted in a new EIA (and public consultation) of the offshore Vesterhav Nord project being required also, due to the similarities between the projects. The new assessment of wind turbines and submarine cables completed in 2020, included relevant information from the previous report, along with other new and publicly available information and survey data. The onshore assessment was not updated as it was deemed to be acceptable [66].

For the more recent offshore tender in Denmark in 2021 for the Thor OWF, a new approach for completing environmental assessments was launched, with the adjustments made to account for the issues experienced with the Vesterhav projects. According to the DEA, the adjusted approach is based on a thorough analysis of the underlying legal framework, approaches used in other areas and in other countries, risk-mitigation, as well as consultation with ministries, the Danish EPA, Energinet, and the wind industry.

The new approach can be summarised as follows [67]:

- Energinet (by order from the DEA) will conduct a Strategic Environmental Assessment (SEA) of the plan for the OWF before tender bids, with this plan consisting of the political decisions motivating the decision to proceed with the project (mainly the Energy Agreement 2018), and the related decision on the tender (e/g. site, capacity grid connection etc.)
- In addition, Energinet will also carry out a range of environmental assessments which will be provided to tenderers, which will provide critical data for as much risk-mitigation as possible for the project
- The concession winner will carry out the EIA of the project at sea (wind farm, OSS and export cables to the landfall). In addition to this, Energinet will EIA of the project on land
- Before the launch of the EIA, a hearing will be carried out of the public and relevant authorities on the scope and content of the EIAR. There will also be a hearing of the public and relevant authorities, when the EIAR and a draft licence for construction has been drafted
- Once the EIA of the project has been carried out and approved, it will be possible to grant the licence for construction, which is the environmental permit for the project.

Guidelines for completing environmental assessments for Thor OWF were also published by the DEA [68]. The SEA for Thor was completed in 2021 [69]. The Marine Mammals report to inform the SEA [70] assessed the project assuming turbines in the range of 8 – 15MW would be used, with 67 to 125 turbines being installed, noting the assessment was performed on a general level. Pile-driven monopiles, jacket-foundations and suction buckets are also considered for foundation options.

The project is due to be commissioned in 2027. In March 2024 it was reported that the DEA has approved the feasibility study report for the project, which includes the Environmental Impact Study (EIS). RWE (the developer which secured the concession to build and operate the wind farm in December 2021) is now due to present the application for the construction licence. The application, along with the approved EIS and other relevant documents, will be submitted for an eight-week consultation period likely starting in early April. The DEA will then make a final decision on granting the construction licence [71]. This EIS is not yet publicly available, so the parameters assessed cannot be reviewed.

The Danish approach could be of interest to Irish government given the way it has evolved to address concerns over too much flexibility being offered, while still attempting to accommodate as much flexibility as is required by developers. The tender and development model also aligns with what may be seen as the ideal plan-led model for OW development, with Ireland currently establishing its first Designated Maritime Area Plan (DMAP) and transitioning to plan-led model.

5.5 THE NETHERLANDS

The Netherlands is another mature European OW market. The process for development in the Netherlands is explained well by the Netherlands Enterprise Agency (RVO) in [72].

The Netherlands' Offshore Wind Energy Act was adopted in 2015 and states that the government assumes control of the spatial planning arrangements and environmental evaluation for OW development.

Once wind farm areas have been designated by the State using a marine spatial planning approach and a Roadmap has been approved setting out the schedule for tenders within the areas and relevant project details e.g. capacity, project area, location etc., EIA is conducted for the project.

At this stage, prior to tender, the site decisions are legally subject to an EIA, commissioned by RVO on behalf of the Ministry of Economic Affairs and Climate Policy and the Ministry of Infrastructure and Environment. The EIA results are published in the site decision, and available for public inspection (and appeal), after which the EIA becomes irrevocable.

Further guidance on EIA in the Netherlands is given in [73]. Government agency 'Rijkswaterstaat' (Directorate-General of the Ministry of Infrastructure and Water Management of the Netherlands) oversees the research companies and specialists conducting the surveys.

During this stage, the Government conducts site investigations, including meteorological and oceanographic survey, geotechnical and geophysical survey, ecological survey, archaeological survey and UXO (unexploded ordnance) surveys. The outcomes of these site data studies are made available for project developers to inform their bids at tender stage. This allows developers to know if a site is viable before bidding, with the costs of the surveys covered by the State.

The final stage for the State before the tender can be organised is to grant the Wind Farm Site Decision (WFSD). A wind farm can only be built after a permit based on a WFSD has been issued. The WFSD specifies the location for the wind farm and the conditions under which it may be constructed and operated, taking into consideration issues such as ecology and decommissioning of the wind farm. The site decision, however, leaves some flexibility for the design of the wind farm. This means that project developers can choose the latest technical innovations – within the natural and environmental framework – to develop and operate the wind farm at the lowest possible cost.

The WFSD is the cornerstone of the Dutch Law Wind Energy at Sea. This law, which received final parliamentary approval in June 2021, stipulates that OWFs can only be built after a permit, based on the site decision, has been issued.

The tender for the site area can then be undertaken, and a developer for the site chosen based on the selection criteria included in the auction (e.g. lowest subsidy amount, comparative feasibility assessment based on identified criteria e.g. ecological innovation or system integration, highest auction price etc.). When a winner has been selected, the Government shortly thereafter issues a permit for the construction, operation and removal of the wind farm. The developer can then start building the project. The developer must comply with the construction and operation plan is submits with its tender, but the permit allows for flexibility in development.

Examples of areas where flexibility is allowed include the number of WTGs, the positioning of the WTGs, the hub height, type of turbine and type of foundation. Any request for an exemption must be accompanied by an explanation of the effect of the change on the aspects set out above, as well as by an amended wind energy yield calculation (if applicable). A deviation from the plan also must be approved by the Minister of Economic Affairs and Climate Policy.

The most recently commissioned project in the Netherlands is the Hollandse Kust Noord project, with the tender for the project decided in 2020 and the project commissioned in 2023 by CrossWind, a consortium of Shell and Eneco.

A summary of the EIA for the site can be viewed in [33]. The EIA describes the environmental impact of the construction, operation and decommissioning of WTGs at the site. This states that the wind farm site within the Hollandse Kust (noord) wind farm zone is issued with the option for the wind farm developer to develop it at its own discretion.

The 'bandwidth' (envelope) that must be adhered to is recorded in the WFSD. The document notes that by issuing wind farm sites in which various wind turbine set-ups and types and foundation methods are possible, within a certain bandwidth, a flexible design of the wind farm sites is possible. The developer is free to make the wind farm design optimal in terms of cost effectiveness and energy yield. As elsewhere, assessment is based on a WCS approach, noting – 'if the worst-case scenario for potential effects is permissible, then all other set-ups within it are also possible.'

The envelope used for the project assessment, referred to as the EIA bandwidth, is shown below. It can be seen a large degree of flexibility is still allowed.

Table 5-1: EIA Bandwith for Hollandse Kust Noord [33]

Design	Bandwidth
Capacity of individual wind turbines	Minimum of 8MW
Highest tip point of individual wind turbines	189 - 251 metres
Lowest tip point of individual wind turbines	25 - 30 metres
Rotor diameter of individual wind turbines	142 - 221 metres
Distance between each wind turbine	At least 4 x rotor diameter
Number of blades per wind turbine	2 – 3
Type of foundations (substructures)	Monopile, jacket, tripile, tripod, gravity-based structure
Type of foundation	Pile foundations, suction buckets, gravity- based structures
Installation method for pile foundations	Vibrohammering pile driving, drilling, suction
In case of pile-driving foundations: pile-driving energy related to turbine type/pile	1,000 - 3,000 kJ depending on soil conditions and diameter of foundation
In case of pile-driving foundations diameter of foundation pile/piles and number of piles per turbine	
Jacket	4 piles of 1.5-3.5 metres
Monoplie	1 pile of 8 to 10 metres
Tripod	3 piles of 2 to 4 metres
In case of foundation without pile driving, dimensions on seabed:	
Gravity-based	Up to 40 x 40 metres
Suction bucket	Bucket diameter: tbd
Electrical infrastructure (inter-array cabling)	66 kV

5.6 THE US

The Energy Policy Act of 2005 (EPAct) authorises BOEM to issue leases, easements and rights of way for ORE development on the Outer Continental Shelf (OCS) of the US. The Act provides a general framework for BOEM to follow when authorising renewable energy activities, and requires that BOEM coordinate with relevant Federal agencies and affected state and local governments, and ensure that renewable energy development takes place in a safe and environmentally responsible manner. The Outer Continental Shelf Lands Act (OCLSA) directs BOEM to study and consider coastal, marine, and human environmental impacts when making decisions on energy development [74].

BOEM published regulations governing its renewable energy program in 2009 (30 C.F.R. Part 585) and provides a Regulatory Roadmap to give guidance on requirements for gaining the necessary approvals to develop an OWF (on the OCS). A high-level overview of its development process is shown below in Figure 5-1.

Figure 5-1: US OW development process, as described by BOEM [74]

In the planning and analysis stage, BOEM conducts environmental compliance reviews and consultations with Tribes, States and natural resource agencies, prepares an Environmental Assessment for the site.

The Site Assessment stage includes submission by the developer, and BOEM's review and approval, of a Site Assessment Plan (SAP). The SAP provides a description of site assessment activities to be performed within the lease area, including details related to the construction and installation.

Under BOEM's ORE regulations, and pursuant to 30 Code of Federal regulations (CFR) 585.626, a lessee must submit a Construction and Operations Plan (COP) for BOEM's review and approval prior to the construction of a wind energy facility. The COP must:

- Include a description of all planned facilities, including onshore and support facilities,
- describe the activities related to the project, including construction, commercial operations, maintenance, and conceptual decommissioning and site clearance procedures,
- include the results of all environmental and geological surveys required to define the site conditions.

A lessee's COP provides the basis for BOEM's analysis of the environmental effects of the proposed construction, operation, and decommissioning activities. This information assists BOEM in complying with statutory obligations under The National Environmental Policy Act (NEPA) and other environmental statutes. Once BOEM conducts its environmental and technical review, it can approve it and the project.

BOEM is also in favour of a Project Design Envelope approach, and released Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan in 2018[4] [75].

BOEM gives ORE lessees the option to use a PDE approach when submitting a COP, having committed in its 2016 National OW strategy [76] to evaluate a design envelope approach. In 2017, BOEM also commissioned a study on Phased Approaches to Offshore Wind Developments and Use of the Project Design Envelope [55] to analyse potential approaches to the process and preparation of the design envelope for phased OW development in the U.S. A review of approaches taken in Europe was a key part of this.

In the guidance BOEM notes there are benefits to allowing a reasonable range of project designs in a COP, due to the complexity of the projects, the unpredictability of the offshore environments, and the rapid technological developments in the industry. It also allows BOEM to begin its evaluation of the project proposal earlier, as the COP can be submitted before the design decisions have been finalised.

BOEM describes a PDE approach as a permitting approach that allows a project proponent the option to submit a reasonable range of design parameters within its permit application, allows a permitting agency to then analyse the maximum impacts that could occur from the range of design parameters, and may result in the approval of a project that is constructed within that range.

The proposed approach as set out by BOEM in its draft guidance is summarised below:

1) **COP Submittal:** Lessees choosing to submit a COP using a PDE approach should describe the reasonable range of project designs in detail in each relevant section of their COP. An indicative schedule/construction program should outline the periods over which key elements of the development will take place. In addition to identifying the highest-impact parameters by physical, biological, and socioeconomic resource, the lessee's COP should also discuss potential variances in impacts among parameters.

2) **BOEM Analysis**: BOEM will assess the impacts of the reasonable range of project designs that are described in a COP that uses a PDE approach by using a "maximum design scenario" process that analyses the aspects of each design parameter that will cause the greatest impact for each physical, biological, and socioeconomic resource. Using a "maximum design scenario," BOEM will consider the parameters (or combination of parameters) that represent the greatest effect for an individual impact for each environmental resource.

3) **Conclusion**: If a lessee's COP is approved or approved with modifications, the lessee must submit a Facility Design Report (FDR) and a Fabrication and Installation Report (FIR) for BOEM's review prior to construction the project. In situations where a lessee's FIR and/or FDR describe a project that deviates substantially from the range of parameters outlined in the

[4] A final version of this Guidance does not appear to be available from BOEM

PDE of a lessee's approved COP, BOEM may require a revision to a lessee's COP and may initiate additional review and other environmental consultations.

BOEM also allows for a leaseholder to request in its COP to develop a project in stages or phases, with a PDE used for the later developments also. Once the lessee is ready to proceed with the development of an additional phase of its project, it shall submit a revised COP with more detail, which BOEM can review and approve before construction.

In [77], BOEM discusses how a design envelope approach allows them to analyse the maximum impacts that could occur within the range of the design parameters included in the envelope – using parameters from the New England Phase 2 project as an example.

In addition to the BOEM SAP and COP approvals discussed above, the US has complex federal, state, and local permitting process that run in parallel to the BOEM process. This makes permitting a project in the US a more complicated endeavour, but this review has focused on the National permitting under BOEMs jurisdiction.

5.7 TAIWAN

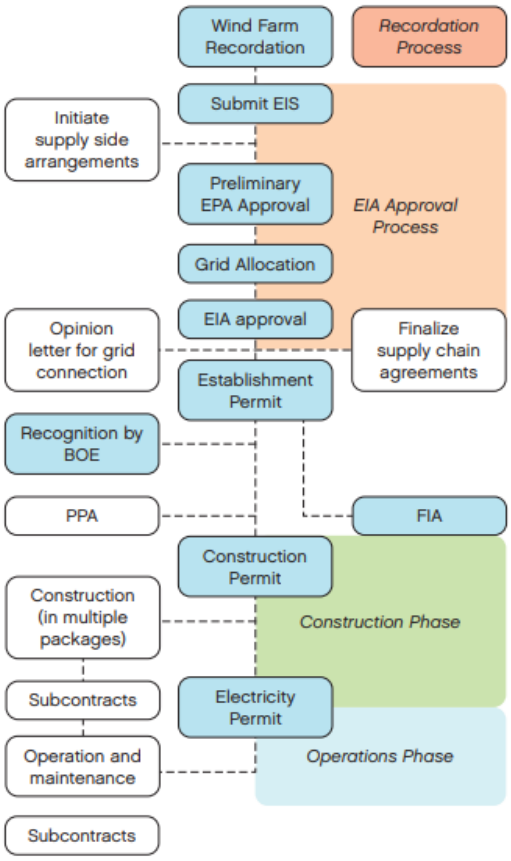
Taiwan currently has around 2.25GW of OW installed across multiple projects including Formosa 1 OWF - phase 2 (120MW), Formosa 1 OWF - phase 1 (8MW), TPC - Changhua phase 1 Demonstration (109MW), Formosa II (376MW), Greater Changhua 2a - South West (295MW), and Greater Changhua 1 - South East (605MW)) [39].

Renewable energy development in Taiwan is governed by the Renewable Energy Development Act [78]. In Recent years Taiwan has ramped up its OW energy ambitions and has set its OW power targets to 13GW by 2030 and up to 55GW by 2050. The scheme for delivering OW is split into three phases: Demonstration Round, Transition Round and Zonal Development Round.

In the most recent zonal development round, developers select sites and propose these to the competent authority, the Bureau of Energy (BoE), of the Ministry of Economic Affairs (MOEA). Following approval of the site, the developer must then acquire an electricity license. In order to do this, they must undergo the EIA process of which the Environmental Protection Administration has final approval.

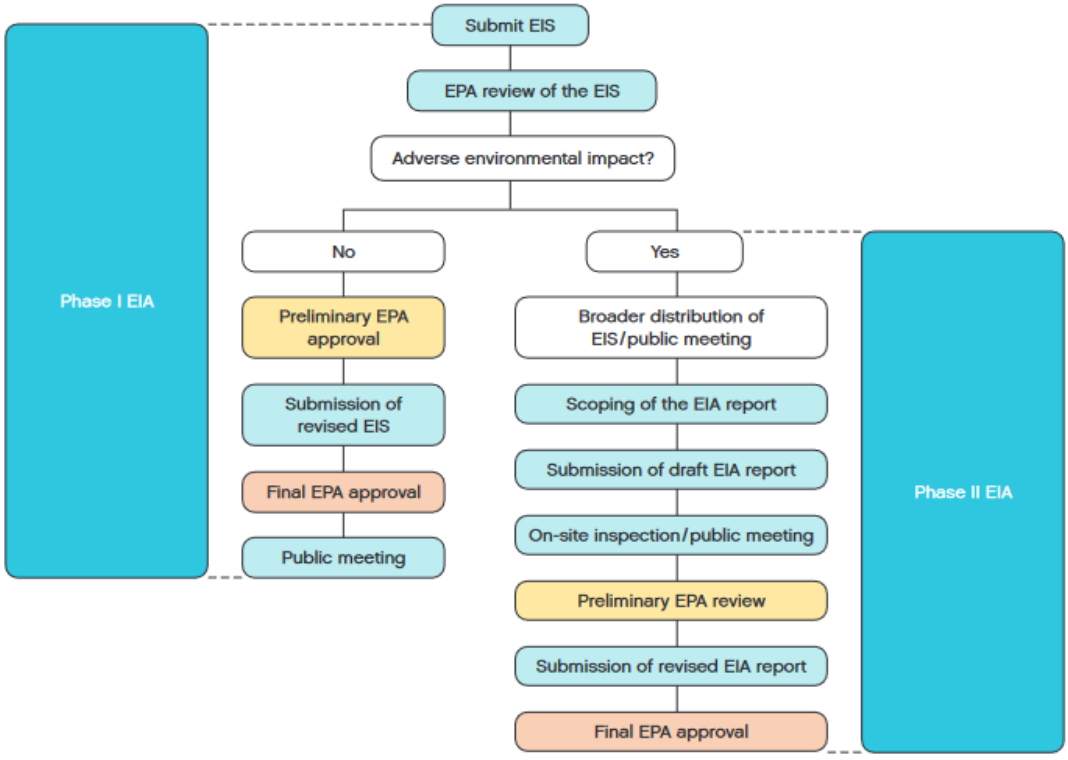
Having completed the necessary steps in the EIA process the developer must then obtain an Establishment Permit. This process involves obtaining consent letters from local government, the National Property Administration and the Ministry of Transportation and Communications as well as providing a Consent Letter of Offshore Wind Power System Installation. BOE then formally recognises the project, a Power Purchase Agreement (PPA) agreement is established. A construction permit is then obtained and following this the Electricity License is granted. An overview of the process is shown in Figure 5-2:

Figure 5-2: High-level overview of Taiwan development process



The EIA process is similar to other jurisdictions and is summarised in the diagram below:

Figure 5-3: Overview of the Consenting Process in Taiwan



The EIA Act governs the EIA process in Taiwan, which is overseen by the Environmental Protection Administration. The process is split into 2 phases. For Phase I EIA, the developer submits an Environmental Impact Statement to the MOEA which is then shared with the Environmental Protection Administration. This is reviewed, and the EPA determines if the development activities are likely to have an adverse environmental impact. If the answer is no, preliminary Environmental Protection Administration approval can be granted, before any revisions to the EIS are made as required to account for comments from the EPA from the preliminary approval, the final EPA approval of the EIA is given, and a public meeting is held by the project to explain the project.

There is also a process outlined for a Phase II EIA, which is required if a project is determined to be likely to have a significant adverse impact on the environment. This includes:

- a broader distribution of the project EIS to relevant government agencies and the public
- communication between the project and the MOEA, local authorities, interested nongovernmental groups, scholars and experts in relevant areas, and representatives of the local community to determine the scope of the EIA report to be submitted by the project
- submission of a draft EIA by the project before on site inspections and a public meeting are held
- Review of the EIA and relevant materials by the EPA, and final approval of the EIA.

For the EIA process, the developer is required to obtain the Environmental Protection Administration's final approval of the EIA to obtain an Establishment Permit, with a preliminary or conditional approval also need to participate in the grid allocation process. The Establishment Permit is then issued by the BOE once the final EIA approval has been obtained, necessary consent letters have been obtained from various authorities including local government, an opinion letter for grid connection has been obtained from Taiwan Power Company (TPC), and letters of intent have been received from financial institutions.

Recognition of the BOE is the required, before a PPA can be entered into with TPC, and a Construction Permit and an Electricity License can be obtained.

With regards planning, project developers are expected to apply to BOE for recordation of the project planning and provide them with a general picture of the project before beginning the EIA process.

One of the most recently commissioned OW projects in Taiwan is the Formosa 2 project, which is jointly developed by JERA, Green Investment Group and Synera Renewable Energy. The project is 376MW, consisting of 47 x 8MW turbines which were connected to the grid in March 2023.

Formosa 2 was awarded its capacity in the selection by BOE, in 2018. The project is part of the zonal development programme being implemented by the State, which aims to add 5.5GW of wind power to its installed capacity by 2025.

The project also agreed a 20-year power purchase agreement (PPA) with TPC. A firm order for 8MW turbines was placed in October 2019 with the project reaching financial close in 2019 [79]. To develop the project, the EIA process was approved by the MOEA, which also granted the project an Establishment Permit (EP) and Construction Permit (CP).

The Formosa 2 OWF Project Summary Environment & Social Impact Assessment completed in June 2019 [80] provides an outline of the information provided in the Project's approved EIA, dated May 2018, and states the project passed the EIA committee review in 2018, and that turbines in the range of 6-9.5MW were being considered for Formosa 2 with a maximum of 47 WTGs installed in the site, with the assessment based on the worst-case scenario. A further summary and environment report completed in September 2019 [81] update this to note that 8MW turbines were chosen for the project, with 47 to be installed.

The Greater Changhua 1 OWF – Report EIA also used a design envelope in the assessment for EIA [82]. The EIA assumed 55-76 WTGs of 8 – 11MW capacity. The project was eventually commissioned using 8MW turbines (first power in April 2022).

5.8 SUMMARY

This review has found that some degree of design flexibility in consenting for OW is a key part of the OW development processes in the countries assessed. This includes markets in Europe (EU and non-EU), North America, and Asia. And both established (the UK, Denmark, the Netherlands) and more emerging (the US, Taiwan) markets.

While the markets operate differently in their overall development processes and timelines, and roles and responsibilities, all have seen the need to facilitate flexibility in design at the consenting stage, and have noted several key benefits to allowing for this, including:

- Allowing projects to proceed despite the complexity of the projects, the unpredictability of the offshore environments, and the rapid technological developments in the industry.
- Allowing the CA to begin its evaluation of the project proposal earlier, before the design decisions have been finalised.
- Allowing project developers to choose the latest technical innovations – within the natural and environmental framework.
- Allowing projects to be developed and operated at the lowest possible cost, and in a way that best suits the projects' business models.

While differences in how this approach is applied may be seen, there are generally a few key principles to follow when deciding on the degree of flexibility required and the approach to the assessment of impacts (by the developer):

- Scoping and consultation (with the public and prescribed bodies) at a very early stage are key to informing the approach to be taken and the level of flexibility to be accommodated.
- Exact levels are not set on how much flexibility should be allowed for (e.g. + / - 10% tip height etc.), but appropriate levels are found through consultation and assessment.
- The level of information provided by the project should be sufficient to enable the likely significant effects of the project on the environment to be assessed by the CA.
- Where flexibility is sought, it should be explained clearly how this has been accommodated for in assessments.
- Any request for flexibility should be justified. The frameworks in place to accommodate flexibility should not be abused or seen as a way to proceed without sufficient information, and an excessive amount of design options should not be requested.
- Where exact parameters cannot be provided, ranges or options can be, and all potential options need to be considered in the assessment of impacts, to look at potential impacts across all relevant receptors.
- The assessment should be based on cautious 'worst case' approach for each receptor which will then feed through into mitigation measures envisaged.
- One consented, the project must be constructed within the bounds of the envelope consented, and not stray outside of this.

All the jurisdictions have proceeded on this basis that flexibility is needed and should be accommodated as much as is reasonable, and there are no indications found from this review that they intend to change approach.

The one slight exception which has seen some criticism for its approach to flexibility is Denmark, where residents living close to nearshore OWFs (< 8km from shore) were unhappy with the lack of certainty around the final layout of the project at tender award stage. This led the DEA to refine its approach to flexibility, and for more recent projects, more survey work is completed by the State prior to bids to increase understanding of any high-risk environmental factors, and the winner of the tender then completes the EIA of the OWF after the tender when there is a better understanding of project design, rather than before the tender. The process still allows for flexibility, however.

A summary table of the market review is shown below in Table 5-2.

Table 5-2: Summary of Approaches and Key Learnings

Jurisdiction	Primary Project Consent(s)	Competent Authority	Provisions for Flexibility and/or Variations to consent and Relevant Guidance	Practical Application and degree of flexibility allowed
England and Wales	DCO is granted under the Planning Act 2008.	The Secretary of State for DESNZ grants or refuses DCO based on a recommendation made by the Planning Inspectorate. In Wales the marine licence is determined by Natural Resources Wales.	PA2008 recognises the need for design flexibility for OW, and allows developers to apply for variations to DCO. Planning Inspectorate NSIP - Advice Note Nine: Rochdale Envelope sets out how to use the approach.	From the parameters outlined in the EIA, individual WCS can be developed for each receptor resulting in a tailored Rochdale Envelope. Once the Rochdale Envelope has been developed for each receptor, it is checked to ensure the assessment covers all aspects of the design that could be constructed, while avoiding an unrealistic project. Ultimately, a clear picture of the realistic WC development scenario is constructed specific to each individual receptor in the EIA, which is assessed by the CA. If the project's technical and engineering parameters fall anywhere within the limits of the envelope established and the EIA process justify all decisions made, then flexibility is permissible under the consent granted. **Original proponents of design flexibility. High Level of flexibility allowed for, with clear guidance and processes.**
Scotland	Section 36 Consent under the Electricity Act 1989. Marine licence.	MD-LOT on behalf of Scottish Ministers.	Section 36 of the Electricity Act, 1989. Guidance for applicants on using the design envelope for applications under section 36 of the Electricity Act 1989 from Marine Scotland and the Energy Consents Unit	Scottish guidance is very clear in setting out the need for design flexibility, in how design flexibility should be applied, and in its instruction that the envelope only be used when necessary. Through the design envelope approach, the application can set out parameters for the proposal including the maximum extents of the proposal and can assess on that basis what the likely worst-case effects of the proposal may be. Useful guidance is in place for the application of the design envelope approach in consenting and EIAR, as well as for seeking variations to consent, should they be required. **Relatively High Level of flexibility – with clear guidance and processes.**

Jurisdiction	Primary Project Consent(s)	Competent Authority	Provisions for Flexibility and/or Variations to consent and Relevant Guidance	Practical Application and degree of flexibility allowed
Denmark	Permission for preliminary investigations License to construct License to produce electricity	The DEA	The Danish Act on the Promotion of Renewable Energy defines requirements and procedures for issuing licences for developing OW power. Approach to EIA and assessment has been refined recently, with Guidance issued for specific tenders as they are carried out. E.g see Guidelines for completing environmental assessments for Thor OWF.	A high level of flexibility was allowed, but this was criticised for nearshore projects due to uncertainty around the final design of projects. The approach for the most recent Thor tender is summarised as: • Energinet will conduct a SEA of the plan for the OWF before tender, and carry out environmental assessments to provide to tenderers. • The concession winner will carry out the EIA of the project at sea. • Before the launch of the EIA, a hearing will be carried out with the public and relevant authorities on the scope & content of the EIAR. • Once the EIA of the project has been carried out and approved, it will be possible to grant the licence for construction. This process still allows for flexibility, as the DEA states that the winner of the tender can decide on the specifications and dimensions within the given frame that will suit best its business model for the project. **Efforts made recently to give more certainty on design before construction (e.g. lower design flexibility), but developers still have an envelope within which it can decide specifications.**
The Netherlands	WFSD granted for site, and permit for the construction, operation, and removal of the project granted to the tender winner.	RVO	EIA conducted for the project by the State, and a WFSD issued before tender takes place.	Since 2013, the Netherlands uses a fully plan-led model, with EIA and consenting completed by the State before tender is complete. Immediately after winning the tender, the Government grants the permit for the construction, operation, and the removal of the wind farm. With this permit, the winning developer can immediately start constructing the wind farm, with grid infrastructure constructed by TenneT. **The model offers a high degree of flexibility. This is almost necessitated by the development process, where EIA is conducted before a developer is chosen.**

Jurisdiction	Primary Project Consent(s)	Competent Authority	Provisions for Flexibility and/or Variations to consent and Relevant Guidance	Practical Application and degree of flexibility allowed
The US	COP submitted by project developer for BOEM's review and approval prior to construction commencing.	BOEM	30 C.F.R. Part 585 Draft Guidance Regarding the Use of a Project Design Envelope in a Construction and Operations Plan	BOEM conducts initial environmental compliance reviews and prepares an Environmental Assessment for the site before leasing. A lessee must then submit a COP for BOEM's review and approval prior to construction. BOEM gives lessees the option to use a PDE approach when submitting a COP, both for the project and for phased development. BOEM will assess the impacts of the range of project designs that are described in a COP that uses a PDE approach by using a "maximum design scenario" process that analyses the aspects of each design parameter that will cause the greatest impact for each physical, biological, and socioeconomic resource. A high level of flexibility can be provided for, where justified, with this approach, but BOEM notes that this can complicate the assessment process and delay approvals. **While the US's development processes are complicated by additional permitting requirements by State, Federal, and local agencies, BOEM offers a well laid out, clear process for permitting, which enables the use of a PDE.**
Taiwan	Establishment Permit, Construction Permit & Electricity Licence	BoE of the MOEA	The EIA Act governs the EIA process. Renewable energy development is governed by the Renewable Energy Development Act. The Electricity Act covers the establishment of power plants and the transmission and distribution of electricity.	Less information available on exact requirements, but established procedures available for EIA. The Formosa 2 Project Summary Environment & Social Impact Assessment completed in June 2019 provides an outline of the information provided in the Project's approved EIA, dated May 2018, and states the project passed the EIA committee review in 2018, and that turbines in the range of 6-9.5MW were being considered for the project with a maximum of 47 WTGs installed in the site, with the assessment based on the WCS. This shows a Design envelope approach has been used. **While less information is available on Taiwanese development processes, work to date has shown an acceptance of a design envelope approach.**

6 IDENTIFICATION AND ASSESSMENT OF RELEVANT DEVELOPMENTS

In this section, GDG has undertaken an international desktop study of OWFs developments that have been consented, to identify projects that have been consented using a PDE approach, and to assess how this flexibility has been accommodated for in assessment and consenting. Effort has also been made to include projects that have sought variations to their consent, to demonstrate how this process has been applied. The primary purpose of the assessment has been to review how much flexibility has been accommodated for in the consenting process, how this has been assessed for EIAR, and where relevant, how variations have been facilitated, and potential changed in impacts have been assessed and consented. This review, in combination with the review of jurisdictions undertaken in Section 5, will be used to inform learnings and recommendations for Ireland.

6.1 INCH CAPE OFFSHORE WINDFARM

Inch Cape OWF provides an interesting example project, as although it has not yet been constructed, it applied a Rochdale Envelope approach to consenting, but has still had to apply for a new consent for a revised design, and several variations to this consent, although these have been relatively minor. All the relevant consent documentation for the project can be found on the Marine Scotland Website [83], and the project website [84].

The planned 1,080MW project is being developed by Red Rock Power Limited and the ESB, in a joint venture named Inch Cape Offshore Limited (ICOL). The site is located in the North Sea, 15km from the Angus coast, East Scotland. It secured a Contract for Difference (CfD) in CfD Allocation Round (AR) 4 in 2022 and is aiming for commissioning in 2026/2027.

Figure 6-1: Inch Cape OW farm [84]

In 2014, ICOL was granted Section 36 Consent and Marine Licences for the construction and operation of the project and the associated transmission works. The 2014 consent was for a project with a combined maximum generating capacity of up to 784MW, comprising of up to 110 WTGs in total (reduced by the developer from 213 WTGs and 1,050MW post EIA and after consultation to address concerns from consultees in relation to potential impacts on ornithology).

The WTG envelope included a maximum blade tip height of 215mLAT, a minimum blade clearance of 22mHAT (meters above Highest Astronomical Tide), a maximum rotor diameter of 172m, and a minimum spacing of 1,000m, with each turbine being subject to micrositing of +/- 50m. The 2014 Section 36 Consent can be found here [85].

The licences granted to ICOL were then subject to JR in early 2015 (along with licences for Seagreen and NNG), with the JR process continuing until November 2017, at which time it was judged unsuccessful. The JRs were petitioned by the Royal Society for the Protection of Birds (RSPB), which claimed that the project posed a threat to key seabirds in the area. Information on the case can be found in [86].

In 2018, following the completion of the JR process, ICOL submitted a new application with a revised design that would enable the project to use more modern turbine technology than that which they were granted consent for in 2014. This new design aimed to reduce the overall number of turbines to a maximum of 72, and increase the height of the turbines installed to 291 mLAT, which the project claimed would also reduce the environmental impact of the project and increase its cost competitiveness. This shows the technological progress that can be made in just a few years, and the impacts this can have on projects designs. New Section 36 and Marine Licence consents for the revised design were granted by Scottish Ministers in 2019.

The project took part in the UK CFD AR3 auction in 2019, but was unsuccessful in securing a CFD.

In February 2020, ICOL applied for a Section 36 variation to increase the maximum generating capacity of the project consent from 'approximately 700MW' to 'up to 1000MW'. No other changes to parameters in the consent we requested in this variation. The variation was linked to a change in project timescales and an increased understanding of WTG technology that could be deployed on site. ICOL undertook a review of WTG technologies and determined that it would be feasible to deploy turbines with a greater capacity while keeping the physical dimensions of any such turbines within those parameters assessed and consented previously. This variation was granted in July 2020.

In January 2021, ICOL sought a further variation to the Section 36 Consent to remove the overall maximum generating capacity (then set at 'up to 1000MW') from the Section 36 Consent. Having held discussions with WTG manufacturers, the project believed it could achieve a capacity greater than 1000MW, and it had secured a grid connection of 1080MW (although the WTGs being considered were to remain with the design envelope and consented parameters originally assessed). The variation was requested to 'both to allow the additional grid capacity to be utilised, and avoid the potential need for further requests to increase the consented maximum generating capacity in the future'. The variation was granted in July 2021, with the Scottish Ministers satisfied that the variation would not have significant effects on the environment.

ICOL secure a CfD in AR4 in July 2022. In November 2022, the project sought a further variation to its existing Section 36 Consent under Section 36C of the Electricity Act 1989 and Marine Licence 06781 – Offshore Wind Farm (OWF) (Revised Design), in accordance with section 30(3) of the Marine (Scotland) Act 2010 (2010 Act). This variation related to:

- **Altered turbine spacing to allow an optimised border layout to maximise wind resource use**; A variation was required to change the nominal WTG spacing of 1,278 m in Marine Licence 06781 and Section 36 to 1,025m.
- **Increased hammer energy required to successfully install the foundations;** while this was not a consented parameter, the project submitted in its variation report that in order to be able to successfully pile monopile foundations in all ground conditions expected within the Development Area, it anticipated that a 5,500 kJ hammer would be required. The variation also clarified that the variation report would then form part of the application documents which must be complied with, which would now include the increased hammer energy than that which was originally assumed (5,000 kJ originally).
- **Confirmed parameters pertinent to the Preferred Design Scenario**: the project set out its preferred design scenario for the project (in terms of WTG numbers and dimensions and number of Offshore Substation Platforms OSPs), to confirm it fell between two scenarios assessed for risks to ornithology, demonstrate that for the Proposed Design Scenario the collision risk to birds is no greater than the consented worst-case parameters

This request was granted in June 2023, with the Scottish Ministers satisfied that the Variation application would not have significant effects on the environment, and was not an EIA project. To support this application, the project submitted a Wind Farm Variation Report, a Screening Report, a Pile Driving Re-assessment, and collision risk estimates for key seabird species, all of which are available on the project website document library [84].

The project is now set to proceed to construction once financial close is reached. An overview of the consents and variations received for the project is given below.

Table 6-1: 2019 consent parameters and variations requested

Relevant Design Parameter	2014 Parameter	2019 Parameter [post JR consent]	Variation Requested in 2020	Variation Requested in 2021	Variation Requested in 2022
Development Area	Not stated – map of area included	150km2	No	No	No
Maximum Generating capacity	'up to 784MW'	'around 700MW'	**Yes, change to: 'up to 1000MW'**	**Yes, request to remove the maximum generating capacity**	No
Max Number of WTGs	110	72	No	No	No
Max Rotor diameter	172m	250m	No	No	No
Max Blade tip Height	215mLAT	291mLAT	No	No	No
Min Blade Tip Height	22mHAT	27.4mLAT	No	No	
Nominal minimum	1,000m	1,278m	No	No	**Change to 1,025m**

Relevant Design Parameter	2014 Parameter	2019 Parameter [post JR consent]	Variation Requested in 2020	Variation Requested in 2021	Variation Requested in 2022
turbine spacing					
WTG Foundation Type	To be confirmed in Development Specification and Layout Plan prior to commencement of the development	Jackets (pin-piled & suction caisson), Gravity Base, Monopile.	No	No	No
Maximum hammer energy	1200 kJ	5000 kJ (monopile)/2400 kJ (pin-pile)	No	No	**Update monopile hammer energy to 5,500 kJ**
OSPs	5	2	No	No	No
Inter-array cabling length	353 km	190 km	No	No	No
Number of Export cables	6	2	No	No	No
Estimated Construction Duration	3 Years	2 Years	No	No	No

A comparison can be made between the impacts identified in the original consent and the revised design (consented in 2019), taken from the ICOL EIAR assessing the new design.

Chapter 6 – Site Selection and Alternatives, states that 'Relative to the Inch Cape 2014 Consent design envelope, the (updated) Development results in a 34% reduction in turbines and substructures, a 66% reduction in the number of Export Cables, a 46% reduction in the length of inter-array cabling, environmentally this therefore results in less direct physical impact on the seabed as well as a reduction in construction time frames.' The report also notes that this will improve the project LCOE, allow them to use more efficient and powerful turbines which can access higher wind speeds and produce more energy, and lower construction costs [87].

Chapter 18 of the EIA report – Summary of Effects – provides a summary of the effects as assessed in the 2018 EIAR compared to the 2013 EIAR [88].

For the updated 2018 EIA, some topics which were assessed in the 2013 EIA were scoped out, as it was found there would be no change to the impact assessment based on the proposed design changes. These topics were: Metocean and Coastal Processes, Underwater Noise, and Benthic Ecology. Table 18.1 in [88] shows the impacts scoped into the new report and assessed, and the updated findings compared to the 2013 assessment. This table demonstrates well the change in impacts identified and assessed to support the updated consent, which was then approved by Marine Scotland.

6.1.1 INCH CAPE SUMMARY & LEARNINGS

The Inch Cape OWF consenting journey is a somewhat complicated one, but one which is very well documented by both the project and Marine Scotland and should provide some good learnings for the Irish case.

[1] The project received consent in 2014, following standard procedures in place in Scotland. A key part of this was the consent of an envelope with a good level of flexibility (e.g. maximum numbers of WTGs, rotor diameter, etc.). The application was submitted in July 2017, and granted in October 2018. The project was then delayed due to an unsuccessful JR, something which could very likely happen for future Irish projects. The JR was unrelated to the flexibility consented, but due to specific concerns from RSPB in relation to potential impacts on ornithology. Regardless, it was not successful.

[2] As a result of the 3-year delay caused by the JR proceedings, due primarily to the evolution in turbine technology during that time, the project felt it could optimise the design by using fewer, but more powerful turbines, lowering the project capacity from 'up to 784MW' to 'around 700MW'. The project sought new consent for this revised design, to replace the original consent, rather than seek a variation. It can be assumed that confidence in the processing timelines of MD-LOT will have contributed to the decision to apply for new consent, as well as the project wishing to keep the old consent in place if issues were found securing the new consent. This consent was applied for in August 2018, and granted in June 2019, a relatively quick processing time.

[3] 3 variations to the new consent were sought, with these being mainly in relation to wording. The first sought to increase the capacity to up to 1000MW, the second sought to remove this limit. Apart from that, the project was to be built within the consented envelope. The variations were granted speedily, both in around 6 months. Learnings here are that it is key to have a quick variations procedure in place to accompany flexibility requirements, and the careful consideration should be given to the wording included in consents, to avoid needless variations for changes that are non-material. The flexibility in the consent also ensured the changes were non-material, and that the newer turbines could be accommodated for in the consented envelope. If more specific parameters were consented for, the variation process would likely have been more complex, and potentially required EIAR, as the newer turbines would likely have breached the original consent.

[4] The 2023 variation considered more material changes to the consent, supporting documents were prepared by the project, a scoping opinion was issued by MD-LOT where it was found the changes did not require EIAR, and the variation was granted in around 8 months.

[5] Overall, this flexibility in consenting, through both the use of a design envelope, and the availability of an efficient consent variations mechanism, has resulted in a consented project of higher capacity (potentially 1080MW versus 784MW originally) using less turbines (maximum of 72 compared to 110), and more efficient technology. The overall result should be more renewable electricity being delivered to Scotland's grid, at a lower LCOE, with all potential impacts from the project properly assessed.

6.2 SEAGREEN OFFSHORE WIND FARM

Seagreen OWF (sometimes referred to as Seagreen 1) provides another interesting case study. Relevant documents in relation to the original project consent can be found here [89] and documents in relation to the consent variation can be found here [90]. The project website can be found here [91].

Seagreen is Scotland's largest operational OWF, with a generating capacity of 1,140MW [39]. The project is located 27km from the coast of Angus in Scotland, and became fully operational in October 2023. It is a joint venture project between TotalEnergies and SSE Renewables, and holds the record of the world's deepest fixed bottom foundation project, with depths of up to 58.6m.

Jacket foundations were used for the project given the depths on site. Seagreen was originally consented for up to 150 turbines. The remaining 36 turbines are still to be built. These turbines form part of the Seagreen 1A project which has consent to connect to the National Grid at Cockenzie in East Lothian (Figure 6-2).

The key consents for the project were:

- Consent under Section 36 of the electricity act 1989 to construct and operate the OWF, including all ancillary infrastructure; and
- Marine Licences under the Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010.

The project was consented in 2014 as two wind farms (Seagreen Alpha and Seagreen Bravo), each consisting of 2 Phases (Phase 1 and Phase 1A). Variations to the consents were approved in 2018 to increase the overall generating capacity of the project. Phase 1 of both Seagreen Alpha and Seagreen Bravo were constructed under these consents (now termed Seagreen), and in 2022 further variations to the project consents were approved to increase the size of the turbines to be installed in the second Phases (1A).

The project originally applied for consent from Marine Scotland in 2012. A non-technical summary (NTS) of the ES produced for the project can be found [92]. The ES reports on the EIA and contains a description of the development and alternatives considered, a description of the receiving environment, a prediction of the potential impacts on human, physical and the natural environment, an assessment of the subsequent effects, and a description of the mitigation measures to avoid or reduce such effects.

The project was assessed as two OWFs – Seagreen Alpha / Project Alpha and Seagreen Bravo / Project Bravo. Both were planned to accommodate up to 75 wind turbines and 525W, for a total of 150 WTGs and 1050MW.

The project used a Rochdale Envelope approach to consenting, seeking consent for a range of design parameters and installation methods within the site area, so that the project design and construction could then be refined within those options when more technical and economic certainty was obtained. They cite the benefits of this as the various options will be assessed and approved for use, so the final design and construction can be varied to meet local conditions without the need for a reapplication process, but will still be subject to the relevant licensing, mitigation and monitoring as required in consultation with Marine Scotland.

Consent was applied for in 2012, with the intention of beginning foundation installation in Q3 2016 and completing the project in Q4 2019.

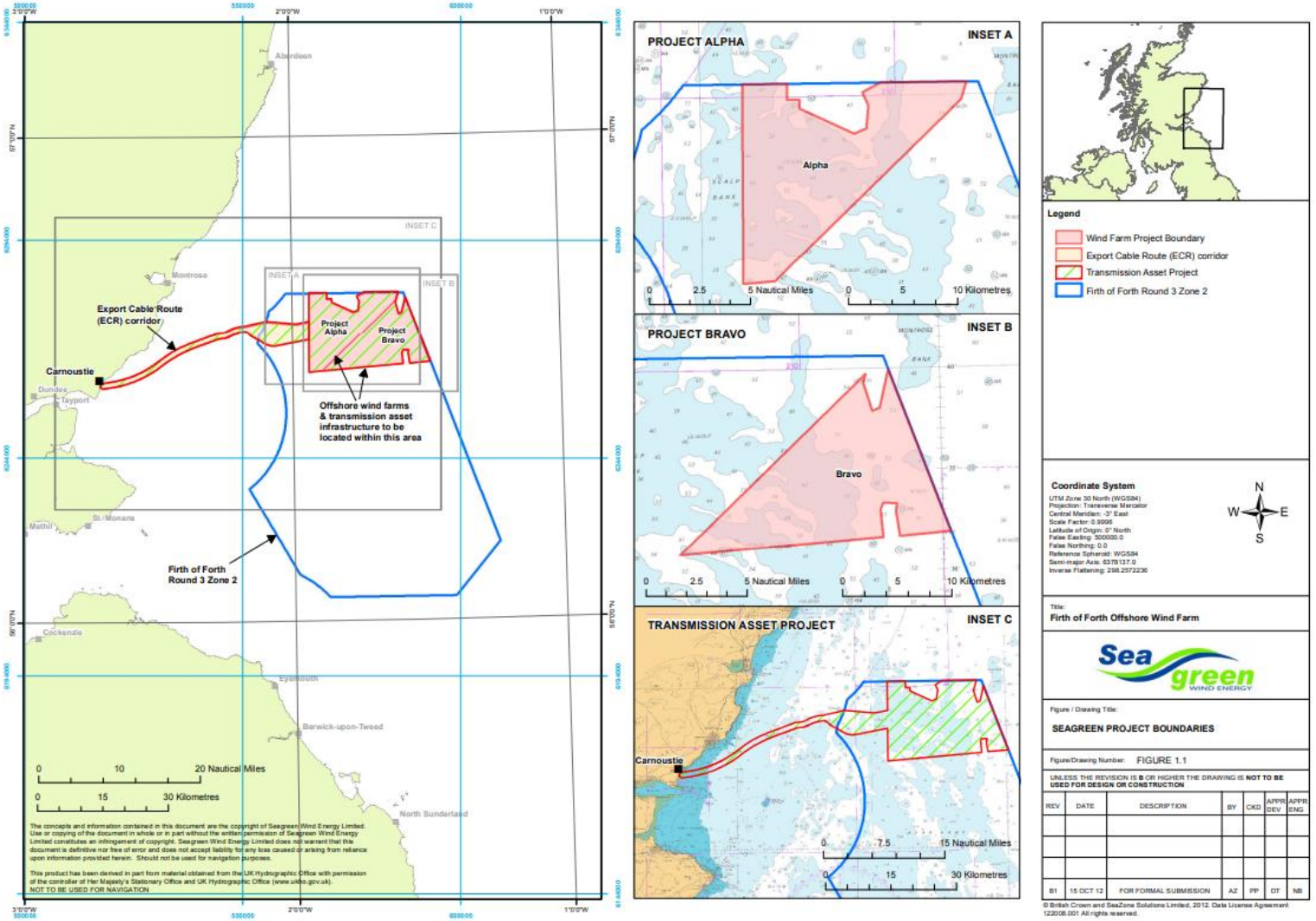


Figure 6-2: Seagreen OWF project map

Table 6-2: Key Parameters of Seagreen project envelope from original NTS [92]

Key Parameter	Project Alpha	Project Bravo
Number of WTGs	Up to 75	Up to 75
Maximum Installed Capacity	525MW	525MW
Area	197km2	194km2
Distance from shore (Closest Point)	27km	38km
WTG Rotor Diameter	122 – 167m	122 – 167m
WTG Hub Height	87.1 – 126mLAT	87.1 – 126mLAT
Maximum Tip Height of WTG	148.1 – 209.7mLAT	148.1 – 209.7mLAT
Minimum Blade Clearance	26.1 – 42.7mLAT	26.1 – 42.7mLAT
Minimum Separation Distance between WTGs	610 – 835m	610 – 835m
Colour of WTGs	Pale matt grey / off-white colour and will include display lighting	Pale matt grey / off-white colour and will include display lighting
Number of offshore platforms	2 – 5 total	
Number of export cables	2 – 6 total	
Indicative Export cable length	up to 530km total	

Impacts from the project were assessed based on magnitude, sensitivity / recoverability of the receptor/species, impact nature (direct, indirect, reversible, irreversible), whether the impacts are in isolation or cumulative or linked to others, conservation status of the receptor or species, confidence of the prediction, the margins by which set values are exceeded. Sensitivity of the receptor and magnitude of the impacts are noted as the most important measures. Impacts are judged as Major, Moderate, Minor, Negligible, or No Impact, based on criteria set out in the ES. Major and Moderate impacts are considered 'significant' for the purposes of EIA Regulations.

Some of the potential significant impacts identified and mitigation measures proposed are shown below, as adapted from the ES NTS for the original consent.

Table 6-3: Summary of potential effects identified on receptors, and proposed mitigation [92]

	Description	Mitigation
Ornithology	indirect effects on birds from potential construction noise impacts on prey, the key fish species being herring and sandeel, based on the worst case installation methodology of impact piling, were predicted to have a significant impact on kittiwake, guillemot, razorbill and puffin.	Impact assessments on birds considered to be very precautionary. Project committed to working with Marine Scotland and the Statutory Nature Conservation Bodies to reduce impacts.
	Collision risk with WTG blades during operation was predicted as a major significant impact for the great black-beard gull species	
	it was predicted the project could potentially have cumulative impacts with neighbouring projects to produce significant	

	Description	Mitigation
	collision and displacement impacts to kittiwake, gannet, guillemot, razorbill, puffin, herring gull, lesser black-backed gull and great black-backed gull.	
Natural Fish and Shellfish Resource	Potential significant noise impacts on herring from construction and pile driving, alone and cumulatively, identified	-
Marine Mammals	Potential significant impacts on harbour seal, grey seal, harbour porpoise due to underwater noise from pile driving during construction, alone and cumulatively	Engineering parameters will be refined following detailed design to reduce impacts, and the project committed to work with Marine Scotland and Statutory Nature Conservation Bodies to reduce impacts.
	Significant potential cumulative impacts on harbour seal, grey seal and bottlenose dolphin through changes in prey resources during construction	
Commercial Fisheries	During construction and operation phases in the export cable route corridor, a significant impact is predicted on a crab and lobster fishery that uses static gear	Regional Fisheries Working Group proposed to facilitate future engagement with the fishing industry to address impacts associated with development in the region
	Cumulatively, it is predicted that the project will produce a significant impact to scallop, squid, nephrops, and crab and lobster fisheries during constriction and to the squid and scallop fisheries during operations	
	Significant cumulative impacts assessed with regards to safety, displacement and interference with fishing vessels	
Seascape, Landscape and Visual Amenity	Installation of the export cables will have a significant impact as the works move progressively towards shore	Impacts deemed to be temporary
	For project Alpha, two significant impacts on seascape character assessed and two significant impacts on visual amenity assessed. Cumulative visual impacts with projects in the area also assessed.	Installation following best practice will reduce visual impacts – whether impacts are positive or negative depends on viewer's perspective. Impacts reversible upon decommissioning.

Due to the issues raised during the project consultation, the project was required to submit a supplementary Environmental Information Statement (SEIS). Subject to the 33 conditions set out in [93] , the project was granted consent under section 36 of the Electricity Act for the construction and operation of the Development with a permitted capacity of up to 525MW for Alpha and the same for Bravo.

Marine licences for the Seagreen Alpha and Bravo OWFs and the Offshore Transmission Asset were also awarded by the Scottish Ministers on 10 October 2014, under Part 4 of the Marine (Scotland) Act 2010 ("the 2010 Act") and the Marine and Coastal Access Act 2009 ("the 2009 Act"). The consents were confirmed in November 2017, following JR by the RSPB to the consent award decision.

The Section 36 and Marine Licences for Project Alpha and Project Bravo OWFs granted on 10 October 2014 were varied on 28th August 2018 [94] to remove the wind farm capacity limits of 525MW for each project. The project submitted supporting information to detail why EIA and AA were not required for this variation, which MD-LOT accepted. 114 turbines were commissioned under this consent, for a total generating capacity of 1,075MW. First power was generated in August 2022 and the project become fully operational in October 2023.

In 2018, Seagreen sought new consents for similar, but improved, designs of the OWF projects in the same sea area, termed the 'optimised' Seagreen Project. New consents were sought to allow the project to take advantage of advances in turbine design and monopile construction since the projects were consented in 2014. On 2 March 2022, those applications for a marine licence and section 36 consents were withdrawn by Seagreen Wind Energy Limited [95]. Some parameters for the optimised design are shown below:

Figure 6-3: 'Optimised' Seagreen design parameters as included in the withdrawn consent application

Key Parameter	Project Alpha	Project Bravo
Number of WTGs	Max 70	Max 70
Maximum Installed Capacity	NA	NA
Area	197	194
Distance from shore (Closest Point)	27	38
WTG Rotor Diameter	up to 220m	up to 220m
WTG Hub Height	up to 170 mLAT	up to 170 mLAT
Maximum Tip Height of WTG	280 mLAT	280 mLAT
Minimum Blade Clearance	32.5 mLAT	32.5 mLAT
Minimum Separation Distance between WTGs	1,000m	1,000m
Colour of WTGs	Pale matt grey/off-white colour and will include aviation lighting	

Seagreen obtained a marine licence for an additional export cable (approximately 108 km) from the consented Seagreen Project Area to an identified landfall location at Cockenzie, to accommodate the remaining 36 consented but not constructed WTGs under the 2014 Consents.

In 2022, Seagreen sought a variation to its section 36 consents for Alpha and Bravo under Section 36(C) of the Electricity Act 1989. Seagreen also requested that should the variation of the section 36 consents be granted, the associated Seagreen Alpha Marine Licence and the Seagreen Bravo Marine Licence be varied by the Scottish Ministers under section 72 of the Marine and Coastal Access Act 2009 and section 30 of the Marine (Scotland) Act 2010. An Environmental Appraisal Report was

prepared in support of this application [96]. Seagreen also requested a variation to the existing Marine Licence, varied in 2019, associated with the Offshore Transmission Asset (OTA) to Carnoustie.

The proposed parameter changes included:

- Increased size of 36 of the consented (but not yet built) WTGs; and
- Increased weight of seabed steel deposits associated with the OSPs (the steel of the jacket structure along with the piles associated with fixing the jackets in place for the OSPs).

The changes were noted as being requested to maximise supply chain opportunities and the production of renewable electricity, and to ensure optimal technology could be deployed at the project. The application Environmental Appraisal report notes that the variation would enable them to consider indicative WTGs in the range of 16MW for the final 36 turbines, where 7MW was assumed for the original consent (10MW turbines were installed). The noted changes between the original consents and the 2022 variation are shown below, as well as what was constructed in the first phase of the project:

Table 6-4: Relevant Section 36 Consent Parameters

	Relevant 2014 Section 36 Consent Parameter	As-built for the original 114 turbines	2022 Variation for 36 remaining turbines
Capacity	525MW each initially, but removed via variation	1,140MW	Increased WTG capacity gives potential for 576MW from final 36 WTGs
WTGs	Up to 75 WTGs for Alpha and Bravo (150 total)	114 constructed in Phase 1	Changes apply to 36 consented but not constructed WTGs only
Indicative WTG capacity	7MW (generating capacity removed in 2018)	10MW	16MW
Maximum Tip Height	209.7mLAT	205 mLAT	increase to 285mLAT
rotor diameter	122 – 167m	164m	increase maximum to 242m
hub height	87.1 – 126.2mLAT	119 – 123m	118 - 165mLAT
Minimum blade tip clearance	29.8 – 42.7 mLAT	37 mLAT	34 - 45m
Blade width	up to 5.4m	5.4m	up to 7.6m
minimum spacing	1,000m	1,000m	No Change
Steel seabed deposits associated with OSPs	13,000	13,000	22,560

For the application, on 17th of January 2022, Seagreen requested a Screening Opinion from Scottish Ministers via MD-LOT. A Screening Report was submitted to support this request, to demonstrate why the variation would not lead to a fundamentally different development as the one already consented, and to demonstrate, based on further technical assessment, that the variation would not give rise to any likely significant adverse environmental effects compared to the consented Seagreen Project, and as such does not require an EIA. Updated assessments were undertaken within the Seagreen

Application Screening Report to investigate potential impacts on receptors relating to ornithology, seascape, landscape and visual and military and civil aviation. For the remaining technical topics, no new or materially different impacts were identified compared to the consented Seagreen Project previously assessed.

On 13th April 2022, a Screening Opinion was given by Scottish Ministers which concluded that the variations did not comprise EIA development, and therefore an EIA was not required in respect of the variation [97].

Some of the reasons given for this conclusion were:

- No changes to the turbine locations were proposed.
- The overall footprint would remain the same, and NatureScot was consulted and advised that the changes would have no significant adverse environmental effects.
- Further onshore works were not required and East Lothian Council confirmed they were content that an EIA was not required as far as impacts on its interests were concerned.
- Both Angus Council and Fife Council were of the view that the Proposed Works were unlikely to have significant impacts on the environment that are new or materially different to those already assessed and consented.

The application for the variation was submitted in May 2022 [98] along with an Environmental Appraisal Report, a Screening Report, proposed consent amendments, and a Collision Risk Modelling Appraisal Report. A decision notice was issued in October 2022 to grant the variation [99].

6.2.1 SEAGREEN SUMMARY AND LEARNINGS

The Seagreen project is in a similar location to Inch Cape, but is included as another useful example of a project consented using a design envelope approach which benefited from this flexibility, but also sought variations to consent that have been important to the progress of the project in a phased manner.

[1] The original consent was sought for two projects, with a combined capacity of 1050MW, and up to 150 WTGs, with an indicative WTG capacity of 7MW. Consented was granted in 2014. The project was then delayed because of the same JR proceedings that were taken against the Inch Cape project, with consent confirmed in November 2017 once the unsuccessful JR concluded. The first phase of the project reached first power in August 2022 and the project become fully operational in October 2023.

[2] Unlike the Inch Cape project, Seagreen did not require a new consent after the JR proceedings were concluded[5]. A consent variation was approved to remove the capacity limit of 525MW per project or 1050MW total, but the project was able to proceed to construction using larger 10MW turbines, within the envelope consented originally in 2014. This shows a clear benefit to having flexibility in the original consent, and can be seen as one of the reasons part of Seagreen has already been commissioned, while Inch Cape is yet to commence construction. If the envelope approach was not used, delays due to JR would more than likely have seen the project apply for new or varied consent to install larger turbines, which would have delayed commissioning.

[3] As with Inch Cape, the project sought non-material consent variations to remove the included maximum generation capacity limit of 525MW per project. Careful consideration should be given

[5] As discussed, in 2018 the project did submit a new consent application for an optimised design using larger turbines, but this application was withdrawn by the project in 2022 and construction took place under the original 2014 consents.

to the inclusion of constraints within consents that have no material influence on impacts, to avoid variation applications like this that could be seen as a waste of time and resources for both the project and the CA.

[4] The most recent consent variation application submitted and approved in 2022 could be seen as a more material change to the consent. This involved an increase in the size of turbine to be deployed for the remaining 36 on site (285m tip height as opposed to 205m), which would enable the project to use WTGs with a capacity of approximately 16MW, as opposed to the 10MW which has been deployed to date. However, Seagreen received a screening opinion from MD-LOT on the application, who judged that the variations did not comprise EIA development, and therefore an EIA was not required in respect of the variation. Seagreen could then submit the application with the required supporting documents as outlined above, and can now proceed to construction of the final phase of the project with the newly consented larger turbines.

[5] The case study shows the complexity of OW development, and the benefit that can be bought from employing a flexible approach to consenting. It also shows that regardless of flexibility, long JR delays to projects may require project designs and business cases to be reconsidered, and to address this it is important to have efficient consent variation procedures in place. This will mean that any delays due to variations that may be required will only cost projects months, rather than years. This could be key for Ireland for future projects and targets.

6.3 THE HORNSEA PROJECTS (WITH FOCUS ON HORNSEA 3)

The Hornsea Projects are four OWFs developed (or in development) by Ørsted off the East Coast of the UK in the North Sea (Figure 6-4, Table 6-5). These wind farms are notable as they are further from the coastline than is typical for UK windfarms (120km from Shore for Hornsea 1, 89km for Hornsea 2, 120km for Hornsea 3, 65km for Hornsea 4), and are larger in size than many other wind farms in the jurisdiction, or indeed the world.

Figure 6-4: A map of the Hornsea offshore windfarms. Image; Ørsted.

Table 6-5: Hornsea Projects Overview

Phase	Capacity	Layout	Status
Hornsea 1	1.2 GW	174 x 7MW WTGs, MP foundations	Commissioned in 2019
Hornsea 2	1.32 GW	165 x 8MW WTGs, MP foundations	Commissioned in 2022
Hornsea 3	2.4 - 2.9 GW	up to 231 x ~ 12.5MW WTGs	Consented in 2020, FID taken in December 2023
Hornsea 4	up to 2.6 GW	up to 180 x ~ 14MW WTGs	Granted DCO in July 2023

All phases of the Hornsea Project are availing of the Rochdale Envelope approach which allows for the wind farms to operate at maximum capacity as the GW output is calculated based on the available technology set out in the PDE.

Hornsea 2 was noted in [55] as a project permitted with 'maximum flexibility'. A single PDE for the project was presented and consented, which enabled the project to have sufficient flexibility to develop up to 1.8GW either as a single project, or as two individual projects, and potentially four phases. For this projects, the potential turbine capacity ranges consented were from 6MW to 15MW. This means while the first phase could have used turbines of 6MW, the second phases could use 15MW turbines, which were consented under the same DCO. 8MW WTGs were installed on the project, but only 1.32GW of the consented 1.8GW has been built to date.

BOEM notes that 'the assessment of phasing for a large scale several GW project needs to be very carefully designed to ensure a robust EIA, to give confidence to regulators and stakeholders that potential impacts are adequately assessed and mitigated'. There is an onus on the developer here to clearly explain the PDE and how it applies to each receptor and how impacts have been assessed. The regulator also requires significant expertise to assess the application.

Another potential disadvantage of the phasing approach could be that while the developer would have consent to build e.g. 2GW in a phase approach, the developer may then choose to only build out a smaller portion of the consent e.g. 1.5GW. This may encourage grid hoarding or make it harder to plan for projects to be connected to the grid (where required) or make it more difficult to monitor progresses versus installed capacity targets. This is an issue which could be managed through conditions in the consent e.g. the full capacity must be built by a certain date or the consent is revoked. It can also be assumed that where developers have consent to build out a certain capacity, they will look to take advantage of this and build out the largest capacity they can.

While these are two potential disadvantages of the approach, BOEM notes several benefits:

- Only a single application needs to be considered, reducing administrative burdens and overall consenting time.
- The approach allows the regulator to understand the potential impacts from the maximum design scenario on each receptor for each impact.
- This approach offers the developer significant flexibility to build efficient projects.
- It provides several cost savings - due to only going through one consenting process, by allowing tasks and activities during permitting to be undertaken simultaneously, including undertaking a single EIA and permitting process, a single consultation exercise and undertaking surveys across the entire project rather than for individual phases.

The Hornsea 3 project was included in the European Commission's 2020 Guidance document on wind energy developments and EU nature legislation [49] as a case study to demonstrate the value of the Rochdale Envelope in covering uncertainty in project design trends.

Hornsea 3 is located within Zone 4, under the Round 3 OW licensing arrangements by the Crown Estate. Its DCO application was submitted for consideration on 14 May 2018 and accepted for examination on 8 June 2018. The examination began on 2 October 2018 and was completed on 2 April 2019. The application can be viewed on the Planning Inspectorate's website [100].

The project's ES NTS from May 2018 can be found [101]. This presents a summary of the project EIA. The EIA Site Description Chapter can be found [102]. Table 6-6 and

Table 6-7 below are extracted and adapted from the project EIA, showing the WTG parameters considered for the assessment, and the foundation options for WTGs and offshore substructures. The tables demonstrate the high level of flexibility sought by the project.

The Secretary of State for BEIS issued a letter stating he was minded-to approve the application in July 2020 [103], subject to the Applicant providing sufficient evidence that compensatory measures were arranged. This noted the Order would grant consent for construction and operation of a project up to 2.4GW and up to 300 WTGs.

Regarding the compensatory measures, the Secretary of State concluded that he could not rule out an Adverse Effect on Integrity on the kittiwake feature of the Flamborough and Filey Coast SPA in-combination with other plans or projects. Nor did he consider that necessary compensatory measures for that impact had been secured. He requested that the project provided a detailed Compensation Plan which would give confidence that any compensatory measures proposed would be sufficient to offset the impact to the kittiwake feature of the Flamborough and Filey Coast SPA 'and thereby maintain the coherence of the network of SPAs designated, at least in part, for kittiwake'.

To address this, the project submitted a Kittiwake Compensation Plan developed in consultation with Natural England and RSPB which included plans to construct 4 artificial nesting structures at English east coast locations to increase the productivity of the eastern Atlantic kittiwake population. The final details of the compensation measures were then to be presented within a Kittiwake Implementation and Monitoring Plan that would be submitted to the Secretary of State prior to the commencement of the development.

The letter also stated that the Secretary of State was satisfied that the project carried out a reasonable site selection process and provided information about the choices made, and that the design flexibility approach sought in respect of the transmission system and phasing was justified.

On 31 December 2020, the Secretary of State for BEIS published a decision letter [104] granting the DCO, despite the Examining Authority's (the ExA - a panel comprising of four examining Inspectors who conducted an examination into the application) conclusion that 'it could not be satisfied that the Development would not adversely affect the integrity of European sites and that the tests in the Habitats Regulations have been met' and that it therefore recommended that development consent should not be granted. The DCO can be viewed here [105]. Some amendments were made to this to correct typographical errors, and a non-material amendment to shorten the length of time which four planned artificial nesting structures for kittiwake needed to be in place before turbine operation.

A CFD for the project was awarded in July 2022, FID was announced in December 2023, construction started in May 2023 and is expected to continue until March 2026.

Table 6-6: WTG maximum design scenarios

Parameter	Maximum design scenario – Most Numerous Turbine	Maximum design scenario– Largest Turbine
Number of WTGs	300	160
Min height of lowest blade tip (mLAT)	34.97	34.97
Maximum blade tip height (mLAT)	250	325
Maximum rotor blade diameter (m)	195	265

Table 6-7: Foundation options for WTGs and offshore structures

	Turbine	Offshore transformer substation	Offshore HVAC booster station	Offshore HVDC converter substation/ Large offshore HVAC substation	Offshore accommodation platform
Maximum number of structures	300	12	4 (6 subsea)	4	3
Monopile	Y	Y	Y	Y	Y
Mono suction bucket	Y	Y	Y	Y	Y
Piled jacket	Y	Y	Y	Y	Y
Suction bucket jacket	Y	Y	Y	Y	Y
Gravity base	Y	Y	Y	Y	Y
OSS suction bucket jacket	N	Y	Y	Y	Y
OSS piled jacket	N	Y	Y	Y	Y
Box-type gravity base	N	Y	Y	Y	N
Converter piled jacket	N	N	N	Y	N
Converter suction bucket jacket	N	N	N	Y	N
Pontoon GBS 1	N	N	N	Y	N
Pontoon GBS 2	N	N	N	Y	N

6.3.1 HORNSEA SUMMARY & LEARNINGS

[1] The Hornsea projects provide the best example of the benefits that maximum flexibility in consenting can provide. The projects have been noted by both BOEM and the European Commissions as case studies on the benefits of design flexibility and PDE.

[2] Previous case studies have shown how flexibility can enable a project to make the best use of modern and efficient technology, while the Hornsea case shows not only that, but how this approach can be implemented on a larger and broader scale, to enable project phasing for GW-scale projects. The proposed WTG envelope included in the application could facilitate WTGs in the 14 – 24MW range.

[3] There are clearly many benefits to this approach which have been discussed in this section and report overall, and it has been used very successfully in the Hornsea case to build projects of massive scale.

[4] The potential benefit to this approach for emerging markets which are developing their supply chain is also one that could be relevant to Ireland, particularly for large scale floating.

[5] Care does need to be taken when facilitating this level of flexibility, however. The assessment of phasing for a large scale several GW project needs to be very carefully designed to ensure a robust EIA. There is an onus on the developer here to clearly explain the PDE and how it applies to each receptor and how impacts have been assessed, but the regulator must also clearly set out what is required, and have significant expertise to assess the application.

6.4 VINEYARD WIND 1

Vineyard Wind 1 is a US OWF (Figure 6-5) located about 13 Nautical miles south of Martha's Vineyard and Nantucket, Massachusetts. It has a total capacity of 804MW and was approved for development by the Massachusetts Department of Public Utilities in 2019 with construction commencing at the end of 2021. The project reached first power in January 2024, and construction is expected to be completed in 2024, although construction to date has been slow. The project, which will be America's first utility-scale OWF, is 50 percent owned by Copenhagen Infrastructure Partners (CIP) and 50 percent owned by Avangrid Renewables LLC (a member of the Iberdrola Group).

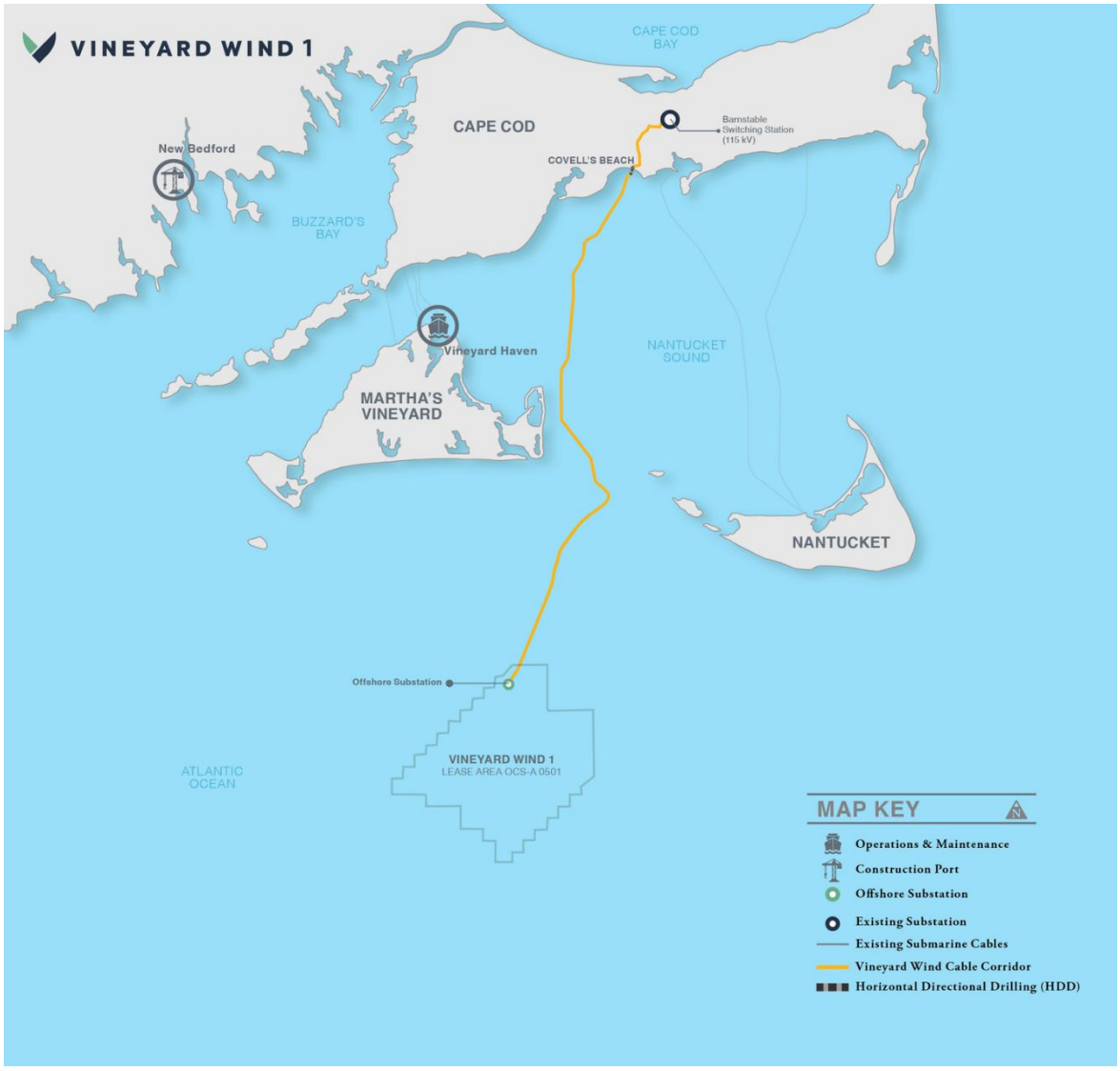


Figure 6-5: Map of Vineyard Wind OWF [106]

Given the nascent nature of the OW industry in America, the project has been described as 'a legal test case for US clean energy' [107]. To date, three lawsuits have been filed against the developers of Vineyard and currently all three of these are at Appeals stage. The plaintiffs, consisting of Nantucket residents, a small-scale solar power company and local fishing communities state that the project does not comply with environmental laws. This area has been notoriously difficult to develop from an OW perspective and Vineyard's predecessor, Cape Wind, was abandoned, with the project filing to terminate its lease in 2017 after years spent battling JR and objections from Cape Cod residents and fisheries, which delayed the project sufficiently that it had to be shelved [108].

As well as this, local authorities denied a consent for construction of undersea cables connecting Vineyard Wind to the mainland. While this issue was eventually resolved, it was another delay to Vineyard Wind's development timeline in relation to design of the project [109]. Given that OW developments are particularly susceptible to JR and litigation in the USA, the use of design flexibility is important in this jurisdiction.

The project's most recent COP reports can be found here [110]. Volume I relates to Project information, Volume II to Technical Information, and Volume III to Environmental Information. Vineyard Wind implemented a PDE concept which the project stated would allow them to properly define and bracket proposed project characteristics for environmental review and permitting while maintaining a reasonable degree of flexibility for selection and purchase of components. The extent of design flexibility incorporated is further detailed in Volumes 1 - 4 of the Vineyard Wind Energy Project Final Environmental Impact Statement (FEIS) [111], [112], [113], [114]. BOEM prepared this FEIS following the requirements of the National Environmental Policy Act. The FEIS is prepared by BOEM to determine whether to approve, approve with modifications, or disprove the COP.

In the FEIS, BOEM assesses the impacts of alternatives, ranging from (A) Proposed Action (project built out to maximum capacity) to (G) No Action Alternative (project not approved or built), and recommends a preferred alternative. BOEM identified the combination of Alternatives C (No Surface Occupancy in the Northernmost Portion of the Project Area Alternative), D2 (East-West and One-Nautical-Mile Turbine Layout), and E (Reduced Project Size Alternative) as its preferred alternative for the project.

Table 6-8 shows the PDE approach utilised in this development.

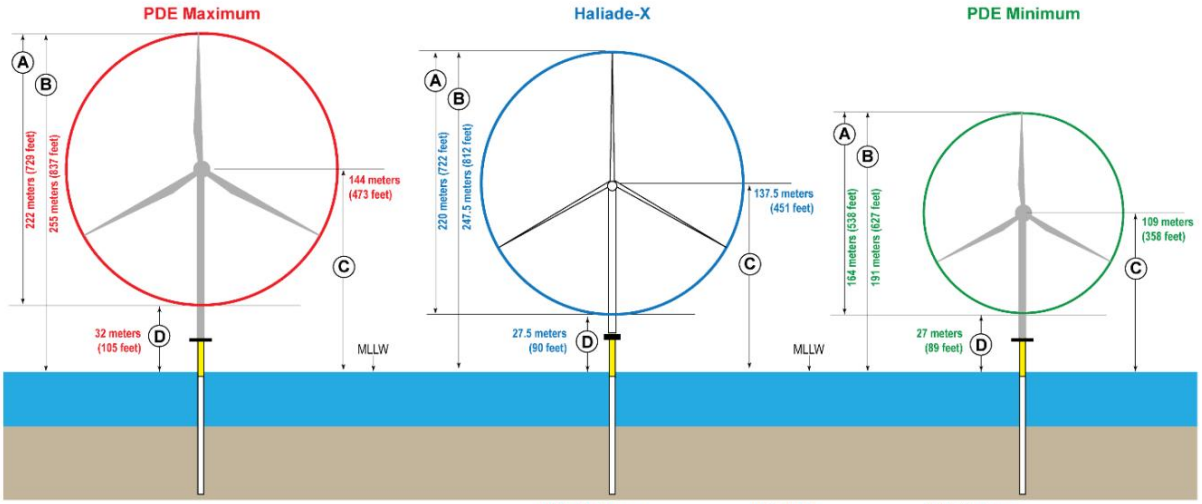
Table 6-8: Proposed Project Design Envelope Parameters, as set out in project COP [110]

Layout and Project Size	Foundation	WTGs
• 800 MW project • Up to 106 WTG positions • Up to 100 WTGs installed • Continuous construction of 800 MW project	• 100% monopiles for WTG foundations or up to 10 jacket foundations for WTGs, with the remainder monopiles • Pile driving hammer • Scour protection on all positions • Installation with a jack-up vessel or vessel on dynamic positioning (DP) with feeder barges	• 8 – ~14 MW WTG • Rotor size of 164-222 m (538-729 ft) • Hub height of 109-144 m (358-473 ft) • Installation with a jack-up vessel or vessel on dynamic positioning (DP) with feeder barges
Inter-array Cables	**Offhore Export Cables**	**Electrical Service Platform (ESP)**
• 66 kV cables beneath the seafloor • Example layout identified, not finalized • Maximum total cable lengths indicated • Installation techniques include jet plow, mechanical plow & mechanical trenching • Installation with a vessel on DP • Pre-lay grapnel run	• Two 220 kV export cables beneath the seafloor • One corridor identified with variants • Max total cable lengths indicated • Installation techniques include jet plow, mechanical plow & mechanical trenching, with dredging in some locations to achieve burial depth • Installation with a vessel on DP and some use of an anchored vessel • Use of rock protection, concrete mattresses, or half-shell, or similar on areas of minimal cable burial • Pre-lay grapnel run	• One 800 MW conventional ESP or two 400 MW conventional ESPs • Each ESP installed on one monopile or a single jacket foundation • Scour protection on all positions • Installation using foundation and turbine installation vessels or specialized crane vessel

The maximum case approach utilised by Vineyard looks at the elements of the design parameter that would impact physical, biological and socioeconomic features of the receiving environment in the most extreme case scenarios. It also takes a holistic approach to PDE factors, examining how design parameters interact with each other.

The FEIS states that "since Vineyard Wind is only proposing up to an 800-megawatt (MW) facility with turbines ranging from 8 to 14MW, this FEIS does not analyze 100 14MW turbines because this would result in a 1,400MW project. This FEIS also analyses the planned action impacts of the maximum-case scenario alongside other reasonably foreseeable past, present, and future actions [112].

Below is an example of the Hallide-X Wind Tower Generators that are used in the Vineyard project in comparison to the PDE maximum and minimum rotor diameters, total blade to tip height, hub height, tip clearance during operation.



	PDE Maximum	Haliade-X	PDE Minimum
A = Rotor Diameter	222 meters (729 feet)	220 meters (722 feet)	164 meters (538 feet)
B = Total Blade Tip Height above MLLW	255 meters (837 feet)	247.5 meters (812 feet)	191 meters (627 feet)
C = Hub Height above MLLW	144 meters (473 feet)	137.5 meters (451 feet)	109 meters (358 feet)
D = Tip Clearance during Operation Above MLLW	32 meters (105 feet)	27.5 meters (90 feet)	27 meters (89 feet)

Figure 6-6: Project Design Envelope Parameters in Comparison to the General Electric Haliade-X Proposed for the Project [115]

OW projects in the US can require permitting at federal, state, local, tribal, and regional levels. This is very much the contrary of the 'one-stop-shop' to permitting that is seen as best practice in Europe.

The project was required to seek permits and approvals from:

- BOEM as the lead federal permitting agency for OW;
- The Massachusetts Environmental Policy Act Office and the Energy Facilities Siting Board at a state level;
- The Cape Cod Commission and the Martha's Vineyard Commission at a regional level; and
- The Conservation Commissions in the Towns of Barnstable and Edgartown at a local level.

Vineyard Wind obtained a lease for the site are in 2015. In December 2017, Vineyard Wind submitted state and federal project plans to build the project, including a COP to BOEM and transmission plans to Massachusetts's Energy Facilities Siting Board. In April 2018, the project submitted plans for state review in Massachusetts, starting the environmental review of the offshore export cable corridor, and

onshore transmission and interconnection. BOEM announced a delay of their decision on the project in July 2019, citing a need to analyse cumulative impacts of projects on the east coast. This was completed in June 2020, by which time all state, regional and local permitting was completed, and in May 2021, BOEM released its Record of Decision [116], enabling the project to proceed to construction, which is now ongoing.

As discussed, the project faced multiple legal challenges, but some have contended that the lawsuits are being bankrolled by oil companies and other conservative interest groups [107]. Regardless, none of these related to how flexibility was provided for in consenting, and all have been dismissed (and appealed).

6.4.1 VINEYARD SUMMARY & LEARNINGS

[1] Vineyard 1 presents another example of a project in another jurisdiction that was developed with a high level of flexibility. As discussed in 5.6, BOEM conducted a review of development in other jurisdictions and decided that flexibility should be given to developers.

[2] Vineyard 1 is the first large scale OW project to go into construction in the US, and will likely set the precedent for future applications, which can be expected to be progressed using a PDE approach.

[3] The PDE employed by the project gave them the option of installing turbines from 8 – 14MW, which is a very large range. This was of particular value given the consenting process took approximately 3 and a half years to complete. The project eventually installed 13MW WTGs.

[4] The US is perhaps a unique case, given its complex permitting requirements at a Federal, State, Local, regional and tribal level, but can still provide learnings to the Irish case, not only in relation to the PDE approach, but also in how legal challenges have been dealt with. Given the litigious environment in Ireland, legal challenges can be expected. It is important that these are not allowed to derail projects (as was the case for Cape Wind).

7 EXAMINATION OF FLEXIBILITY IN IRISH REGULATORY DECISION MAKING AND SUITABILITY FOR ORE DECISION MAKING

This section examines the provisions that are available for design flexibility to be accommodated for OW development in Ireland, looks at relevant legalisation and cases, and reports on interviews held with Phase One project developers to inform understanding.

7.1 RELEVANT LEGISLATION

The Planning and Development Act 2000 (as amended) [117] forms the foundations for planning in Ireland. This Act covers a huge range of planning-related issues, and combines a wide range of different legislation into one place.

This Act:

- Sets out the detail of regional planning guidelines, development plans and local area plans.
- Explains how Ministerial Guidelines work.
- Sets out how the process of applying for and obtaining planning permission works.
- Contains special requirements for protected structures, conservation areas and areas of special planning control.
- Explains the relationship between planning and social housing supply.
- Sets out Ireland's planning appeals and enforcement processes.
- Describes Strategic Development Zones and Environmental Impact Assessment.
- Clarifies how a range of particular planning processes, including for State development, operates.

The principal regulations underpinning the Planning and Development Acts are the Planning and Development Regulations 2001 (S.I. No. 600 of 2001). A number of Regulations amending the 2001 Regulations have been made, which, taken together, are collectively cited as the Planning and Development Regulations (PDR) 2001 to 2024. These regulations set out the need for a planning application to be accompanied by such 'plans and particulars' as are necessary to enable the planning authority to make a decision in relation to the siting, layout or other proposals for development in respect of which a decision is sought.

The MAP Act 2021 includes several amendments to the Planning and Development Act 2000, including to account for development in the maritime area. The Planning and Development (Amendment) Bill 2023 is also important in this context in that it will bring about further changes, powers and functions in relation to the planning system in Ireland once finalised, approved and enacted.

The Planning and Development, Maritime and Valuation (Amendment) Act 2022 [118] introduced amendments to the Planning and Development Act 2000 (as amended) (the Act of 2000) and the MAP Act 2021 to facilitate procedures that enable planning authorities to consider design flexibility as part of the assessment of planning applications.

How this should work is set out in [1], and is summarised below:

Opinion on Design Flexibility as part of Pre-planning (Section 287 of the Act of 2000)

Prior to making a planning application for maritime development, an applicant is required to enter into pre-planning consultation with ABP, under Section 287 of the Planning & Development Act 2000 (as amended).

In addition to this pre-application consultation, section 287A of the Act of 2000 provides that an applicant may separately request an opinion from ABP with regard to design flexibility for the proposed development. The flexibility opinion request must be made separately to the pre-application consultation request initially, but the flexibility issue may then be addressed as part of the pre-application consultation.

This request for an opinion on flexibility must include:

- **287A**(2)(e)(i) the details, or groups of details, of the proposed development that, owing to the circumstances set out in subparagraph (ii), are unlikely to be confirmed at the time of the proposed application, and
- **287A**(2)(e)(ii) the circumstances relating to the proposed development, including such circumstances as the Minister may prescribe in relation to any class or description of development for the purposes of this subparagraph, that indicate that it is appropriate that the proposed application be made and decided before the prospective applicant has confirmed the details referred to in subparagraph (i) in particular, whether the prospective applicant may be able to avail of technology available after making the proposed application that is more effective or more efficient than that available at the time of the application

When requesting the meeting under Section 287A, the following information is required:

- **287A(2)(f)(i)** two or more options in respect of each detail or group of details referred to in paragraph 287A (2)(e)(i), containing information on the basis of which the proposed application may be made and decided;
- **287A(2)(f)(ii)** parameters within which each detail referred to in paragraph 287A (2)(e)(i) will fall and on the basis of which the proposed application may be made and decided, or;
- **287A(2)(f)(iii)** A combination of both options and parameters in respect of these details to be confirmed.

Following the provision of this information and consultation with ABP, if ABP is satisfied that specific circumstances of the development mean the application can be made and decided before certain details of the application are confirmed, it shall provide an opinion to that effect under Section 287B9(i). This is contingent on that fact that ABP believes that the application that will be made on foot of the opinion can still be assessed properly.

If ABP is not satisfied that that due to the specific circumstances of the development an application can be made and decided before certain details of the application are confirmed, it must notify the prospective applicant of this.

Any opinion on this matter will only be made public when the planning application is made in accordance with section 291 of the Act of 2000.

Applications for Maritime Development (Section 291 of the Act of 2000)

Once an opinion on flexibility has been sought, the information submitted as part of the application must be consistent with the opinion provided by ABP and shall include clear design options, design parameters or a combination of both. This provides for the consideration of design flexibility at application stage while ensuring ABP has the necessary information to carry out a comprehensive assessment.

Where a planning application is submitted on foot of an opinion issued by ABP under section 287B, there must be consistency across all application documents, including the supporting environmental documents. Where permission is granted pursuant to design options or parameters being agreed, ABP will include a condition requiring the specific details to be agreed with them prior to construction.

DHLGH notes in its circular letter that flexibility should only be granted where justified, that it should not be exploited, and that it should not be a reason for substandard applications.

EIA and Design Flexibility

DHLGH also comments on EIA requirements with respect to design flexibility, noting that EIAR must contain the necessary information to enable to competent authority to carry out an assessment of all likely significant effects of the development on the environment.

The information provided as part of the EIAR should, among other things, enable an assessment of the impact of each specific option or, in the case of design parameters, any developments which could fall within the scope of the proposed design parameters including combinations thereof. The information to be provided by a developer in an EIAR when describing a project is set out in Article 5 and Annex IV of the EIA Directive (DIRECTIVE 2014/52/EU, [119]).

This includes:

- a description of the location of the project;
- a description of the physical characteristics of the whole project
- a description of the main characteristics of the operational phase of the project
- A description of the reasonable alternatives
- A description of the relevant aspects of the current state of the environment and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge.
- A description of the factors specified in Article 3(1) likely to be significantly affected by the project: population, human health, biodiversity (for example fauna and flora), land (for example land take), soil (for example organic matter, erosion, compaction, sealing), water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.
- A description of the likely significant effects of the project on the environment

As discussed, EPA Guidance is also available to inform the information to be included in EIA.

These new provisions allow for flexibility to be accommodated for in the consenting and development of OWFs in Ireland. The level will depend on how this is interpreted and applied by ABP.

7.2 THE DERRYADD DECISION

The best-known case in relation to design flexibility in Ireland is the case of the Derryadd Wind Farm at Lanesborough, Co. Longford (An Bord Pleanála Case reference: PA14.303592 [120]) – the so called 'Derryadd Decision'.

The Derryadd project consent application was for a 10-year planning permission for the construction of an onshore wind farm comprising 24 no. wind turbines, 1 no. 110kV substation and all related works. The applicant was Bord na Móna Powergen Ltd., the application was lodged with the board under the SID provisions of s. 37A of the Planning and Development Act 2000 on 31/01/2019, permission was granted with conditions on 12/06/2020, and ABP's decision was then quashed by Order of the High Court on 14/02/2022.

In the original inspector's report from 06 September 2019 [121], it was recommended permission be refused for the proposed development, with a primary consideration by the inspector being that the proposed development constituted a non-integrated approach to the redevelopment of industrially extracted peatlands for renewable energy projects, and that the project would result in significant but unquantified ongoing CO2 emissions from the extracted peatland and forgo the site's carbon sequestration potential over the lifetime of the project due to the proposal to pump drain the site. It was considered by the inspector that the proposed development would be contrary to the Climate Action Plan 2019 and to the National Peatland Strategy 2015-2025 and mitigate against Ireland meeting its obligatory greenhouse gas reduction targets to 2030 under the EU's Effort Sharing Regulation.

In November 2019, the developer responded to a request for further information that was issued on foot of the first inspector's report, a procedure that is permitted in the strategic infrastructure context under s. 37F(1)(a) of the 2000 Act.

Following the submission of further information to ABP, the Board in its Direction [122] from May 2020, decided to grant permission with conditions. ABP considered and agreed with the Inspector's conclusions in the September report, except with reference to the conclusion regarding long term indirect adverse impact on climate due to ongoing pumping of the industrial peatland site. ABP concluded that the main significant direct and indirect effects of the proposed developed on the environment would be mitigated against. In making this decision, the Board considered the additional information submitted to the Board by the applicant on 18/11/2019 which it said clarified that the rehabilitation of the peatlands within the overall application site but outside of the working footprint of the proposed wind farm project would continue, and that the proposed development would not require the ongoing pumping of the entire site for the duration of the construction and operation.

One condition (1) attached to the permission stated that 'the development shall be carried out and completed in accordance with the plans and particulars lodged with the application, as amended by details submitted by the applicant to the oral hearing held from the 12th day of June, 2019 to the 14th day of June, 2019, and the applicant's further information submission received by the Board on the 18th day of November, 2019, except as may otherwise be required in order to comply with the following conditions …'

Another condition (7(a)) was that 'the wind turbines will have a maximum tip height of 185 metres. Final details of the turbine design, hub height, tip height and blade length complying the maximum limit and within the range set out in the application documentation, along with details of colouring, shall be submitted to, and agreed in writing with, the planning authority prior to commencement of development.'

The project's EIAR submitted with its planning application, noted that:

'The proposed turbine will be detailed by the turbine manufacturer on award of the contract. However, the proposed Derryadd Wind Farm turbines will be the typical three bladed, horizontal axis type with general specifications as follows:

- Maximum height envelope of 185m; and
- Installed capacities of approximately 4MW per turbine resulting in an estimated 96MW in total for the wind farm.

The project EIAR or consent did not specify a minimum tip height.

For the EIAR, various types and sizes of turbines (up to 185m tip height) were considered in the relevant sections of the EIAR to assess the worst-case scenario (e.g tallest for visual impact, loudest for noise, longest rotor for shadow flicker).

The EIAR also stated that at the turbine selection stage of the project, new turbine models or variations of currently existing models may be available that were not on the market at the EIAR preparation stage that would suits the project and fit within the proposed 'size envelope', and that if this should arise, the parameters of the new turbines would be assessed by the project for their compliance with the criteria set out in the EIAR.

Following a JR challenge in Sweetman v An Bord Pleanála [123] the Court ruled that the design envelope approach is contrary to the requirement under the PDR to provide "plans and particulars" in relation to the relevant application.

The judgement is shown in [123] and summarised in [124]. A key point from the judgement of Humphreys J. delivered on Wednesday the 16th day of June, 2021 [123] was a complaint of inadequate detail in respect of design.

Ground 25 stated: "[t]he Plans and Particulars lodged and in particular the detail in respect of the Turbine which is one of if not the largest series of structures ever to be constructed in the Jurisdiction has no detail in terms of their design relative to their particular siting. When one compares the level of detail that one requires to produce in a conventional Planning Application for even the most modest extension which is required to show existing ground levels, method of construction, all the surrounding features and each specifically related to the structure the subject matter of the Application here is completely inadequate. The Plans and Particulars lodged show virtually no detail and no site-specific detail and given the scale and extent of the Development and the likely consequences and impacts it will be impossible on the basis of these Plans to formulate any definitive findings in respect of their impacts."

The judge notes three elements to the complaint by the applicant:

i. the application does not give precise details of the design of structures but only "typical" arrangements;

ii. the application also fails to specify dimensions for the structures, only maximum dimensions;

iii. the application does not specify the exact location of all of the structures and foundations.

He also likens the expressing of turbine heights and blade lengths in terms of maxima rather than actual dimensions as 'equivalent to applying for planning permission for a house on the basis that it could be anything from a one-storey bungalow to a ten-storey mansion'.

A key issue was that the design envelope and maximum dimensions provided didn't constitute 'plans and particulars' as required under Article 214(1) of the 2001 regulations, with the judge noting that plans and particulars, while not defined by the regulation, must mean something specific that can be measured and drawn on a plan, and cannot include a widely variable design envelope.

Issue was also taken with the worst-case scenario assessment undertaken by ABP – the judge did not see it as suitable to seek permission for a project that is 'open-ended at one end of the scale and which could be anything up to a maximum specified'.

The judge discusses the term 'Rochdale envelope' – noting that while the board called this 'well known', it was new to Irish caselaw and adding that 'Firstly, the concept of the design envelope has, in English law, a written basis in national guidelines, albeit guidelines that build on caselaw. There is no such written basis in this jurisdiction, either in statute or in guidelines. And secondly, it is not simply a question of assessing a project by reference to a "worst case scenario" alone but "by reference to those parameters and any flexibility they involv[e]". That involves considering the range of situations that could arise within the flexibility so provided, not just the top end of the scale.'

The judge did not see the Rochdale Envelope approach as compatible with the 2001 regulations requirements for plans and particulars, nor a direct comparison between the Rochdale case and this one – 'In that context, the discussion of the project evolving over time has a very different flavour to the present case. The particular development there (in R v. Rochdale Metropolitan Borough Council ex parte Milne [2001] Env. L.R. 406 (Sullivan J.), an industrial park, could only take final shape as different businesses moved in and occupied the various units. That is miles removed from the present case.' He also noted that planning law had become a lot more complicated since 2001, when the Rochdale case was decided upon.

Another key point the judge noted was that the greater the variability in what is permitted in an application, the less definite information is there for other interested parties availing of public participation, and the greater the range in terms of what the built outcome on the ground would look like. This was seen as a concern particularly in light of the increased focus on public participation in a European context.

The final decision was for Mr Justice Humphreys to grant certiorari, quashing the permission granted by ABP.

In the judgment of Humphreys J. delivered on Tuesday the 26th day of October, 2021 [125] on whether or not leave to appeal should be granted, he noted that his judgment did not constitute a rejection of the concept of a design envelope, as the permission in question only contained one constraint (i.e. a maximum). He noted that the judgement did recognise the legitimacy of a certain limited flexibility giving an example that a variation of plus or minus 10% from a mean height specified in the application might have been legitimately within the concept of plans and particulars in the context of a turbine in a location like the one at issue in the case.

The decision was not appealed by ABP or Bord na Móna [126], although leave to appeal the decision to the Court of Appeal was granted in October 2021, as the judge saw questions arising from the case as ones of exceptional public importance. Two of these questions were:

- Whether it is permissible to allow a variable design application that (i) goes beyond a reasonable limited degree of flexibility and/or (ii) could give rise to a genuine planning issue after the grant of development consent in the SID context
- Insofar as a permission can lawfully allow a degree of flexibility, is the board required to consider and assess the range of options within that flexibility as opposed to merely assessing the worst-case scenario, having regard in particular to:

  (a) the inherent incompleteness of assessing only one option for the outcome where potentially a number of alternatives could be constructed;

  (b) the subjectivity of the concept of what is worst-case; and/or

  (c) the impact on public participation of such a limited form of assessment.

This decision can be seen as a key reason for the more limited flexibility which is being accepted by ABP for OW development. But key points to note are:

- The project did not specify a minimum turbine envelope, only a maximum, so it could be said this was not a PDE as would normally be seen. It could be reasonably expected that a project would provide a minimum as well as a maximum.
- The case related to an onshore wind farm, which has different flexibility requirements, and different impacts on relevant receptors, to an OWF. It can reasonably be expected given the smaller scale of project, the shorter development timeline, the increased site access and site investigation opportunity, and the closer proximity to people onshore, that an onshore wind farm would have a greater need to provide more certainty in design, as well as more opportunity to have that certainty, at planning application stage. Simply put, an OWF will require and can reasonably expect to be provided with, more flexibility in consenting than an onshore wind farm.
- The judgement recognised the legitimacy of design flexibility, noting an arbitrary example that a variation of plus or minus 10% from a mean height specified in the application might have been acceptable. While the 10% is just an example, a figure like this would see a design envelope (assuming a max height of 185m, with a +/- 10% variation) of 151m – 185m (mean height of 168m). It is likely the project would have been happy to proceed with this flexibility. This may also have been seen as sufficient to satisfy the requirements for 'plans and particulars'.
- The judge notes with regards to the WC scenario assessment approach that there is an incompleteness to assessing only one option where potentially a number of alternatives could be constructed. But as has been discussed in this report, EIA based on WC scenario does not only assesses one scenario, it assesses the WC scenario for each receptor, which can involve the assessment of multiple scenarios. Once this is done in a robust fashion, a complete assessment can be made. Similarly, concerns from the judge that there is a subjectivity to the identification of the WC should be addressed by a robust EIA process which sets out the methodology used to identify the WC scenario(s), and the scientific basis on which each is based, as well as engagement and consultation with relevant stakeholders to inform and confirm findings.
- OW will farms will be required to undergo a high level of public consultation before submitting their planning applications, and as part of their planning applications. One this consultation clearly sets out the design envelope that is being / has been assessed, and informs the public sufficiently on the likely different project scenarios and impacts, design flexibility should not impact the role of public participation.

Overall, the case can be seen as important to informing how design flexibility is facilitated for OW in Ireland, and raises some important questions that should be addressed, but it should not be seen as a reason to limit the amount of flexibility that can be allowed to an unnecessary degree.

7.3 Changes to a Development After it has received Planning permission or approval

ABP does have procedures in place to permit changes to a SID after it has received planning permission or approval. As shown from some of the case studies reviewed in this report, an efficient process for variations to consent can go hand-in-hand with a flexible approach to consenting.

The likelihood of Irish OWFs needing to seek variations to their consent is increased by the more limited level of flexibility that is being facilitated in the Irish OW development consenting process, with developers acknowledging in interview that it is likely consent variations will be required.

ABP's categorisation and description of changes that can be made to a consent post approval is summarised in Table 7-1 below from the ABP website [127]. Depending on what is proposed to be changed or amended, ABP will follow the required relevant process.

Table 7-1: ABP categorisation and description of changes that can be made to a development after it has received planning permission or approval

	Category of change	Description
1	**Alteration**	A proposed change that is considered not to be significant and not requiring a public consultation.
2	**Material alteration (not likely to have significant effects on the environment)**	A proposed change which is considered not likely to have significant effects on the environment. In this situation the Board may allow a change after the information about the requested change has been made available for inspection. The Board has the power to invite any person (including members of the public) to make submissions about the request.
3	**Material alteration (likely to have significant effects on the environment)**	A proposed change which is considered likely to have significant effects on the environment. The Board will require the applicant to prepare an EIAR about the proposed change and submit it to the Board. The usual EIA procedures will then apply which will include steps such as: ▪ public notification of EIAR, and ▪ request for public submissions to the Board.
4	**Clarifying or correcting errors in Board Orders**	The Board can amend its decision if it considers there is: a. a clerical error in the Board Order, or b. a need to clarify what the Board intended should be permitted by the permission or approval. This type of change is not allowed to result in significant changes to the development as was given in the grant of permission or approval. The Board may invite submissions about the proposed changes before it decides to amend or not amend a decision.

7.3.1 LEGISLATIVE BASIS FOR ALTERATIONS TO CONSENT

Section 146B(1) of the Planning and Development Act 2000, as amended, provides that on the request of any person who is carrying out or intending to carry out a SID, ABP can alter the terms of the development, the subject of a planning permission, approval or other such consent granted under the Act.

Section 146B(2)(a) requires ABP to decide whether the making of the alteration would constitute a material alteration of the terms of the development concerned. The Board may invite submissions prior to making this decision under Section 146(B)(2)(b).

Under Section 146B(3)(a), if ABP decides that the making of the alteration would not constitute the making of a material alteration, then it must alter the approval accordingly.

If it determines under Section 146B(3)(b) that it would constitute the making of a material alteration, it shall require the requester to submit information specified in Schedule 7A to the Planning and Development Regulations 2001-2020, unless the requester has already provided such information for example in an EIAR.

Under 146B(3)(b)(ii) ABP shall then determine whether to

(I) make the alteration,

(II) make a different alteration to the one requested (but not one which is a more significant change to the terms of the development than that which would be represented by the requested alteration) or

(III) refuse to make the alteration.

Sections 146B(3A) and (3B) of the Act outline the requirements for the information to be submitted by the requester under Section 146B3(b)(i).

Section 146B(4) requires that before making a determination under subsection (3)(b), ABP must determine whether the extent and character of the alteration requested or any alternative alteration it is considering would be likely to have significant effects on the environment.

Section 146B(5) requires that where ABP determines that the making of either kind of alteration referred to in subsection (3)(b)(ii) is not likely to have significant effects on the environment, it shall proceed to make a determination or where it is determined the alterations are likely to have such effects, the provisions of section 146C shall apply (preparation of an EIAR).

Section 146B(6) of the Act requires that if in a case to which subsection (5)(a) applies, ABP makes a determination to make an alteration of either kind referred to in subsection (3)(b)(ii), it shall alter the planning permission, approval or other consent accordingly.

Section 146B(7) requires ABP to have regard to criteria for the purposes of determining which classes of development are likely to have significant effects on the environment set out in any regulations made under section 176. Section 146B(7A) provides that where the determination of the Board is that the alteration under consideration would not be likely to have significant effects on the environment and the applicant has provided a description of the features of the alteration concerned and the measures envisaged to avoid or prevent what might otherwise have been significant adverse effects on the environment of the alteration concerned, the Board shall specify such features, if any, and such measures, if any, in the determination.

An example of a wind farm that sought an amendment to its consent is the Yellow River Wind Farm, in county Offaly. The request was made by Green Wind Energy (Wexford) Ltd. to seek an alteration to a previously permitted wind farm development (Reg. Ref. 19.PA0032) submitted directly to the Board, and which was subsequently altered by s146 request (Reg. Ref. ABP-307357-20) [128].

The alterations requested were to lengthen the blades so as to increase the rotor diameter from 113m (permitted) to 126m, whilst retaining the permitted layout and tip height of 156m (11 turbines) and 166 metres (18 turbines) and remaining within the maximum tip height of between 156 and up to 166 metres. Green Wind Energy did not consider the alteration would constitute the making of a material alteration, but did provide An Environmental Report with the application, as well as an AA Screening Report. The inspector agreed and recommended that ABP decide that the making of the alterations requested did not constitute the making of a material alteration of the terms of the development as granted.

While the variations / alterations process is not necessarily related to design flexibility, it should be ensured that efficient procedures are in place for variations to consent, to support the development of OW in Ireland.

7.4 INTERVIEWS WITH PHASE ONE PROJECTS

To inform this work, GDG held interviews with a number of the Irish Phase One Irish OW project developers. Interviews were held over the course of April - June via Microsoft Teams with a representative of the project that worked in the area of consenting or design. It should be noted that these interviews took place before any of the projects had submitted planning applications, so details on flexibility sought by any of the projects were not publicly available.

Learning from the interviews will be presented here as they were completed, with commentary added on the actual flexibility that was sought for the projects whose planning applications are now available online[6].

To guide each interview, a series of discussion points were sent on to the interviewee in advance of the call. These discussion points are shown below, with key findings included under each point.

7.4.1.1 MAIN PROJECT PARAMETERS IN NEED OF FLEXIBILITY IN DESIGN AND CONSENTING

At the start of the interviews, a discussion was held on the key design parameters for which projects required flexibility in consenting. These were in line with the points that were discussed earlier in this report in Section 2.2, so are not repeated here.

These discussions were very useful as they took place before any information on the flexibility that was being sought by projects was available. As this information is now available for some of the projects, a summary of the parameters which they have received flexibility on is shown in Table 7-2.

It can be seen from the table the projects have sought flexibility in different areas, and to different degrees, for site and project specific reasons. This is a key point in that if a project can justify why the flexibility is needed, it should not be required to have the same certainty in design as another project that may have more uniform ground conditions, increased site understanding etc.

All projects have sought and received flexibility in their final layouts (referred to as Limits of Deviation (LoDs)), as well as in their associated cable routes and lengths.

In the case of NISA, Codling Wind Park, and Arklow Bank 2, they have presented 2 project options, and requested flexibility on the areas noted below. Oriel has instead chosen to only present 1 project option (with the exception of requesting consent for 2 transition joint bay locations) and requested flexibility on the relevant parameters.

Areas which projects noted in interview that had been discussed but not been accepted by ABP as appropriate for flexibility was the nature and quantities of cable protection systems the project would use, and construction methodologies, as well as operations and maintenance methods (these cannot be known until a turbine supplier has been chosen (e.g. will turbines be serviced by a Service Operation Vessel, a Crew Transfer Vessel, a helicopter etc.). ABP may wish to review these areas to consider if flexibility should be allowed.

[6] Note: these are the projects who have submitted planning applications at the time of writing, which can be viewed online. For the purposes of this work, the projects which were interviewed will remain anonymous, and a general summary of key findings from the interviews will be shared.

Table 7-2: Overview of flexibility sought by projects to date (for those with public planning consent applications)

Parameter	NISA	Arklow Bank 2	Oriel OWF	CWP
General Approach	2 project options.	2 project options.	1 overall option presented.	2 project options presented.
Turbines	Y – model, number and dimensions	Y – model, number and dimensions	N – Has flexibility on height of offshore infrastructure.	Y – model, number and dimensions
Turbine foundations	Y – jacket or monopile	N – monopile only	N – monopile only	N – monopile only (flexibility sought on dimensions)
Offshore substation platform	Y – foundation types and dimensions	N – monopile foundation	N – monopile foundation	N – monopile only (flexibility sought on dimensions)
Layout / Siting of infrastructure	Y - fixed locations with a 500m LoD	Y – WTGs and OSSs with 100m LoD	Y - Final location of WTG and OSS with 50m LoD	Y – 100m LoD from the centrepoint of each WTG / OSS location
Offshore cabling	Y - subsea cable size and length	Y – has sought LoD for cabling	Y – The final route and length, of the cables	Y – LoD of 100 m buffer either side of preferred alignments
Height of offshore infrastructure	N	N	Y	N
Location and layout of the landfall transition joint bay.	N	N	Y – 2 options presented	N
Design for outdoor equipment within onshore SS compound.	N	N	Y	N
Average annual revolutions per minute (RPM)	N	Y	N	N

7.4.1.2 KEY DRIVERS FOR UNCERTAINTY / NEED FOR FLEXIBILITY IN CONSENT

Timelines between when a project needs to submit a planning application, and when a project may eventually commence construction, were noted as the key driver for uncertainty in OWF design and the need for flexibility in consenting. It was noted that at planning submission state, projects can't have the level of engineering design completed that would enable them to say with certainty what the project design will be. Flexibility is needed to adapt the project over the long timelines between preparing a planning application and building a project.

It was noted by interviewees that ABP's primary justification for granting flexibility has been to allow for potential advances in technology between application and construction, but while technological advances are a key consideration which all interviewees acknowledged, other reasons such as a need for greater site information and supply chain constraints should be seen as just as valid.

Ground conditions were also noted as a key driver, as for projects to find optimal layouts, they need to have an intimate understanding of the ground conditions at site, and to know which locations can be built on, and which cannot. Once out on site, projects need to have a sufficient level of flexibility to micro site turbines (and OSSs) to avoid having to be forced to build on bad ground conditions. Geo hazards (e.g. boulders) could also be present on site which could prevent a location from being developed, and if this cannot be addressed through micro siting, the project may need to remove a turbine from its layout, which would have serious financial implications for the project. The interconnected nature of turbine layouts needs to be considered here, where a change to one location can necessitate changes to multiple other locations to ensure optimal energy yield can be maintained.

Larger projects generally have more uncertainty, and also require more flexibility.

Generally, it was noted OW is such a dynamic industry with big changes in technology and regulations happening constantly, and projects need to be able to respond to these changes to be able to build the most efficient projects, which is in everyone's interest. Even when projects get to final design, there will be late changes that flexibility is needed to accommodate.

7.4.1.3 DISCUSSION ON PRE-APPLICATION ENGAGEMENT WITH ABP

It was noted in interviews that the Phase One projects were encouraged by ABP to consult with each other in relation to EIA and cumulative impacts assessments, and that they wanted to ensure that projects were aligned in their approaches here. This meant that each Phase One project should be aware of the approaches the other projects were taking.

Generally, all projects spoken with felt ABP were only willing to facilitate a more limited degree of flexibility than was optimum, although some projects were not as concerned with this as others. The result of this, however, has been that some projects have had to make some assumptions in the EIA/consent applications that they otherwise would not, which has made the likelihood of consent variations being required further down the line much higher. Projects did note that there was an established process for variations/alterations to consent in place should this be required, but projects being required to seek variations to consent would cause significant delays to Ireland's targets.

Projects also noted that it was not efficient for pre-application engagement on design flexibility to be required to be undertaken separately to general pre-application engagement between ABP and the projects, and that it would be easier to do this as one process. It was thought that ABP may be overly nervous on the issue of design flexibility, which may be a reason for the meetings being held separately.

Projects acknowledged that ABP is in a difficult position, given the publicity and fallout around the Derryadd Decision, as well as the high likelihood of JR challenges being raised against the projects.

It was also noted that there were some inconsistencies between what is set out in the Planning and Development Act 2000, and what was then applied by An Bord Pleanála in relation to design flexibility, particularly in relation to the number of project options that could be included.

8 SUMMARY AND RECOMMENDATIONS

8.1 SUMMARY

GDG has investigated the requirement for design flexibility in OW development and consenting, and identified the key parameters in need of flexibility, as well as the key drivers for this design flexibility. While some parameters can generally require flexibility more than others each project will have unique circumstances and its own flexibility requirements.

However in summary the key drivers for the need for flexibility are similar:

- OW projects are developed in complex environments and using phased site investigation and design strategies which means final designs cannot be complete at the time of consent/planning application.
- Long consenting timelines mean projects need to submit their applications as early in the development process as is practicable, exacerbating this issue.
- OW technology (particularly WTG technology) is continuously advancing, and projects' consents need to allow them to install modern technology when they get to construction, details of which may not be available at the time of application submission.
- Supply chain constraints mean certain components or installation vessels may not be available when projects reach a position to place firm orders.

As has been noted in this report, technological advancement is a key reason for the need for flexibility in consenting, but the other reasons noted above are just as valid. This need for flexibility applies to the global OW industry and is something that has also had to be addressed in other jurisdictions that have successfully built OWFs. This research has found that some degree of design flexibility in consenting for OW is a key part of the development processes in the countries assessed. This includes markets in Europe (EU and non-EU), North America, and Asia, and both established (the UK, Denmark, the Netherlands) and more emerging (the US, Taiwan) markets.

While the markets operate differently in their development processes, timelines, roles and responsibilities, there are certain key principles followed when deciding on the degree of flexibility required and the approach to the assessment of impacts (by the developer and in turn CA):

- Scoping and consultation (with the public and prescribed bodies) at a very early stage are key to informing the approach to be taken and the level of flexibility to be accommodated.
- Exact levels are not set on how much flexibility should be allowed for (e.g. + / - 10% tip height etc.) but appropriate levels are found through consultation and assessment.
- The level of information provided by the project should be sufficient to enable the likely significant effects of the project on the environment to be assessed by the CA.
- Where flexibility is sought, it should be explained clearly how this has been accommodated for in assessments.
- Any request for flexibility should be justified. The frameworks in place to accommodate flexibility should not be abused or seen as a way to proceed without sufficient information.
- Where exact parameters cannot be provided, ranges or options can be, and all potential options need to be considered in the assessment of impacts.
- The assessment should be based on a realistic worst case scenario approach for each receptor which will then feed through into mitigation measures envisaged.

To bolster this review of jurisdictions, GDG has also reviewed several case studies of projects which have been consented internationally using a design envelope. These projects have provided several important learnings on the value of accommodating flexibility in OW consenting, as well as having robust processes in place for varying or altering consents. Above all they have demonstrated the complexity of OW project development generally, and the need for projects (and consenting authorities) to be able to adapt to changing conditions, timeline delays, and legal challenges.

Finally, this work analysed the Irish case more specifically. Through the Planning and Development Act 2000 (as amended), the Planning and Development Regulations 2001, the MAP Act 2021, and the Planning and Development, Maritime and Valuation (Amendment) Act 2022, provisions have been made for ABP to allow for flexibility in consenting of OW projects. The degree of flexibility allowed will depend on how ABP interprets this legislation. From interviews with Phase One projects on their engagements with ABP in relation to design flexibility, and from reviews of planning applications submitted by some of the Phase One projects, it can be seen that ABP has attempted to give the Phase One projects some design flexibility. However, there is an opinion that the more limited level of flexibility which ABP is willing to accommodate (compared to what has been allowed in other jurisdictions, most notably the UK) is sub-optimal, and forcing projects to make assumptions in consent applications and EIA that may make it more likely that variations to consent will be needed. This could have serious implications to development timelines for the projects should they require material alterations to their consents.

A key driver that has been cited for ABP's approach is the 'Derryadd Decision', and the requirements around 'plans and particulars' as required under Article 214(1) of the Planning and Development regulations. While it is understandable that this case has influenced ABP's approach to design flexibility, it should be noted that this case did not relate to an OWF, and the judgment recognised the legitimacy of design flexibility (to an 'appropriate' degree).

8.2 RECOMMENDATIONS

In addition to reviewing this work for learnings to apply to Ireland, GDG makes the following recommendations:

- A workshop should be held between GDG, MI, DHLGH, ABP, and an industry representative such as Wind Energy Ireland to discuss in more detail how the Phase One approach to design flexibility has worked, and what could be improved going forward (without prejudice to current and future applications for these projects). GDG is happy to lead this workshop and present on findings and recommendations and facilitate discussion between the key parties. This should help ensure key learnings are taken from the Phase One process which can be applied to future projects. Other work on this subject being undertaken by UCC and UCD may also be presented and discussed here, depending on timelines.
- While it is understood that both DHLGH and ABP already have a good understanding of how design flexibility has been facilitated in other jurisdictions, GDG believes that this review has shown that a higher level of flexibility in consenting has operated well in other more mature jurisdictions. GDG recommends that jurisdictions of interest from this review are studied in more detail. The Danish approach in particular could be of interest to Irish government given the way it has evolved to address concerns over too much flexibility being offered, while still attempting to accommodate enough flexibility. Their tender and development model also aligns with what may be seen as the ideal plan-led model for OW development, with Ireland currently establishing its plan-led model.
- While GDG believes the main reason for a limited level of flexibility in consenting for OW development in Ireland is the Derryadd decision and the impactions of this, it should be confirmed with ABP if this is the case. If it is, a thorough legal review of this case should be undertaken, as

the case did not rule out design flexibility, it more so questioned appropriate levels. If there are other reasons for ABP taking its current approach to design flexibility, this should also be established.

- ABP should ensure that it has robust processes in place for altering / varying consents for OW development, which is clearly set out for developers. It seems likely that some of the projects may require this, and it has been shown from this review of others jurisdiction that an efficient consent variation process goes hand in hand with design flexibility and OW development. Regardless of the level of flexibility in consenting, project's circumstances change, and consent variations can be required for a number of reasons.
- It should be ensured there is clarity in the exact process for accommodating design flexibility in offshore wind development, as discussions with project developers have noted some inconsistencies between what is set out in the Planning and Development Act 2000, and what was then applied by An Bord Pleanála, particularly in relation to the number of project options that could be included.

9 REFERENCES

[1] DHLGH, "Circular MPP 01/2023 - An Opinion on Design Flexibility for Maritime Development," 17 July 2023. [Online]. Available: https://www.gov.ie/en/circular/4eca1-circular-mpp-012023-an-opinion-on-design-flexibility-for-maritime-development/. [Accessed 13 Feb 2024].

[2] European Parliament, Council of the European Union, "Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC as regards the promotion of energy from renewable sources, and repealing Council," 20 11 2023. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302413. [Accessed March 2024].

[3] Global Wind Energy Council, "IRENA/GWEC report identifies key permitting reforms that unlock offshore wind's potential and accelerate the energy transition," 18 September 2023. [Online]. Available: https://gwec.net/irena-gwec-report-identifies-key-permitting-reforms-that-unlock-offshore-wind-potential/#:~:text=Permitting%20is%20a%20key%20bottleneck,rapid%20rollout%20of%20offshore%20wind.. [Accessed March 2024].

[4] Global Wind Energy Council, "Global Wind Report 2023," 2023. [Online]. Available: https://gwec.net/wp-content/uploads/2023/04/GWEC-2023_interactive.pdf. [Accessed April 2024].

[5] WindEurope, "Wind Energy Permitting Insights (Member only access)," November 2023. [Online]. Available: https://windeurope.org/. [Accessed 28 March 2024].

[6] An Bord Pleanála , "Annual Report and Accounts 2020," June 2021. [Online]. Available: https://www.pleanala.ie/getmedia/fc1c1237-99de-4636-a32f-005a7057d323/Annual_Report_2020_en.pdf?ext=.pdf.. [Accessed March 2024].

[7] An Bord Pleanála, "2022 Annual Report and Accounts," July 2023. [Online]. Available: https://www.pleanala.ie/getmedia/6ea2b87f-6bf5-4f83-aed8-0c24d69a7357/Annual-Report-2022-with-C-AG-Final.pdf?ext=.pdf. [Accessed March 2024].

[8] E. Burke-Kennedy, "No wind farms granted planning permission anywhere in State last year, climate conference hears," 22 Feb 2024. [Online]. Available: https://www.irishtimes.com/business/2024/02/22/planning-risk-for-energy-projects-highlighted-with-no-wind-farms-granted-permission-last-year/#:~:text=Planning%20uncertainty%20posed%20potentially%20the,climate%20was%20told%20on%20Thursday.. [Accessed march 2024].

[9] Irish Government, "Planning and Development Bill 2023," November 2023. [Online]. Available: https://www.oireachtas.ie/en/bills/bill/2023/81/. [Accessed March 2024].

[10] Codling Wind Park , "Offshore Scoping Report," November 2020. [Online]. Available: https://www.dropbox.com/s/1h0h6fdk23m5s0a/CWP%20Offshore%20EIA%20Scoping%20Report.pdf?dl=0. [Accessed April 2024].

[11] Codling Wind Park , "Codling Wind Park reveals final design of project and number of turbines to be constructed," 5 April 2024. [Online]. Available: https://codlingwindpark.ie/codling-wind-park-reveals-final-project-design-and-number-of-turbines/. [Accessed April 2024].

[12] C. H. S. LLP, "Offshore Reneable Energy Porjects in Ireland- Overview of the Risks and Challenges in the Planning Process and with Judicial Review 2023-2030," Dublin, July 2023.

[13] WindEurope, “EU starts investigation into Chinese wind turbines under new Foreign Subsidies Regulation,” April 2024. [Online]. Available: https://windeurope.org/newsroom/press-releases/eu-starts-investigation-into-chinese-wind-turbines-under-new-foreign-subsidies-regulation/. [Accessed April 2024].

[14] WindEurope , “Wind Energy in Europe - 2023 Statistics and the outlook for 2024-2030,” 2024.

[15] Avi Salzman, “GE Is Losing $1 Billion a Year on Offshore Wind. There’s Also a Bright Spot for the Industry.,” October 2023. [Online]. Available: https://www.barrons.com/articles/ge-offshore-wind-power-new-york-state-d6a3815e. [Accessed April 2024].

[16] D. DiGangi, “Ørsted cancels two offshore wind projects citing supply chain problems,” Nov 2023. [Online]. Available: https://www.supplychaindive.com/news/orsted-cancel-ocean-wind-offshore-project-development-new-jersey/698554/. [Accessed April 2024].

[17] Wind & Water Works, “Dutch Offshore Wind Innovation Guide,” 2024. [Online]. Available: https://www.rvo.nl/sites/default/files/2023-11/KiCdPayqFKa36nM1EBHlRdiJwgIneUZgPPy3N0_Q6KI.pdf. [Accessed April 2024].

[18] P. Nanganong, “The 9 Stages of Complex Engineering Projects,” [Online]. Available: https://www.assai-software.com/the-9-stages-of-complex-engineering-projects/. [Accessed April 2024].

[19] N. n. Gaoithe, “The Approach to EIA: Neart Na Gaoithe Offshore Wind Farm Environmental Statement,” Marine Scotland , 2019.

[20] EPA, “Guidelines on the information to be contained in Environmental Impact Assessment Reports,” May 2022. [Online]. Available: https://www.epa.ie/publications/monitoring--assessment/assessment/EIAR_Guidelines_2022_Web.pdf. [Accessed 13 Feb 2024].

[21] Dublin Array Offshore Wind Farm , “Dublin Array Offshore Wind Environmental Impact Assessment Scoping Report,” September 2020. [Online]. Available: https://dublinarray.com/wp-content/uploads/2020/10/Dublin-Array-EIAR-Scoping-Report-Part-1-of-2.pdf. [Accessed April 2024].

[22] ARUP, “North Irish Sea Array Offshore Wind Farm EIA Scoping Report,” May 2021. [Online]. Available: https://northirishseaarray.ie/stat-cont/uploads/2021/05/281240-00-NISA-EIA-Scoping-Report-Final.pdf. [Accessed April 2024].

[23] RPS, “Orield Wind Farm Project EIA Scoping Report,” August 2019. [Online]. Available: https://www.orielwindfarm.ie/assets/uploads/documents/EIA-Scoping-Report.pdf. [Accessed April 2024].

[24] GoBE Consultants, “Arklwo Bank Phase 2 Environmental Impact Assessment Scoping Report,” March 2023. [Online]. Available: https://www.sserenewables.com/media/hlrh3zef/00189_arklow_scoping.pdf. [Accessed April 2024].

[25] RPS, “Berwick Bank Wind Farm Digital Offshore Scoping Report,” October 2021. [Online]. Available: https://berwickbank-eia.com/offshore-scoping/2.-Proposed-Development-Description.html. [Accessed April 2024].

[26] Fehily Timoney and Company, June 2022. [Online]. Available: https://shelmalereoffshorewindfarm.com/wp-content/uploads/2022/06/S004IE_RPT_EIAR-Scoping-Report_20220623_Website-Version.pdf. [Accessed April 2024].

[27] GoBe Consultants , “Neart na Gaoithe Offshore Wind Farm Scoping Report,” May 2017. [Online]. Available: https://nngoffshorewind.com/wp-content/uploads/2017/07/UK02-0504-0673-MRP-NNG-SCOPING-REPORT-2017-RPT-A1.pdf. [Accessed April 2024].

[28] T. E. E. N. S. U. Ltd., “Culzean- Floating Offshore Wind Turbine Pilot Project Environmental Impact Assessment Report,” 21 02 2024. [Online]. Available:

https://marine.gov.scot/sites/default/files/eia_report_chapter_1_-_introduction.pdf. [Accessed 4 05 2024].

[29] X. G. Ltd., "Pentland Floating Offshore Wind Farm EIAR," 7 July 2022. [Online]. Available: https://marine.gov.scot/sites/default/files/chapter_1._introduction.pdf. [Accessed 3 6 2024].

[30] Oriel Wind Farm Planning Application , "Bord Pleanála Case reference: OA15.319799," 24 May 2024. [Online]. Available: https://www.pleanala.ie/en-ie/case/319799. [Accessed July 2024].

[31] North Irish Sea Array Windfarm Ltd, "North Irish Sea Array Offshore Wind Farm - Planning Information," 2024. [Online]. Available: https://northirishseaarraysid.ie/. [Accessed July 2024].

[32] Inch Cape Offshore Limited, "Documents Library (Offshore EIA)," 2018. [Online]. Available: https://www.inchcapewind.com/library/. [Accessed July 2024].

[33] RVO, "Project and Site Description HKN; Appendix B, Summary of Environmental Impact Assessment - version May 2018," September 2019. [Online]. Available: https://offshorewind.rvo.nl/file/download/0480a369-d3f7-4ab0-9b3a-3f67e9ef6d96/1569574115hkn_20180530_project%20and%20site%20description_appendix%20b%20-%20summary%20eia-f.pdf.pdf. [Accessed April 2024].

[34] E. Parliament, "ANNEX IV OF DIRECTIVE 2014/52/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 16 APRIL 2014 AMENDING DIRECTIVE 2011/92/EU ON THE ASSESSMENT OF THE EFFECTS OF CERTAIN PUBLIC AND PRIVATE PROJECTS ON THE ENVIRONMENT," Strasbourg, 2014.

[35] GE Vernova, "Haliade-X offshore wind turbine," [Online]. Available: https://www.gevernova.com/wind-power/offshore-wind/haliade-x-offshore-turbine. [Accessed 10 April 2024].

[36] GE Renewable Energy, [Online]. Available: https://www.ge.com/news/sites/default/files/ge-infographic-2-haliade-x.jpg. [Accessed April 2024].

[37] A. Durakovic, "22 MW Offshore Wind Turbine in the Works for 2024/25," October 2023. [Online]. Available: https://www.offshorewind.biz/2023/10/23/22-mw-offshore-wind-turbine-in-the-works-for-2024-25/. [Accessed April 2024].

[38] A. Memija, "World's First 26 MW Offshore Wind Turbine Rolls Off Production Line," 14 October 2024. [Online]. Available: https://www.offshorewind.biz/2024/10/14/worlds-first-26-mw-offshore-wind-turbine-rolls-off-production-line/. [Accessed October 2024].

[39] 4COffshore, "Offshore Wind Farms Intelligence: Project Overview (Subscription Only)," 2024. [Online]. Available: https://www.4coffshore.com/. [Accessed June 2024].

[40] J. S. Hill, "Size limits urged to stop "wind turbine arms race" as factories struggle to keep up," August 2023. [Online]. Available: https://reneweconomy.com.au/size-limits-urged-to-stop-wind-turbine-arms-race-as-factories-struggle-to-keep-up/. [Accessed April 2024].

[41] Michelle Lewis, "GE scraps plans to make giant 18 MW offshore wind turbines," Feb 2024. [Online]. Available: https://electrek.co/2024/02/23/ge-offshore-wind/. [Accessed April 2024].

[42] NedZero, "The North Seas Standard: enable growth with wind turbine standardization," September 2023. [Online]. Available: https://www.nedzero.nl/en/news/the-north-seas-standard-enable-growth-with-wind-turbine-standardization. [Accessed April 2024].

[43] ReCharge, "China test for 30MW wind turbines as green power 'arms race' goes on," 29 February 2024. [Online]. Available: https://www.rechargenews.com/wind/china-test-for-30mw-wind-turbines-as-green-power-arms-race-goes-on/2-1-1605290. [Accessed April 2024].

[44] NISA, “North Irish Sea Array Offshore Wind Farm - Planning Information,” 2024. [Online]. Available: https://northirishseaarraysid.ie/. [Accessed October 2024].

[45] SSE Renewables, “Arklow Bank Wind Park 2 Environmental Impact Assessment Report (EIAR),” 2024. [Online]. Available: https://www.arklowbank2offshoreplanning.ie/eiar/. [Accessed October 2024].

[46] Codling Wind Park, “Codling Wind Park EIAR,” 2024. [Online]. Available: https://codlingwindparkplanningapplication.ie/environmental-impact-assessment-report-eiar/. [Accessed October 2024].

[47] Oriel Wind Farm , “Environmental Impact Assessment Report (,” March 2024. [Online]. Available: https://orielwindfarm-marineplanning.ie/environmental-documents/eiar/. [Accessed July 2024].

[48] SEAI, “Offshore Renewable Energy Technology Roadmap,” June 2024. [Online]. Available: https://www.seai.ie/publications/ORE-Technology-Roadmap.pdf. [Accessed August 2024].

[49] European Commission, Directorate-General for Environment, “Guidance document on wind energy developments and EU nature legislation,” 2020. [Online]. Available: https://data.europa.eu/doi/10.2779/457035. [Accessed 2024 February 14].

[50] European Commission , “Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment,” 13 December 2011. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0092. [Accessed April 2024].

[51] European Commission , “Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment,” April 2014. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052. [Accessed April 2024].

[52] European Commission , “Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora,” 21 May 1992. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01992L0043-20130701. [Accessed April 2024].

[53] E. Commission, “COMMISSION STAFF WORKING DOCUMENT- Guidance to member states on good practices to speed up permit-granting procedures for renewable energy and related infrastructure projects,” European Commission, 13 May 2024. [Online]. Available: https://energy.ec.europa.eu/document/download/ad850f73-ab84-4ce1-9e66-7430f8f0c7e5_en?filename=SWD_2024_124_1_EN_autre_document_travail_service_part1_v3.pdf. [Accessed 29 May 2024].

[54] Planning Inspectorate, “Nationally Significant Infrastructure Projects - Advice Note Nine: Rochdale Envelope,” July 2018. [Online]. Available: https://www.gov.uk/government/publications/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope/nationally-significant-infrastructure-projects-advice-note-nine-rochdale-envelope. [Accessed April 2024].

[55] BOEM, “Phased Approaches to Offshore Wind Developments and Use of the Project Design Envelope,” July 2017. [Online]. Available: https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/Phased-Approaches-to-Offshore-Wind-Developments-and-Use-of-Project-Design-Envelope.pdf. [Accessed February 2024].

[56] UK DECC, “Varying consents granted under section 36 of the Electricity Act 1989 for generating stations in England and Wales,” 2013 July. [Online]. Available:

https://assets.publishing.service.gov.uk/media/5a7cd14ee5274a34d8d331e6/DECC_varying_consents.pdf.

[57] Marine Scotland, "Marine Scotland Consenting and Licensing Guidance," October 2018. [Online]. Available: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/02/marine-licensing-applications-and-guidance/documents/guidance/guidance-manual-for-offshore-wind-wave-and-tidal-energy-application/guidance-manual-for-offshore. [Accessed June 2024].

[58] Scottish Government, "Applications for variation of section 36 consents," May 2019. [Online]. Available: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2019/05/applications-variation-section-36-consents/documents/guidance-note-applications-variation-section-36-consents/guidance-note-applications-variation-section-36-. [Accessed April 2024].

[59] Davidson Chalmers Stewart, "Planning Law Basics: Section 36 Consents," September, 2023. [Online]. Available: https://www.dcslegal.com/news-insights/planning-law-basics-section-36-consents/#:~:text=Onshore%20projects%20with%2050MW%2B%20capacity,under%20Section%2036%20of%20the. [Accessed June 2024].

[60] legislation.gov.uk, "Electricity Act 1989," 1989. [Online]. Available: https://www.legislation.gov.uk/ukpga/1989/29/section/36. [Accessed 4 April 2024].

[61] M. Scotland, "Guidance for applicants on using the design envelope for applications under section 36 of the Electricity Act 1989," June 2022. [Online]. Available: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2020/02/marine-licensing-applications-and-guidance/documents/guidance/guidance-for-applicants-on-using-the-design-envelope-for-applications-under-section-36-of-the-el. [Accessed 2 April 2024].

[62] Danish Energy Agency, "The Danish Energy Agency as a one-stop-shop authority," October 2020. [Online]. Available: https://ens.dk/sites/ens.dk/files/Globalcooperation/one-stop_shop_oct2020.pdf. [Accessed June 2024].

[63] Ramboll, "Anholt Offshore Wind Farm - Method for impact assessment," July 2009. [Online]. Available: https://ens.dk/sites/ens.dk/files/Vindenergi/anholt_memo_method_eia.pdf. [Accessed April 2024].

[64] D. E. Agency, "Offshore Wind Development," June 2022. [Online]. Available: https://ens.dk/sites/ens.dk/files/Vindenergi/offshore_wind_development_final_june_2022.pdf. [Accessed April 2024].

[65] Danish Energy Agency, "New EIA process for Vesterhav Syd initiated," February 2019. [Online]. Available: https://ens.dk/en/press/new-eia-process-vesterhav-syd-initiated. [Accessed April 2024].

[66] Orbicon and WSP for Vattenfall, "Vesterhav Nord windfarm - EIA Summary," 24 April 2020. [Online]. Available: https://ens.dk/sites/ens.dk/files/Vindenergi/espoo_vhn_english.pdf. [Accessed April 2024].

[67] Danish Energy Agency, "New approach for completing environmental assessments for Thor offshore wind farm is being launched," September 2019. [Online]. Available: https://ens.dk/en/press/new-approach-completing-environmental-assessments-thor-offshore-wind-farm-being-launched. [Accessed April 2024].

[68] Danish Energy Agency, "Guidelines for completing environmental assessments for Thor," September 2019. [Online]. Available:

https://ens.dk/sites/ens.dk/files/Vindenergi/uk_guidelines_for_completing_environmental_assessment_thor_10sept2019.pdf. [Accessed April 2024].

[69] Energinet for the Danish Energy Agency, ": Environmental Assessment of Plan for Thor Offshore wind Farm, report 1: Nontechnical summary and overall assessment.," February 2021. [Online]. Available: https://ens.dk/sites/ens.dk/files/Vindenergi/environmental_assessment_sea_plan_for_thor_offshore_windfarm_report_1_non-technical_summary_overall_assessment.pdf. [Accessed April 2024].

[70] Ramboll, "Thor Offshoer Wind Farm Marine Mammals," March 2021. [Online]. Available: https://ens.dk/sites/ens.dk/files/Vindenergi/210_marine_mammals_final_march_2021.pdf. [Accessed April 2024].

[71] S. Djunisic, "Denmark's 1-GW Thor close to thundering as EIS gets approved," Renewables Now, march 2024. [Online]. Available: https://renewablesnow.com/news/denmarks-1-gw-thor-close-to-thundering-as-eis-gets-approved-852628/. [Accessed April 2024].

[72] Wind and Water Works , "Dutch Offshore Wind Innovation Guide," 2023. [Online]. Available: https://www.rvo.nl/sites/default/files/2022-11/Dutch-offshore-Wind-Innovation-Guide-Edition-2023.pdf. [Accessed April 2024].

[73] Wind and Water Works, "Environmental Impact Assessments," 2024. [Online]. Available: https://www.windandwaterworks.nl/eia. [Accessed June 2024].

[74] BOEM, "Regulatory Framework and Guidelines," 2024. [Online]. Available: https://www.boem.gov/renewable-energy/regulatory-framework-and-guidelines. [Accessed June 2024].

[75] BOEM, "Draft Guidance Regarding the use of a project desing envelope in a construction and operations plan," 12 January 2018. [Online]. Available: https://www.boem.gov/sites/default/files/renewable-energy-program/Draft-Design-Envelope-Guidance.pdf. [Accessed February 2024].

[76] US Department of Energy and Department of the Interior , "National Offshore Wind Strategy," September 2016. [Online]. Available: https://www.boem.gov/sites/default/files/renewable-energy-program/National-Offshore-Wind-Strategy-report-09082016.pdf.

[77] BOEM, "New England Wind Project - Project Design Envelope," [Online]. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/NE-Project%20Design%20Envelope.pdf#:~:text=A%20project%20design%20envelope%20is,the%20%E2%80%9Cmaximum%20design%20scenario%E2%80%9D.. [Accessed April 2024].

[78] Ministry of Economic Affairs, "Renewable Energy Development Act (Amended)," June 2023. [Online]. Available: https://law.moj.gov.tw/Eng/LawClass/LawAll.aspx?PCODE=J0130032. [Accessed June 2024].

[79] S. Gamesa, "Press Release," 28 October 2019. [Online]. Available: https://www.siemensgamesa.com/en-int/newsroom/2019/10/191028-siemens-gemesa-of-tw-formosa-2. [Accessed 4 April 2024].

[80] Formosa 2, "Summary Environment & Social Impact Assessment," June 2019. [Online]. Available: https://www.ekf.dk/media/dzqb353j/f2-per-con-f2-rp-en-00001-summary-esi.pdf. [Accessed April 2024].

[81] Formosa 2, "Summary Environment & Social Impact Assessment," 05 September 2019. [Online]. Available: https://formosa2windpower.com/wp-content/uploads/2019/10/1571020258-637132654.pdf. [Accessed April 2024].

[82] "The Greater Changhua 1 offshore wind farm – Report EIA," [Online]. Available: https://orstedcdn.azureedge.net/-/media/files/tw/tw-temporary-files/chw01finalized-eia-report-en-02996868a.pdf?rev=77751231392a45f2b220d72a5a004dbc&hash=5A5E3703D0A00D8C67DCD9E09BB186A6. [Accessed June 2024].

[83] Marine Scotland , "Inch Cape Offshore Windfarm (Revised Design)," [Online]. Available: https://marine.gov.scot/ml/inch-cape-offshore-windfarm-revised-design. [Accessed April 2024].

[84] Inch Cape Offshore Limited, "Inch Cape Offshore Wind Farm," [Online]. Available: https://www.inchcapewind.com/. [Accessed April 2024].

[85] Marine Scotland , "Inch Cape Offshore Windfarm - Section 36 Consent (2014)," 10 October 2014. [Online]. Available: https://marine.gov.scot/data/inch-cape-offshore-windfarm-section-36-consent-2014. [Accessed April 2024].

[86] Law Society of Scotland, "Appeal judges overturn ruling against offshore wind farms," May 2017. [Online]. Available: https://www.lawscot.org.uk/news-and-events/legal-news/appeal-judges-overturn-ruling-against-offshore-wind-farms/. [Accessed June 2024].

[87] ICOL, "EIAR Chapter 6 - Site Selection and Alternatives," 2020. [Online]. Available: https://www.inchcapewind.com/wp-content/uploads/2020/10/IC01-EC-OFA-002-060-CHP-001_Chapter_6_Site_Selection_and_Alternatives_RevA-1.pdf. [Accessed June 2024].

[88] ICOL, "EIAR Chapter 18 - Summary of Effects," 2020. [Online]. Available: https://www.inchcapewind.com/wp-content/uploads/2020/10/IC01-EC-OFA-002-180-RRP-CHP-001_Chapter_18_Summary_of_Effects_RevB.pdf. [Accessed June 2024].

[89] Marine Scotland, "Seagreen Alpha and Bravo Offshore Wind Farms," [Online]. Available: https://marine.gov.scot/ml/seagreen-alpha-and-bravo-offshore-wind-farms. [Accessed April 2024].

[90] Marine Scotland, "Section 36 Consent Variation - Seagreen Alpha and Bravo Wind Farm, Firth of Forth," 10 May 2022. [Online]. Available: https://marine.gov.scot/ml/section-36-consent-variation-seagreen-alpha-and-bravo-wind-farm-firth-forth. [Accessed April 2024].

[91] Seagreen Wind Energy, "Seagreen Wind Energy," [Online]. Available: https://www.seagreenwindenergy.com/. [Accessed April 2024].

[92] Seagreen Wind Energy , "Non-Technical Summary," September 2012. [Online]. Available: https://marine.gov.scot/sites/default/files/non-technical_summary_1.pdf. [Accessed April 2024].

[93] Marine Scotland , "Decision Notice – Construction and operation of generating station, Seagreen Alpha Offshore Wind Farm, Firth of Forth," October 2014. [Online]. Available: https://marine.gov.scot/sites/default/files/decision_notice_-_seagreen_alpha.pdf. [Accessed April 2024].

[94] Marine Scotland, "Seagreen Alpha and Bravo S36 Consent Variation Determination," 28 August 2018. [Online]. Available: https://marine.gov.scot/sites/default/files/seagreen_-_alpha_and_bravo_-_varied_consent.pdf. [Accessed April 2024].

[95] Marine Scotland , "Seagreen Alpha and Bravo Offshore Wind Farms (Optimised Project)," [Online]. Available: https://marine.gov.scot/ml/seagreen-alpha-and-bravo-offshore-wind-farms-optimised-project. [Accessed April 2024].

[96] Seagreen Wind Energy , "Seagreen S36C Application Environmental Appraisal Report," April 2022. [Online]. Available: https://marine.gov.scot/sites/default/files/seagreen_s36c_environmental_appraisal_report.pdf. [Accessed April 2024].

[97] Marine Scotland, “Seagreen 2022 EIA Screening Opinion,” April 2022. [Online]. Available: https://marine.gov.scot/sites/default/files/screening_opinion_12.pdf. [Accessed June 2024].

[98] Marine Scotland, “Section 36 Consent Variation Application - Seagreen Alpha and Bravo Wind Farm, Firth of Forth,” May 2022. [Online]. Available: https://marine.gov.scot/data/section-36-consent-variation-application-seagreen-alpha-and-bravo-wind-farm-firth-forth. [Accessed June 2024].

[99] Marine Scotland , “Seagreen Alpha and Bravo Wind Farm - Section 36 Consent Variation - Decision Notice,” October 2022. [Online]. Available: https://marine.gov.scot/node/22985. [Accessed June 2024].

[100] Planning Inspectorate, “Hornsea Project Three Offshore Wind Farm - All project updates,” May 2024. [Online]. Available: https://national-infrastructure-consenting.planninginspectorate.gov.uk/projects/EN010080/project-updates. [Accessed June 2024].

[101] Orsted, “Hornsea Porject 3 - Environmetnal Statment Non-Technical Summary,” May 2018. [Online]. Available: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000525-HOW03_6_Non-Technical Summary.pdf. [Accessed June 2024].

[102] Orsted, “Hornsea Project Three Environmental Statement: Chapter 3: Project Description,” May 2018. [Online]. Available: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000528-HOW03_6.1.3_Volume%201%20-%20Ch%203%20-%20Project%20Description.pdf. [Accessed June 2024].

[103] BEIS, “APPLICATION FOR THE HORNSEA THREE OFFSHORE WIND FARM ORDER,” July 2020. [Online]. Available: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003225-Hornsea%20Project%20Three%20Minded%20To%20Letter%20-%201%20July%202020.pdf. [Accessed June 2024].

[104] BEIS, “Decision Letter - APPLICATION FOR THE HORNSEA THREE OFFSHORE WIND FARM ORDER,” Dec 2020. [Online]. Available: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003265-EN010080%20Hornsea%20Three%20-%20Secretary%20of%20State%20Decision%20Letter.pdf. [Accessed June 2024].

[105] BEIS, “Hornsea 3 - DCO as Made,” December 2020. [Online]. Available: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003266-EN010080%20Hornsea%20Three%20-%20Development%20Consent%20Order.pdf. [Accessed June 2024].

[106] Vineyard Wind, “Windyard Wind,” [Online]. Available: https://www.vineyardwind.com/vineyardwind-1. [Accessed June 2024].

[107] B. Storrow, “E&E News,” Politico , 19 1 2024. [Online]. Available: https://www.eenews.net/articles/why-vineyard-wind-is-a-legal-test-case-for-us-clean-energy/. [Accessed 6 June 2024].

[108] R. Walton, “Cape Wind developers call it quits,” Utility Dive , 4 December 2017. [Online]. Available: https://www.utilitydive.com/news/cape-wind-developers-call-it-quits/512203/. [Accessed 7 2 2024].

[109] N. Asimow, “Conservation Commission Denies Cable for Vineyard Wind,” Vineyard Gazette, 10 July 2019. [Online]. Available: https://vineyardgazette.com/news/2019/07/10/setback-vineyard-wind-conservation-commission-denies-undersea-cable. [Accessed 4 June 2024].

[110] BOEM, September 2020. [Online]. Available: https://www.boem.gov/renewable-energy/state-activities/vineyard-wind-1. [Accessed June 2024].

[111] BOEM, “Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume 1,” March 2021. [Online]. Available: https://tethys.pnnl.gov/sites/default/files/publications/Vineyard-Wind-1-FEIS-Volume-1.pdf. [Accessed 27 March 2024].

[112] BOEM, “Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume II,” 2021. [Online]. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-2.pdf. [Accessed June 2024].

[113] BOEM, “Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume 3,” March 2021. [Online]. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-3.pdf. [Accessed June 2024].

[114] BOEM, “Vineyard Wind 1 Offshore Wind Energy Project Final Environmental Impact Statement Volume 4,” March 2021. [Online]. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Vineyard-Wind-1-FEIS-Volume-4.pdf. [Accessed June 2024].

[115] BOEM, “Supplement to the Finding of Adverse Effect For the Vineyard Wind 1 Project Construction and Operations Plan March 9, 2021,” 9 March 2021. [Online]. Available: https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/Supplemental-FoAE.pdf. [Accessed October 2024].

[116] BOEM, “Record of Decision - Vineyard Wind 1 Offshore Wind Energy Project Construction and Operations Plan,” 10 May 2021. [Online]. Available: https://vineyardwind.app.box.com/s/blldin0s1ykrwma2hlysvtg3stzwubx0. [Accessed June 2024].

[117] “Planning and Develoment Act, 2000,” 2000. [Online]. Available: https://www.irishstatutebook.ie/eli/2000/act/30/enacted/en/html. [Accessed 13 Feb 2024].

[118] “Plannign and Develpoment, Maritime and Valuation (Amendment) Act 2022,” 2022. [Online]. Available: https://www.irishstatutebook.ie/eli/2022/act/29/enacted/en/html. [Accessed 13 Feb 2024].

[119] The European Parliament and the Council of the European Union , “DIRECTIVE 2014/52/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment,” 16 April 2014. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0052. [Accessed 13 Feb 2024].

[120] An Bord Pleanála, “Bord Pleanála Case reference: PA14.303592,” [Online]. Available: https://www.pleanala.ie/en-ie/case/303592. [Accessed 03 March 2024].

[121] An Bord Pleanála, “Inspector's Report ABP-303592-19,” September 2019. [Online]. Available: https://www.pleanala.ie/anbordpleanala/media/abp/cases/reports/303/r303592.pdf?r=416548. [Accessed March 2024].

[122] An Bord Pleanála, “Board Direction BD-005855-20 ABP-303592-19,” 29 May 2020. [Online]. Available:

https://www.pleanala.ie/anbordpleanala/media/abp/cases/directions/303/s303592.pdf?r=640361063216. [Accessed March 2024].

[123] Courts Service , "Judgements - Sweetman -v- An Bord Pleanála & Ors," June 2021. [Online]. Available: https://www.courts.ie/view/judgments/47b71140-5825-48ee-9d35-5e3ec694af6a/62c07669-d64d-4478-a4dd-6df05d2ad306/2021_IEHC_390.pdf/pdf. [Accessed March 2024].

[124] "High Court calls "design envelope" into question, Court of Appeal to clarify scope," November 2021. [Online]. Available: https://www.algoodbody.com/insights-publications/high-court-calls-design-envelope-into-question-court-of-appeal-to-clarify-scope. [Accessed March 2024].

[125] J. Humphreys, "JUDGMENT of Humphreys J. delivered on Tuesday the 26th day of October, 2021," 26 October 2021. [Online]. Available: https://www.courts.ie/acc/alfresco/3c25b060-c48d-4fac-8bff-1b2629d34264/2021_IEHC_662.pdf/pdf#view=fitH. [Accessed March 2024].

[126] Longford Leader, "Planning permission for massive Longford wind farm decisively refused," 16 February 2022. [Online]. Available: https://www.longfordleader.ie/news/home/745093/planning-permission-for-massive-longford-wind-farm-decisively-refused.html. [Accessed March 2024].

[127] An Bord Pleanála, "SID: After the Board has made its decision," [Online]. Available: https://www.pleanala.ie/en-ie/strategic-infrastructure-development-guide/sid-after-the-board-has-made-its-decision. [Accessed June 2024].

[128] An Bord Pleanála , "Case Details: Yellow Wind Farm, North of Rhode, County Offaly," 2020. [Online]. Available: https://www.pleanala.ie/en-ie/case/307357. [Accessed July 2024].

GLOBAL PROJECT REACH

Offices

Dublin (Head Office)
Gavin & Doherty Geosolutions
Unit A2, Nutgrove Office Park
Rathfarnham
Dublin 14, D14 X627
Phone: +353 1 207 1000

Utrecht
Gavin & Doherty Geosolutions
WTC Utrecht, Stadsplateau 7
3521 AZ Utrecht
The Netherlands

Belfast
Gavin & Doherty Geosolutions (UK) Limited
Scottish Provident Building
7 Donegall Square West
Belfast, BT1 6JH

Cork
Gavin & Doherty Geosolutions
Unit 4E, Northpoint House,
North Point Business Park
Cork, T23 AT2P

Edinburgh
Gavin & Doherty Geosolutions (UK) Limited
21 Young Street
Edinburgh
Scotland, EH2 4HU

London
Gavin & Doherty Geosolutions (UK) Limited
85 Great Portland Street, First Floor
London
W1W 7LT

Rhode Island
Gavin & Doherty Geosolutions Inc.
225 Dyer St, 2nd Floor
Providence, RI 02903
USA

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Website: www.gdgeo.com
Email: info@gdgeo.com

Contact Details

Research Funding Office
Marine Institute
Rinville
Oranmore
Co. Galway H91 R673
Ireland

Tel: +353 (0)91 387200
Email: funding@marine.ie

www.marine.ie


www.facebook.com/
marineinstituteireland


www.linkedin.com/company/
marine-institute


www.instagram.com/
@marineinstituteireland