IDEA - IRL

INTEGRATED DESIGN OF FLOATING WIND ARRAYS IRELAND

Data gap analysis

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External links

This project is closely coordinated with the IEA Wind TCP Task 49 – Integrated Design on floating wind Arrays (IDeA)[1]

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[1] https://iea-wind.org/task49/

Executive Summary

The IDEA-IRL (Integrated Design of Floating Wind Arrays Ireland) project's overarching goal is to promote the national and global sustainable development of Floating Offshore Wind Arrays (FOWA). This will be achieved by building upon key background knowledge and by coordinating and leveraging the international FOWA research effort under the framework of the supported International Energy Agency (IEA) TCP Wind Task 49. Specific objectives include:

1. Deliver a set of fully defined reference sites characteristic of the international global floating wind deployment pipeline including all relevant technical, social, environmental and economic parameters.
2. Deliver a set of fully open source and customisable floating wind array reference designs including key engineering tool input files, cost and environmental impact models.
3. Deliver a Failure Mode, Effects & Criticality Analysis framework for floating wind arrays including for coupled / cascading failures.
4. Engage with the international groups developing innovations for the floating wind energy industry, categorise in terms of multidisciplinary impact and ensure that functionality for their development is included in the reference sites and/or reference farm definitions.
5. Engage with the international agencies responsible for Marine Spatial Planning (MSP) to collect open research questions and concerns. Provide responses directly where possible and otherwise ensure that the reference sites and reference farms are defined in such a manner that they enable the required research.
6. Apply the work of Task 49 in an Irish context and engage with the local supply chain to provide specific policy recommendations and development pathways.
7. Raise the profile of floating wind energy technology, related research and expertise in Ireland through the delivery of a multifaceted communications strategy.

This study presents a data gap analysis for floating offshore wind energy under WP5 of the IDEA-IRL project. WP5 adapts Task 49's work for the Irish environment and collaborates with the regional supply chain to offer policy recommendations and development prospects. The report, which is the first deliverable of WP5, summarises the data and models developed in the earlier MaREI projects EirWind, OPFLOW and SELKIE. It pinpoints the gaps and required updates for supporting FOWA development prior to and after 2030.

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1 Introduction

Close to 80% of the world's offshore wind resource potential is in areas where the water depth is greater than 60 metres [1], making floating offshore wind structures the most technically possible option at present. In the case of Ireland, this is especially important, given the bathymetry off our south and west coasts in particular. Furthermore, Ireland's maritime area is seven times the size of its landmass and, with some of the highest average wind speeds in Europe, it has one of the leading offshore wind resources. Figure 1.1 provides a map to illustrate the average wind speeds at 100m High around the Irish coastline. Wind speeds on the west coast average at 12m/s at 100m high, while the Scottish North Sea is 9.5-10m/s at the same height [2].

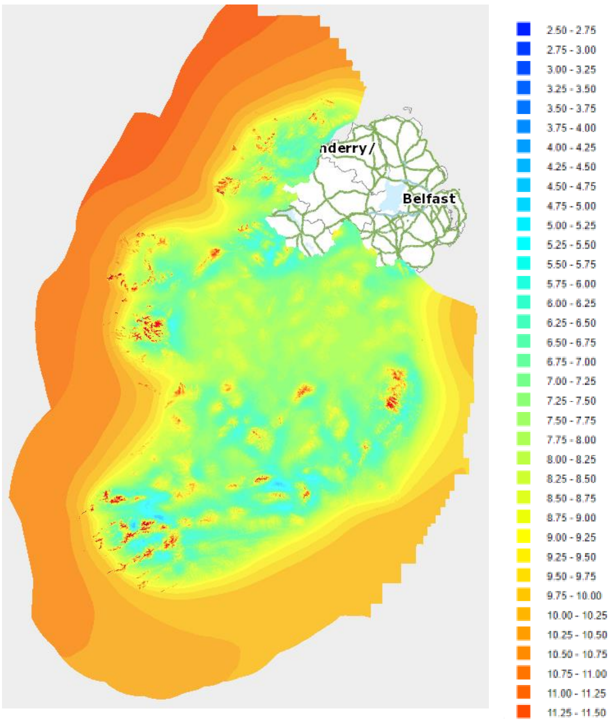


Figure 1.1 Wind speed at 100m: SEAI Wind Mapping System, copyright Ordnance Survey Ireland.

To date, only 1 x 25MW project, the Arklow Wind Bank, has actually been installed. However, the Irish Government has committed to deploying 5GW of bottom fixed offshore Wind by 2030 and having 2GW of floating wind in development by the same time. Government is also aiming for an offshore wind installed capacity of 20GW by 2040, and 37GW by 2050. It is currently expected that this will comprise mainly floating wind projects, in the deeper waters on the southern and western Coasts of Ireland, with the programme for government outlining an intention take advantage of a potential of at least 30GW of offshore floating wind power in our deeper waters in the Atlantic. [3] [4] There are currently approximately >16GW of fixed and floating offshore wind projects in development, early planning or consenting stages. However, the industry has been delayed by lack of a cohesive planning permissions process, support schemes and regulatory framework; uncertainty about grid capacity to accommodate offshore wind and connection procedures; as well as lack of sufficient port infrastructure, skills shortages etc.

Two recent projects, EirWind and OPFLOW, sought to provide development pathways for offshore wind energy in Ireland. EirWind was an industry-led[2] and SFI co-funded research project (2018-2020), which produced a blueprint for offshore wind energy in Ireland, addressing the national gaps in knowledge in relation to offshore wind in Ireland. The project focused on a pathway to the deployment of large-scale (1GW) fixed and floating offshore wind farms in the near and medium-term and included:

- The development of Geographic Information Systems (GIS), data gap analysis, new data layers and recommendations for data in the study of strategic areas for offshore wind, off Ireland's east, south and west coasts.
- Cost optimization, developing an advanced approach to planning for bottom fixed and floating offshore wind scenarios in Ireland.

[2] Industry partners: DP Energy Ireland, Equinor ASA, Enerco Energy, Statkraft Ireland, Brookfield Renewable Ireland, EDP Renewables, SSE Renewables, Simply Blue Energy, ENGIE, and Electricity Supply Board (ESB).

- Review the challenges associated with consenting offshore wind projects and making recommendations for stakeholder engagement, including co-existence with fisheries. [5]
- Assessing seabird vulnerability and review impacts on marine mammals.
- Identify options for route to market for offshore wind in Ireland.
- Research synthesis, combining project conclusions to release a 30-year strategy for the development of fixed and floating offshore wind in Ireland. [6]

The EirWind project concluded that the rapid development of Floating Offshore Wind (FLOW) technology, which can be deployed in deep Irish waters, is a “game changer.” To reach long-term goals, capacity needs to be built in the short to medium term with Bottom Fixed Offshore Wind farms (BFOW) in the Irish Sea - in the first half of the 2020s. In addition, research found that there was considerable potential for FLOW on the south and west coasts. However, the Atlantic Ocean (west coast) is extremely challenging due to the harsh Metocean conditions. Therefore, to achieve future FLOW targets post 2030, the project asked the question whether smaller projects (100-300MW) were needed to ramp up the Irish supply-chain; converge on technology; and optimise operations and costs. This question was the focus of the OPFLOW project [7]. The SEAI-funded[3] OPFLOW (2020) project further refined data gathered in EirWind, testing strategic locations off the Cork and Clare coast for theoretical 120 and 300MW FLOW farms. OPFLOW sought to determine whether there is a case for pre-commercial, pilot floating offshore wind farms in the near-term. If so, the project sought to propose the appropriate size and location.

The IDEA-IRL project will expand on the key inputs from the Eirwind and OPFLOW initiatives to account for the rapidly developing legislative, consenting and technological landscapes related to FLOW, and focusing on the overall array design. The global objective of the IDEA-IRL project is to accelerate the sustainable development of Floating Offshore Wind Arrays (FOWA) both domestically and internationally. This will be achieved by building upon key background knowledge and by coordinating and leveraging the international FOWA research effort under the framework of the supported International Energy Agency (IEA) TCP Wind Task 49. Specific objectives include:

8. Deliver a set of fully defined reference sites characteristic of the international global floating wind deployment pipeline including all relevant technical, social, environmental and economic parameters.
9. Deliver a set of fully open source and customisable floating wind array reference designs including key engineering tool input files, cost and environmental impact models.
10. Deliver a Failure Mode, Effects & Criticality Analysis framework for floating wind arrays including for coupled / cascading failures.
11. Engage with the international groups developing innovations for the floating wind energy industry, categorise in terms of multidisciplinary impact and ensure that functionality for their development is included in the reference sites and/or reference farm definitions.
12. Engage with the international agencies responsible for Marine Spatial Planning (MSP) to collect open research questions and concerns. Provide responses directly where possible and otherwise ensure that the reference sites and reference farms are defined in such a manner that they enable the required research.
13. Apply the work of Task 49 in an Irish context and engage with the local supply chain to provide specific policy recommendations and development pathways.

[3] SEAI funded project with UCC, ORE Catapult with in-kind support from industry partners Principle Power Inc. and Simply Blue Energy Ltd.

14. Raise the profile of floating wind energy technology, related research and expertise in Ireland through the delivery of a multifaceted communications strategy.

This report is separated into **key topics**, with each section giving an overview of **"Previous work"** i.e. the current knowledge, data and/or tools produced in previous projects and found in the literature as well as any recent developments in the technology, supply-chain and policy landscape, focusing on the Irish context; and a **"Data gap analysis"** that identifies where additional information is needed to achieve the IDEA-IRL objectives. Data will be gathered through WP1-4 and in cooperation with the IEA Task 49, considering the inputs required to employ the array scale design, cost and LCA tools in WP2 and the additional information needed for scenario-based modelling of Irish specific scenarios in WP5.

2 Marine Spatial Planning and Stakeholder engagement

2.1 Previous work

In terms of MSP, the EirWind project did a comparative analysis of the regulatory regimes in Ireland and Scotland [8]; undertook stakeholder mapping; and produced recommendations for innovation and best practice in stakeholder engagement. [9] [10] A series of stakeholder perception reports [11] [12] introduced methodologies designed to undertake a national study of public perception of offshore wind farms in Irish waters and the findings of the first national survey undertaken May-June 2019. The EirWind project blueprint suggests that pathways for FOWA need to be enabled, in parallel with support for the relevant projects, in the next 18 to 24 months (2023). The report stressed that a timeline needed to be specified for technology specific FOWA auctions taking into consideration the pre-commercial status of this technology. [6]

The OPFLOW project asserted that Ireland needs to have pre-commercial demonstration projects fully operational by the latter part of the decade to 'get in the game' for FLOW. The final report identifies a 300MW farm off the Cork coast as a competitive FOWA that could kick-start Ireland's leadership in this sector. It also provides a series of recommendations for designing a mechanism for procurement and site selection for pre-commercial FLOW capacity in Ireland. It reviewed three mechanisms to understand the possible options for offshore wind or FLOW pre-commercial demonstration projects including i). open awards (the approach in Scotland); ii). auctions (France); and iii). a government-led process (Japan). Based on this international analysis, a competitive auction was identified as the preferred procurement option for promoting a pre-commercial demonstrator. However, it is critical that the auction is balanced and does not focus solely on lowest cost. Ideally, the mechanism used for procurement of pre-commercial FLOW capacity will be the same, or at least reflective of, the mechanism to be used for longer-term commercial-scale procurement. In an Irish context, this means alignment with the Renewable Energy Support Scheme (RESS). OPFLOW advocated FLOW specific auctions beginning between 2025-2030 in order for pre-commercial activity to commence this decade. The project stressed that a pre-commercial demonstration plan for Ireland also needs to be nested in a long-term roadmap, to avoid a repeat of the Arklow Bank experience in Ireland for bottom fixed wind. [7]

2.2 Data gap analysis

There have been extensive developments in the Irish MSP processes since the EirWind and OPFLOW projects. Given the significant ambitions for offshore wind in Ireland, a cross-Departmental Offshore Wind Delivery Taskforce has been established to accelerate and drive delivery of offshore renewables in Ireland working on marine planning and consenting (the National Marine Planning Framework

Figure 2.1 ORESS 1 Provisional Auction Results 2023 [33]

(NMPF), the Maritime Area Regulatory Authority (MARA), the Maritime Area Planning (MAP) Act 2021); grid development framework; offshore renewable electricity auction framework; and ports policy. The Maritime Area Planning Act (2021) provided for a streamlined planning process known as the New Maritime Area Consent (MAC) regime. This is now being implemented, with the first batch of MACs granted to the six qualified Offshore Wind projects (known as the Phase 1 projects) in December 2022:

- Arklow Bank Phase 2
- Codling Wind Park
- Dublin Array (Bray and Kish Bank)
- North Irish Sea Array
- Oriel Wind Farm
- Sceirde Rocks

These projects were assessed in key areas under the MAP Act 2021, including financial and technical competency to ensure that they are viable. Phase 1 project MACs were granted by the Minister for the Environment, Climate and Communications to expedite the process. However, the MARA was established in July 2023, and will take over responsibility for the MACs granted to these projects and future applications. Developers who are awarded a MAC can then apply for development permission (planning) from An Bord Pleanála, where the project proposals will undergo environmental assessment. The granting of a MAC was a pre-requisite for projects to enter the first Offshore Renewable Energy Support Scheme Auction, (ORESS1).

ORESS is an auction-based process, which invites renewable energy projects to bid against each other to win two-way contracts for difference (cfd). These guarantee a strike price for energy generated over a period of up to 20 years. This method means that where wholesale prices are less than the strike price, operators are guaranteed this amount, de-risking projects for investors. This in-turn can reduce the cost of capital etc. However, where prices are in-excess of the strike price, projects must return the revenue difference to electricity consumers. The first auction for offshore wind (ORESS1) took place in May 2023. Six projects applied to the auction, submitting an offer price. As illustrated in *Figure 2.1*, four projects (Codling Wind Park; Dublin Array; North Irish Sea Array; and Sceirde Rocks - 3.1GW total capacity) were provisionally successful with the weighted average strike price of €86.05/MWh.

Projects are expected to begin construction c. 2026-2028 with commercial operation by 2030. All will be fixed offshore wind farms and the majority of these are located on the east coast. However, the

Sceirde Rocks farm on the west coast will have the increased challenges of building and operating an offshore wind farm in the extreme conditions of the Atlantic Ocean.

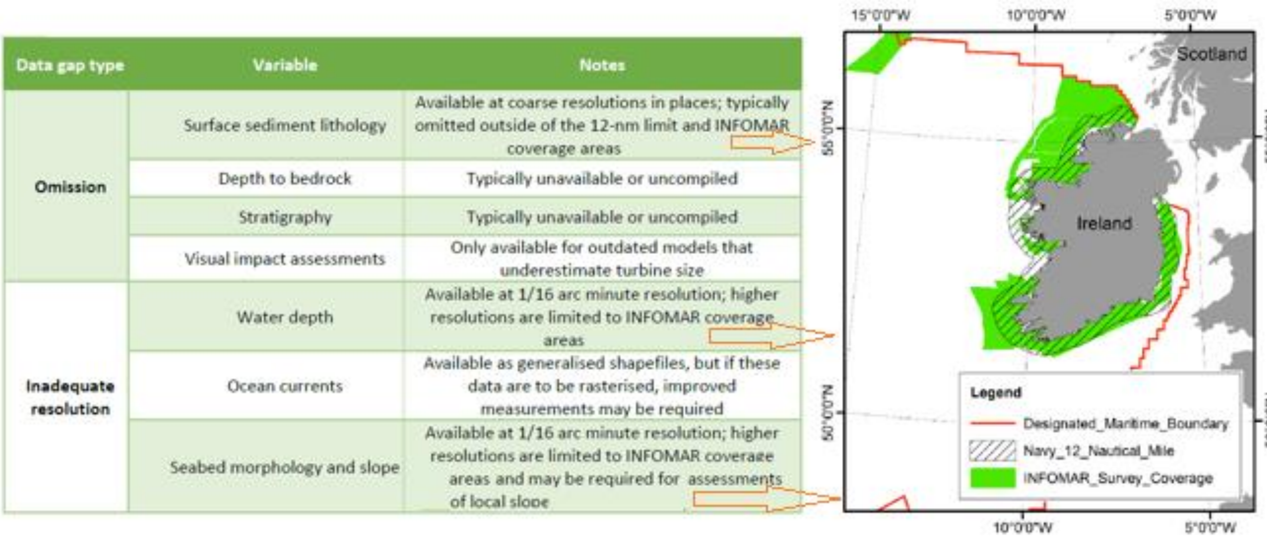
While there have been extensive advances in the MSP process, there are still considerable gaps in strategic planning, particularly for FOWA, and stakeholder engagement work. The Offshore Renewable Energy Development Plan (OREDP – 2014 and 2018) aims to map the areas most suitable for Offshore Renewable Energy (ORE) and is currently being updated (OREDPII) to better consider advances in technology and ambitions e.g. 30GW FLOW beyond 2030. However, this is still in development and there is no timeline set for the inclusion of FLOW in the ORESS.

The IDEA-IRL project WP4 will re-evaluate the MSP process and key issues as well as stakeholder engagement methods and perceptions of FOWA, particularly within the Irish context and recent developments. This WP will identify, characterise, and publish the major research questions faced by the industrial, academic and MSP communities in the development of innovations and the strategic planning for FOWA. Through the deliverables, a feedback loop will be established with the technical work packages to ensure that the reference sites and farms contain a sufficient level of detail and are configured in such a manner to address the identified research needs. In particular, WP4 will feed information into the WP2 reference farms, the WP5 Irish case-studies and policy recommendations.

3 Variables for offshore wind assessment and Metocean data

3.1 Previous work

The EirWind project undertook a data assessment for development of Ireland's offshore wind energy industry [13] determining the most commonly used variables (wind data, water depth and marine protected areas) as well as the least examined ones (geological characteristics and shipwreck locations). A list of required data was compiled consisting of 22 variables. The availability and quality of each variable's data were described e.g. available resolutions and file types of existing data. A comparative examination of the required and available data were performed revealing four types of data gaps and shortfalls: (1) omitted data; (2) unavailable data; (3) data with inadequate resolution; and (4) data with inappropriate file types. Figure 3.1 provides a visual summary of the data gaps identified in the EirWind project [14].



Data gap type	Variable	Notes
Omission	Surface sediment lithology	Available at coarse resolutions in places; typically omitted outside of the 12-nm limit and INFOMAR coverage areas
	Depth to bedrock	Typically unavailable or uncompiled
	Stratigraphy	Typically unavailable or uncompiled
	Visual impact assessments	Only available for outdated models that underestimate turbine size
Inadequate resolution	Water depth	Available at 1/16 arc minute resolution; higher resolutions are limited to INFOMAR coverage areas
	Ocean currents	Available as generalised shapefiles, but if these data are to be rasterised, improved measurements may be required
	Seabed morphology and slope	Available at 1/16 arc minute resolution; higher resolutions are limited to INFOMAR coverage areas and may be required for assessments of local slope

Figure 3.1 Summary of data gaps from EirWind D2.1 [14]

EirWind conducted a field measurement plan making significant improvements to the available data, producing a distance-cost analysis for installation port and grid connections and visual impact datasets for key development zones [14]. It also made improvements to spatial data, producing rasters at desirable spatial resolutions for modelled wind and wave data (ERA5 data; see D2.3 [15] for details) and established boundaries for spatial investigations, delineating the Irish seabed most suitable to offshore development in very broad terms. EirWind examined select spatial data coverage within three zones: the Irish EEZ, the 200-m isobath, and the 70-m isobath. These assessments reveal that high-resolution INFOMAR data is currently best suited for fixed-bottom assessments and that low-resolution European data (EMODnet) improves in coverage with distance from shore—highlighting the efforts of national research programmes like INFOMAR. These assessments also reveal that environmental restriction zones are more likely to affect fixed-bottom developments, because their largest spatial percentage falls within the 70-m isobath.

Figure 3.2 outlines the advances made in the problematic data while the following points provide further detail of the progress made during EirWind and where gaps remain:

- Modelled wind and wave data are now compatible with the Multi-Criteria Decision Analysis (MCDA).
- Seabed (geomorphology) and surficial sediment data have improved coverage and resolutions.
- Every aspect of visual impact data has been improved.
- Water depth and seabed morphology data are incomplete at high resolutions. These datasets are being improved by the MBES bathymetric data being collected by the INFOMAR programme (https://www.infomar.ie/). Data on shipping density has not been made publicly available, however these can be purchased.
- Data on ocean currents are modelled at low resolutions, but higher resolution data should be acquired for site selection analyses.

  Gaps remain in the surface sediment dataset and, although several EirWind research cruises have improved key areas, coverage remains variable.

  The entire visual impact assessment data gap has been filled by EirWind [15].

Data	Availability and coverage description	Available resolution	Desired resolution**	Improvements since D2.1
Water depth	Select areas of high resolution; good (w/ Olex & GEBCO)	0.10 – 0.025 km	31 km	na
Shipping	Fair (AIS & VMS availability problems)	na	na	na
Wind velocity	Fair (modelled)	2.5 – 200 km	31 km	Extracted and rasterised at 24 km resolution
Hs	Good (modelled)	7 – 31 km	31 km	Extracted and rasterised at ~47 km resolution
Ocean currents	Fair (modelled)	na	31 km	na
Seabed morphology and slope	Fair (w/ Olex & GEBCO)	0.10 – 0.025 km	31 km	Added to with new MBES data
Surface sediment lithology	Variable with omissions	~60 m (varying)	31 km	Added to with new sediment samples
Depth to bedrock	Largely Omitted	na	31 km	Improved in key areas with new seismic data
Stratigraphy	Largely Omitted	na	31 km	Improved in key areas with new seismic data
Visual impact	Omitted for >4-MW turbines	na	na	Modelled for 12-MW turbines to 63 km offshore for Ireland's EEZ

Figure 3.2 Summary of problematic data and improvements made during the EirWind project. Required resolution transformations – yellow; problematic resolutions - red [12]

EirWind produced a GIS Repository (D2.3) [15] comprising the parameters described in Figure 3.3.

Variable	Description
Wind speed	Mean wind speed at a given height for a given period derived from the ERA5 model.
Water depth	From various bathymetric models (e.g. INFOMAR; EMODnet).
Significant wave height	The mean wave height of the highest third of the waves derived from the ERA5 model.
Ocean currents	Includes surface and deep-water currents from various models.
Seabed properties	Morphology and slope derived from rasters of depth models. Surface sediment from sediment grab data.
Depth to bedrock	Depth to bedrock and stratigraphy estimated from seismic and sedimentary data.
Distance to infrastructure	Incorporates information on offshore distances to appropriate ports and potential grid connections. (From the cost-distance analysis described in D2.3).
Biological features	Marine mammal distribution and seabird vulnerability data.
Visual impact	An assessment of how many people can see modern offshore wind farms modelled around Ireland. (From the visual impact assessment described in D2.3.)

Figure 3.3 EirWind GIS variables (model parameters) [14]

The project constructed a GIS-based Multi-Criteria Decision Analysis (MCDA) containing 5 individual models (industry restrictions; environmental restrictions; cultural heritage restrictions; exclusion zones; and technical opportunities). These models combine EirWind's own data improvements into a modified MCDA that was first developed for the SEAI (ORESG – Environmental SubGroup) from 2015 to 2017 [16]. Figure 3.4 outlines the available parameters for the MCDA including the parameters developed in the EirWind project. The project contributed most significantly to the technical opportunities model with 9 parameters.

	Available parameters	EirWind parameters	Unavailable parameters	Number of sources
Environmental Restrictions	65	0	1	5
Exclusion	14	1	5	11
Cultural Heritage Restrictions	18	1	0	10
Technical Opportunities	15	9	1	7
Industry Restriction Criteria	8	0	0	7

Figure 3.4 Summary of model data for the MCDA – included in the EirWind D2.3 [14] [15]

The MCDA serves as a tool for both offshore wind farm planning and informing policy makers when reviewing potential sites [14], considering different restrictions and key opportunities. These constituent models were included in the GIS repository (D2.3) [15]. Figure 3.5 shows the cultural heritage restrictions model.

The EirWind project also assessed the opportunities for synergies in Irish offshore energy farms. This examines potential use conflicts between distinct sea uses represented by 11 variables:

1. Protected sites
2. Cultural heritage (shipwrecks)
3. Navigation and shipping (ports and shipping lanes)
4. Recreation and tourism
5. Military zones
6. Cables and pipelines
7. Dumping grounds (dredge waste)
8. Existing renewable energy sites or lease areas
9. Oil and gas extraction sites
10. Construction aggregate extraction sites
11. Fisheries

Aquaculture activities were not included in this assessment because they typically take place too close to shore for relevance to OWE developments.

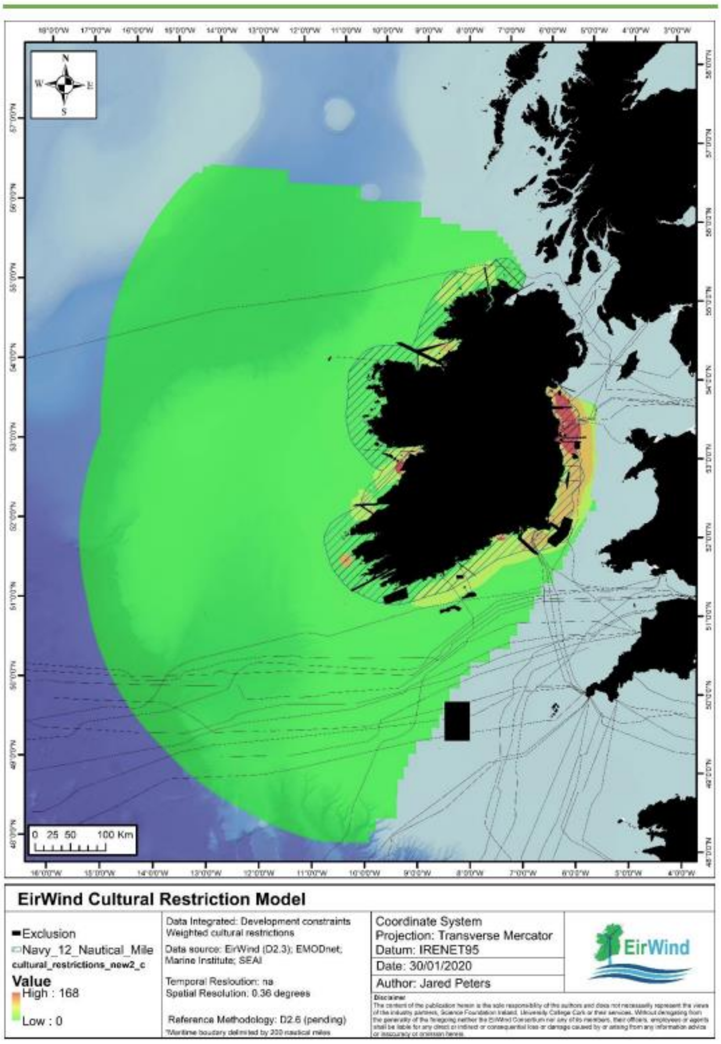


Figure 3.5 EirWind Cultural Restriction Model [12]

For the metocean data, as part of the logistics and cost modelling undertaken for representative sites in both the EirWind and OPFLOW projects, 10–25-year time-series of hourly mean wind speed (m/s) and significantly wave height (Hs) (m) data were downloaded using public data sources as follows:

EirWind
east coast:

Data	Source	Methodology	Years	Coordinates
Wind	ECMWF ERA5 Reanalysis Dataset [17]	Hindcasted data and forecast data based on future trends	1996-2005	52.66376, -5.9543
Wave	ECMWF ERA5 Reanalysis Dataset [17]	A mixture of modelled data and satellite observations	1996-2005	52.5, -6

south coast:

Data	Source	Methodology	Years	Coordinates
Wind	ECMWF ERA5 Reanalysis Dataset [17]	Hindcasted data and forecast data based on future trends	1996-2005	51.64028, -8.0259
Wave	ECMWF ERA5 Reanalysis Dataset [17]	A mixture of modelled data and satellite observations	1996-2005	51.5, -8

west coast:

Data	Source	Methodology	Years	Coordinates
Wind	ECMWF ERA5 Reanalysis Dataset [17]	Hindcasted data and forecast data based on future trends	1996-2005	52.50462, -10.8581
Wave	ECMWF ERA5 Reanalysis Dataset [17]	A mixture of modelled data and satellite observations	1996-2005	52.5, -11

OPFLOW
south coast:

Data	Source	Methodology	Years	Coordinates
Wind	ECMWF ERA5 Reanalysis Dataset [17]	Hindcasted data and forecast data based on future trends	1992-2018	51.52, -8
Wave	ECMWF ERA5 Reanalysis Dataset [17]	A mixture of modelled data and satellite observations	1992-2018	51.4, -7.9

west coast:

Data	Source	Methodology	Years	Coordinates
Wind	ECMWF ERA5 Reanalysis Dataset [17]	Hindcasted data and forecast data based on future trends	1992-2018	52.75, -10.25
Wave	ECMWF ERA5 Reanalysis Dataset [17]	A mixture of modelled data and satellite observations	1992-2018	52.7, -10.2

3.2 Data gap analysis

IDEA-IRL WP 1 will add to the data collected to date including:

- Extend time-series data for other data points using the ECMWF ERA5 dataset in line with sites selected on south and/or west coasts in line with the IEA Task 49.
- Gather additional parameters for selected sites based on the needs of the reference farms being developed in WP2. This will focus on criteria need to develop comprehensive mooring, anchor and cabling designs. This information is due to be passed to WP1 in project month 9, October 2023.

It should also be noted that considerable advancements in site data have been made available via the SEKLIE GIS techno-economic tool.[4] This entails creating Coastal Web Atlases (CWAs) using the International Coastal Atlas Network (ICAN) criteria to reflect the different constraints, restrictions, and opportunities that come into play when determining whether a location is suitable for the development of ocean energy [18]. Energy resource, depth range, seafloor ocean energy applications and functionality for both site selection and project feasibility are a number of factors included in the site selection process. The coordinates (12^{o} W_ 2^{o} W and 56^{o} N–50^{o} N) covered in the SELKIE CWA tool and the SELKIE CWA interface are shown in Figure 3.6.

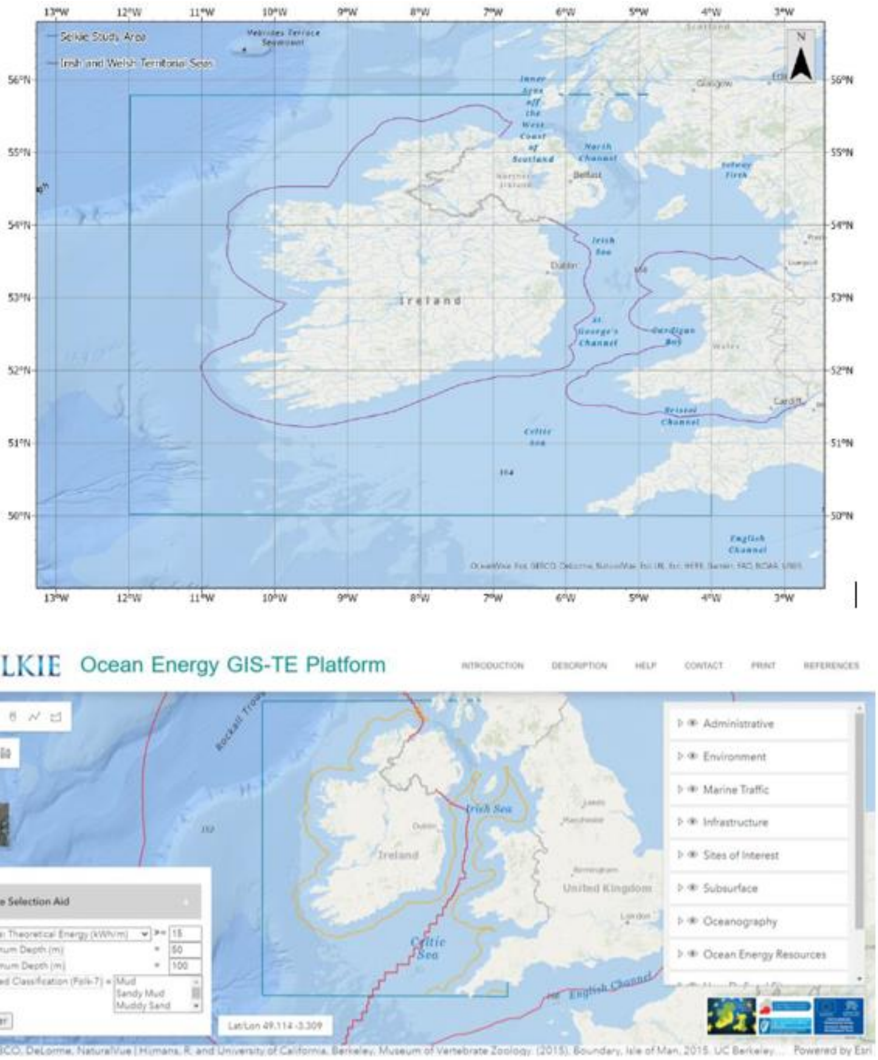


Figure 3.6: The SELKIE CWA coordiantes and interface [18].

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[4] https://www.selkie-project.eu/selkie-tools-gis-technoeconomic-model/

The following is a list of the available Metocean data from the SELKIE project [18]:

- **Wave data:** The Atlantic – Iberian Biscay Irish – Ocean Wave Reanalysis (Product Identifier - IBI_MULTIYEAR_WAV_005_006) was used to model the wave climate. The model is based on the MFWAM model developed by Meteo-France (MF). It is fed by the ERA 5 reanalysis wind data from ECMWF, covers the extents 19°W – 5°W; 56°N – 26°N and has a spatial resolution of 0.05° x 0.05°, or ~ 3 to 5 km. It has an hourly temporal resolution. The variables used were 'Spectral significant wave height (Hm0)', 'Spectral moments (-1,0) wave period (Tm-10)' and 'Wave period at spectral peak / peak period (Tp)'. The time series applied was 2000-01-01 00:00:00 to 2019-12-30 23:00:00.
- **Wind data:** The hourly wind data, with a spatial resolution of 0.25^{o} $\times 0.25^{o}$ (17 km × 27.5 km gird at the latitude of Ireland, obtained from the ECMWF ERA5 dataset. The variables downloaded were the '10m U-component of wind (u10)' and the '10m V-component of wind (v10)' The time series applied was 2000-01-01 00:00:00 to 2019-12-30 23:00:00.
- **Tidal data:** The ocean current data used for the Oceanography and Ocean Energy Resources layer groups were obtained from the Irish Marine Institute. Their hydrodynamic Regional Ocean Modelling System (ROMS) model covers the entire Selkie study area. The model has an hourly temporal resolution and a spatial resolution of 1.9 km × 1.9 km. The variables used were 'uB' (U-component barotropic velocity) and 'vB' (V-component barotropic velocity). Reynolds-averaged Navier-Stokes equations served as the underlying model/equation. The analysis included the period from January 1 to December 31, 2020.

These will be considered when developing reference sites in Irish waters and particularly in the development of Irish Pathways to deploying FOWA in WP5.

4 Wind Turbine

4.1 Previous work

No significant work was undertaken in developing wind turbine reference data during the EirWind or OPLOW projects. EirWind focused on 12 and 14MW wind turbines, which was extrapolated from the DTU 10MW reference turbine.[5] OPFLOW assessed a 15MW turbine using the 15MW IEA[6] reference turbine. Costs were scaled based on [19].

4.2 Data gap analysis

A number of reference turbines already exist:

- 5MW NREL[7]
- 8MW LEANWIND[8]
- 10MW DTU[9]
- 15MW IEA[10]

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[5] https://backend.orbit.dtu.dk/ws/portalfiles/portal/55645274/The_DTU_10MW_Reference_Turbine_Christian_Bak.pdf
[6] https://www.nrel.gov/docs/fy20osti/75698.pdf
[7] https://www.nrel.gov/docs/fy09osti/38060.pdf
[8] https://iopscience.iop.org/article/10.1088/1742-6596/753/9/092013/pdf
[9] https://backend.orbit.dtu.dk/ws/portalfiles/portal/55645274/The_DTU_10MW_Reference_Turbine_Christian_Bak.pdf
[10] https://www.nrel.gov/docs/fy20osti/75698.pdf

It has been agreed to use the IEA 15MW reference turbine going forward due to trends and IEA Task 49. Therefore, there are no substantial gaps to fill during IDEA-IRL. Details of this will be included in WP2_D1 Design Basis. Costs should be updated in line with today's figures and validated where possible by industry.

5 Substructure, Moorings and Anchors

5.1 Previous work

The EirWind and OPFLOW project considered a number of theoretical sites and farms for fixed and floating offshore wind farms. As part of the FOWA, steel semi-submersibles with steel chain catenary mooring systems and drag embedment anchors were selected as the most appropriate base case design for the Irish scenario. No actual design work was done; however, both projects loosely assumed a design similar to the WindFloat and used the current literature and engineering expertise to estimate material weights and costs to produce a floating structure that could support 12 and 14MW turbines on the South and west coasts respectively for EirWind. Details of substructure assumptions and scaling methods used in the EirWind project can be found in [20] and are summarised in Table 5.1 and Table 5.2.

Table 5.1 EirWind Semi-submersible platform for 12MW turbine

Steel	**3,180t**
Platform cost	€12,879,000
Anchor cost	€342,000
Mooring cost	€2,000,000
Total cost	**€15,221,000**

Table 5.2 EirWind Semi-submersible platform for 14MW turbine

Steel	3,710t
Platform cost	€15,025,500
Anchor cost	€342,000
Mooring cost	€2,000,000
Total cost	**€17,367,500**

The OPFLOW project further refined these estimates based on discussion with partners and industry and adjusted for a 15MW turbine resulting in costs of €14,492,000 for a 3,000t steel semi-sub on the south coast site and €16,517,000 for a 3,500t steel semi-sub on the west coast site (more expensive than the south coast due to the deeper water depth and more extreme site conditions requiring a larger substructure).

5.2 Data gap analysis

5.2.1 Substructure

As more FLOW foundation concepts are tested in an operational environment, both semi-spar and Tension Leg Platform (TLP) solutions are also viable options. Therefore IDEA-IRL needs to review the substructure designs most suitable for Irish Reference Farms. However, IDEA-IRL will not design the substructure itself. The project will use existing reference designs where possible e.g. the IEA

VolturnUS-S Reference Platform Developed for the IEA Wind 15- Megawatt Offshore Reference Wind Turbine.[11] The existing designs will be identified and detailed in WP2-D1 Design Basis.

The cost assumptions for steel and concrete semi-submersibles made in the EirWind and OPFLOW projects need to be reviewed and updated based on more recent data, and where possible, validated with industry. Further cost estimates need to be derived for other platform options that will be implemented in the Reference Farms (WP2) and Irish case studies (WP5).

These cost assumptions will consider manufacturing and labour costs as well as price fluctuations e.g. the volatile price of steel, and learning rates considering economies of scale for large farm arrays. However, these assumptions will require further research to determine reasonable estimates.

5.2.2 Moorings and Anchors

There is very little detailed, reliable information available for mooring and anchoring systems for FOWA given the limited number deployed, the IP-sensitive nature of existing designs, and at a range of water depth and for different Metocean conditions. IDEA-IRL will produce mooring and anchor designs for a selection of FOWA reference farms (WP2) in shallow, intermediate and deep-water depths considering mild, moderate and severe site conditions. In tandem, it will seek to refine cost estimates based on the figures produced in the EirWind and OPFLOW projects considering updated information in the literature and through discussions within the IEA Task 49 and the wider industry.

6 Array and inter-array cabling layout

6.1 Previous work

The EirWind project assumed regular rectangular array layouts for the reference farm case studies. The dimensions of these were primarily defined by assumed distances between turbines and the cable capacity. The assumptions and designs are illustrated in Figure 6.1 and Figure 6.2.

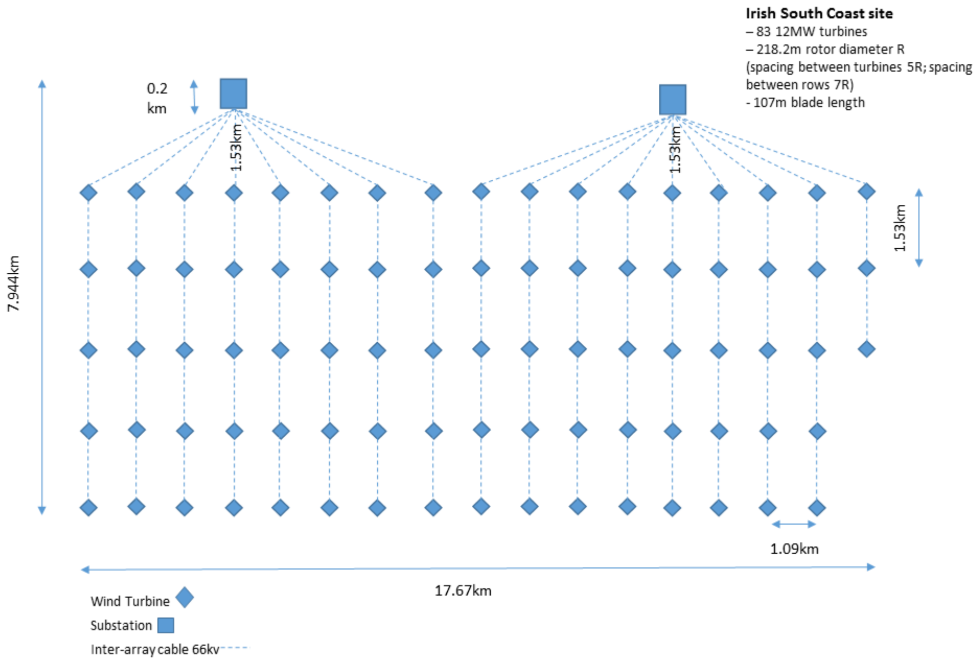

Figure 6.1 EirWind south coast case study farm layout [21]

[11] https://www.nrel.gov/docs/fy20osti/76773.pdf

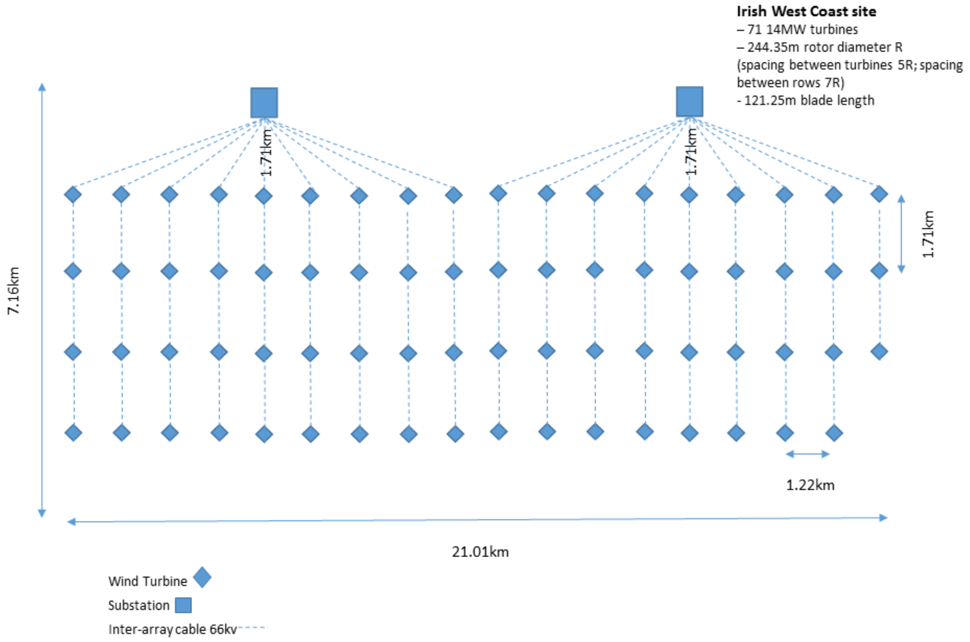

Figure 6.2 EirWind west coast case study farm layout [21]

Cable costs were estimated based on [19] for EirWind but updated based on discussions with industry for OPFLOW.

6.2 Data gap analysis

The assumptions (e.g. distances between turbines) need to be updated and validated to develop array designs in line with the IEA task 49 reference farms. Considerable work is needed to design the dynamic inter-array cable system, considering the umbilical cable configuration options e.g. catenary, lazy wave etc.

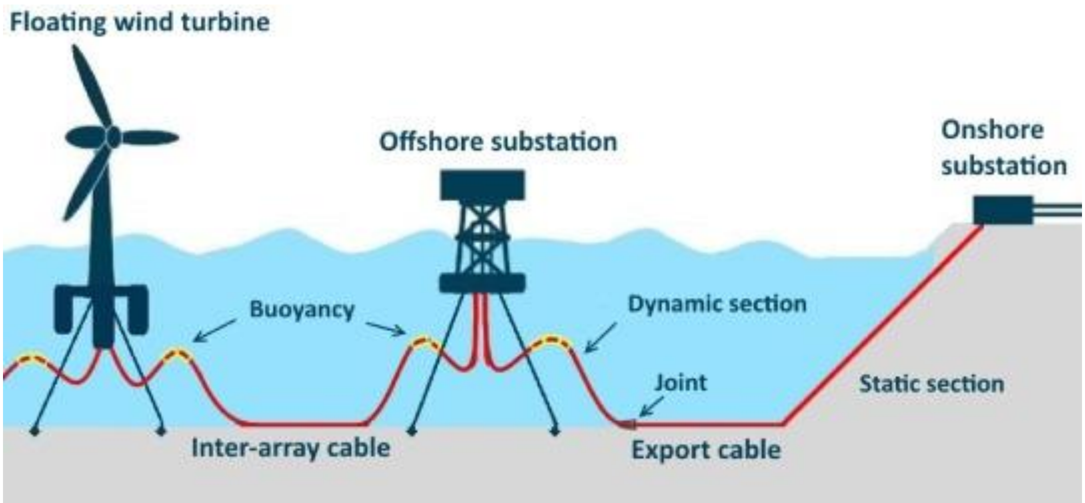

Figure 6.3 Electrical System of a Floating Offshore Wind Farm [22]

Cable capacity, lengths and costs need to be defined based on the updated designed and validated with the latest literature and/or discussions with industry.

7 Balance of System

7.1 Previous work

The EirWind and OPFLOW projects estimated the number, size and length of the **export cabling.** Costs were based on figures for fixed offshore substations in the current literature [21] and discussions with industry. It was assumed that an offshore substation (maximum capacity of 500MW) could be installed on a floating semi-submersible platform.

The EirWind and OPFLOW projects scaled figures from the current literature [19] to consider **onshore substation and grid connection, development and survey costs.**

Percentages of c. 10% of installation (section 8) was considered for **project management** costs during the construction phase. 9-12% of the total Capital Expenditure (CAPEX) was considered for **contingency and insurance costs** (9% for EirWind but updated to 12% for OPFLOW). These were based on similar assumptions made in studies in the current literature.

7.2 Data gap analysis

It should be noted that design of the electrical infrastructure for IDEA-IRL will be limited to the inter-array cabling. The substation, export cable and onshore cabling will be beyond the scope of the WP2 designs. However, general balance of plant costs will be needed to produce the overall assessments e.g. costs for WP2 reference farms and Irish specific scenario modelling in WP5. Therefore, the assumptions used in previous projects need to be reviewed in light of advances in the current literature and discussions with industry. Where water depths are suitable for fixed jacket offshore substations, it is likely these will be considered, although information is extremely limited. Further data is need on the size and viability of floating offshore substations and assumptions should consider the latest ORE Catapult Guide to a Floating Offshore Wind Farm released in May 2023 [23].

8 Installation strategy and logistics

8.1 Previous work

EirWind undertook an extensive review of the different strategies for installing fixed and floating offshore wind farms. [21] and [24] defined and optimised installation strategies for FOWA. This considered the installation of the offshore electrical system (export cabling, substation and inter-array cabling; substructures and turbines. In summary, it was assumed for FOWA that the turbine would be pre-installed on the substructure at port and floated to site using an Anchor Handling Tug Vessel (AHTV) and smaller tug vessels where it is hooked up to pre-installed anchor and mooring lines. The timings of operations, the vessels and equipment required, operational weather restrictions (maximum significant wave height (Hs, m) and mean wind speed (m/s)), and costs were defined and reviewed by industry partners. The key assumptions are detailed in the EirWind deliverables listed above.

The EirWind and OPFLOW projects used the LEANWIND financial tool, specifically the installation module, [25] to model installation of reference farms on the South and west coasts. Outputs included installation time and costs.

8.2 Data gap analysis

Installation assumptions (strategy and costs) for the anchors and moorings and the turbine and substructure should be reviewed in light of increased industry experience. There was very little information available for installation of the offshore cabling system. Therefore, further research and industry validation would greatly increase confidence in the existing assumptions.

Input from the IEA Task 49, which is conducting a logistics survey amongst task participants, will be a key source of information as well as the NREL OBRIT Offshore renewable balance of plant and installation tool report [26].

IDEA-IRL will prepare input data in an open-access logistics tool as part of WP2, but where useful to expand this work, WP5 will also conduct more detailed analysis of installation of reference farms relevant to Ireland using UCC's existing in-house installation model [25].

9 Operation and Maintenance (O&M) strategy and logistics

9.1 Previous work

EirWind undertook an extensive review of the O&M strategies for fixed and floating offshore wind farms. [21] and [24] define O&M strategies for FOWA. However, the strategies are based on Corrective Maintenance (CM - dictated by failure rates) and scheduled Preventive Maintenance (PM) intervals for fixed offshore wind farms defined in [27]. These consider maintenance for the turbine and balance of system (e.g. cables and substation). However, they were themselves based on onshore wind farms. EirWind updated these to include failure rates for a semi-submersible mooring system and anchors based on [28]. The strategy has also been adapted for FOWA assuming that the turbine will be towed to shore for maintenance of major repairs that require Jack-up Vessels (JUV) in [27], given the site water depths for a FOWA farm would require specialised JUVs or expensive dynamic-positioning/semi-submersible vessels. Details (e.g. operation time) for a tow-to-shore-maintenance operation were based on [29]. Crew Transfer Vessels (CTVs) undertook minor repairs offshore for the south coast case-studies. However, larger Service Operations Vessels (SOVs) with higher operational capabilities (e.g. higher maximum Hs) were available for the west coast site given the extreme Metocean conditions of the North Atlantic Ocean.

The EirWind and OPFLOW projects used the LEANWIND financial tool, specifically the O&M NOWiCOB model developed by SINTEF, [25] to model the O&M of reference farms on the South and west coasts. Outputs included energy production and costs. Operations (non-maintenance) costs were set at €30.9/kW based on [27].

9.2 Data gap analysis

IDEA-IRL needs to update and validate O&M strategies for CM and PM – method, equipment, repair cost, weather restrictions, time etc. In particular, the project needs to verify port equipment requirements, costs and spare part storage and inventory methods. The O&M guarantee period should be taken into account.

It needs to update the failure rates, considering recent work in the existing literature and outcomes of the IEA Task 49 effort to gather and validate FMECA for FOWA (WP3). A key challenge of the FMECA will be to define what is considered a "failure", is full shutdown needed to prevent further damage, what are monitoring system standards? Can a "cost priority number" be assigned to failures so the most urgent (in terms of maximum impact on production and cost) are addressed first? The project should also look into PM in more detail, e.g. what are the main strategies and how does it impact/preserve device health.

IDEA-IRL will prepare input data in an open-access logistics tool as part of WP2 but, where useful to expand this work, WP5 will also conduct more detailed analysis of O&M of reference farms relevant to Ireland using UCC's existing in-house O&M model.

10 Decommissioning strategy and logistics

10.1 Previous work

The EirWind and OPFLOW projects modelled decommissioning of case study farms using the decommissioning module of the LEANWIND financial model [25]. This simulated the reverse of installation using AHTVs and tugs to return the turbine to site and dismantle at quayside. Removing cabling and dismantling the substation is beyond the scope of the model. The decision to limit the model scope was made following a review of available decommissioning plans, where the predominant assumption is that elements such as cabling are left in-situ. Further details are included in [21].

It should be noted that the decommissioning model also facilitates calculation of the salvage value, considering the recycling or disposal cost of different parts of the turbine and substructure. These were calculated based on an assessment in [30].

10.2 Data gap analysis

Significant work was done in the EirWind and OPFLOW projects to model a realistic decommissioning strategy and determine reasonable costs and salvage revenues. However, updated research and assessment are needed for IDEA-IRL, as well as industry validation of assumptions and estimates where possible. In particular, the current assumption regarding leaving cabling in-situ will depend on the respective national environmental laws. Therefore, this assumption should be reviewed considering different regulations globally and particularly in Ireland.

It is also highly likely that farm operators will opt for repowering and extending the OWF lifecycle, upgrading and replacing obsolete components and infrastructure, rather than fully decommissioning a site. While the EirWind and OPLFOW scenarios considers the complete removal of the turbine and substructure, future work could consider a re-powering scenario e.g. where the turbine is upgraded in a major retrofit rather than fully removed. Therefore, the current model and calculations would need to be adjusted to consider this option. If such a repowering strategy is applied, financial analysis may need to consider a decommissioning bond (required as part of leasing agreements) and limited salvage of the elements that are replaced, while the retrofit would be part of a new, separate project assessment.

11 Vessels

11.1 Previous work

Based on the strategies defined in EirWind and OPFLOW for installation, O&M and decommissioning activities, UCC have developed an extensive database of existing vessel categories, capabilities and costs.

11.2 Data gap analysis

The existing database of vessels is constantly being updated. However, a full review considering today's figures and the latest vessel designs would ensure IDEA-IRL is using the most up-to-date information. Where possible details (capabilities and costs) should be validated against real vessels with industry. It would also be useful to gather more information on the different contracting methods and options as well as the mobilisation time and costs associated with these options.

12 Technicians

12.1 Previous work

Limited work was done in EirWind and OPFLOW assessing technician skill requirements and costs for the different operations across a wind farm project lifetime. This was due to the more significant impact of vessel costs etc. In general, it was assumed that technician costs were included in vessel day rates (installation and decommissioning modules) or that they were set as a day rate or annual salary in the NOWiCOB tool. [25]

12.2 Data gap analysis

Depending on the assessment tools used for WP2 as well as the Irish case-studies (WP5), the IDEA-IRL project would need to gather more detail on the different skillsets required, the contracting arrangements (e.g. available year round as a core team, hired as required etc.), numbers required for different tasks and costs.

13 Financial Assessment – LCoE, Strike Prices, Support Schemes

13.1 Previous work

Creating a development pathway, EirWind analysed three scenarios for BFOW in the Irish Sea, and FLOW in the Celtic Sea and the Atlantic. FLOW in the Celtic Sea shows considerable potential; an estimated Levelized Cost of Energy (LCoE) range of €63-90/MWh[12] for circa 1GW coming on stream in 2035. For the Atlantic zone, the wind resource yields a high-capacity factor (62%). The estimated LCoE range (€75- 107/MWh for 1GW from c.2035) is higher than the Celtic Sea scenario, primarily due to the harsher conditions reducing the number of weather windows available to complete offshore operations during installation and O&M, reducing potential production and revenue. [6]

The OPFLOW project refined the EirWind case-studies,[13] examining smaller FOWA (120MW in 2025[14] and 300MW in 2028[15]) in the Celtic Sea (coast of Cork) and Atlantic Ocean (coast of Clare) to determine if a case could be made for developing smaller projects sooner to ramp up the supply-chain; converge on technology; and optimise operations and costs. Some case-study inputs were revised based on further validation by industry. The LCoEs were used to estimate strike prices and the cost of early financial support considering power prices, estimated over a 15-year period. The south coast results for 120MW showed an LCoE of €104/MWh and a 300MW LCoE of €77/MWh, which were both competitive results. The west coast results were: 120MW LCoE of €131/MWh and 300MW LCoE of €97/MWh. As found in EirWind, the west coast will ultimately cost more due to the site conditions, achieving a lower availability than the south coast. However, the resource potential is considerably higher; if this can be exploited this will considerably lower the LCoE.

High and low strike prices based on a long-term market view were estimated. The Co. Cork 120MW project (2025) was given a strike price range of €115-120/MWh. The Co. Cork 300MW project (2028)

[12] Simple LCoE calculation using a real discount rate (based on Internal Rate of Return - IRR) of 6.5%.
[13] A number of input figures were adjusted based on further feedback from industry. These are considered the latest data that will be used as the baseline information to develop in IDEA-IRL.
[14] Real IRR-based discount rate of 8%
[15] Real IRR-based discount rate of 7%

strike price estimate was €80-85/MWh, which suggests this scenario is cost competitive in light of the recent ORESS1 weighted average strike price of €86.05/MWh. The Co. Clare 120MW and 300MW projects were given strike price ranges of €145-150/MWh and 105-110/MWh respectively. The average revenue support cost was calculated for each scenario (considering a best, mid case 1 and 2 and worst case) and clearly indicates that the 300MW Cork Coast project (CS1.1) is always be the lowest cost per MWh and, depending on market prices, may even be lowest in absolute terms (in fact close to subsidy-free if market prices are sufficiently high). [7]

Average Revenue Support Cost	Units	Cork Coast CS1.0	Cork Coast CS1.1	Clare Coast CS2.0	Clare Coast CS2.1
Worst Case	€/MWh	63.44	26.81	93.44	51.81
Best Case	€/MWh	34.13	0.53	64.13	24.57
Mid 1	€/MWh	39.13	4.59	69.13	29.57
Mid 2	€/MWh	58.44	21.81	88.44	46.81

Figure 13.1 Average Revenue Support Cost of Pre-Commercial Floating Wind Case Studies (€/MWh, 2020 real) [7]

13.2 Data gap analysis

As the data in all previous sections are updated, the LCoE analysis will also require re-assessment. In addition to updated inputs, the LCoE calculation method may also be reviewed considering a more complex assessment including loan and interest repayments, tax and depreciation. This was previously not included given the limited knowledge of conditions in Ireland. However, it will be valuable to assess some different scenarios and business models in IDEA-IRL. In addition, updated strike price analysis and revenue support cost scenarios could be re-evaluated in the WP5 case-studies, particularly if it is possible to get more clarity on Irish price forecasts.

14 Socio-economic and supply analysis: policy recommendations

14.1 Previous work

[6] asserts that the critical path to offshore wind development is contingent on decisions the government will make now (2020), on investing in more personnel for key government departments and agencies. Up to 30 new personnel are recommended to be recruited in the next 18 to 24 months (2021-2022).

EirWind conducted a socio-economic study [31], exploring the opportunities associated with the development of the offshore wind sector in Ireland including potential environmental, social and economic benefits. The report focuses on the key areas of job creation, economic value and regional development potential with the aim of informing policy. This is the first study to quantify the GVA impact of offshore wind development for Ireland. Key findings of this report suggest that in 2030, 2.5-4.5GW of domestic offshore wind development would support between 4,620 and 8,316 jobs in the domestic supply chain and generate between €325m and €585m in GVA. Research also explored ways in which Ireland can maximise the socio-economic benefits and minimise negative impacts on stakeholders. A demographic assessment of the areas around ports with capabilities or potential capabilities in offshore wind reveals offshore wind development, and the development of an offshore wind supply chain, could be an effective means for addressing Ireland's regional economic imbalance and associated issues, such as rural depopulation and the decline of coastal communities. The report concludes with a number of recommendations for maximising the socio-economic benefits of offshore wind development including:

1. *Create an offshore wind supply chain stimulus package*
2. *Invest in port infrastructure to support*
    1. *manufacturing (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs),*
    2. *staging (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs), and*
    3. *O&M (e.g. at Shannon-Foynes, Waterford, Rosslare, Killybegs, New Ross, Rossaveal, and Fenit/Tralee)*
3. *Take a strategic approach to development of regional clusters around ports in preparation for the next wave of projects on the south and west coasts*
4. *Support R&D and the development of skills training programmes* [31]

In terms of maximising the socio-economic benefits for stakeholders, the EirWind project examined models for community co-ownership, including best practice in terrestrial and international cases (D4.6). However, a public version is not currently available.

The EirWind project undertook a study of the initial issues in the development of offshore wind in Ireland, finding that development of the supply-chain is essential, particularly manufacturing and port facilities [32]. [6] recommend developing at least three port clusters as catalysts for jobs and enterprise in the Irish Sea (e.g. Rosslare), the Celtic Sea (e.g. Cork Harbour) and the Atlantic coast (e.g. Shannon Foynes and Killybegs). The project identified a key lack of skills within the supply-chain with the need for a significant increase in training for offshore wind sector jobs. [33]

The EirWind project undertook studies of infrastructure and market development ([34]; [35]; [36]; [37]; [38]; [39]; [40]; [41]), providing key recommendations to inform policy. EirWind findings indicate that there is a route to market for up to 25GW of offshore wind in Ireland, with 6.5GW to 7.3GW possible by 2030. To achieve this, recommendations include that a national route to market study should be prioritised, considering how Ireland will become an energy exporter including a cost-benefit analysis of national investment scenarios for large-scale interconnectors and hydrogen. Regional plans are further envisaged for the three production zones (Irish Sea, Celtic Sea and Atlantic). These should contain the timelines for roll-out of commercial activities and pilot and demonstration-scale projects. At the local level, investment in key ports is a critical enabler; coupled with the opportunity to attract Foreign Direct Investment (FDI) e.g. into the Shannon region as a manufacturing hub. Exchequer funding and private investment will play an important role in providing the financial support to fully exploit the opportunity that the emerging offshore wind sector in Ireland represents for the taxpayer, the labour force and consumers. [6]

14.2 Data gap analysis

A long-term roadmap and policy recommendations (WP5) for FOWA deployment in Ireland needs to consider the above and a number of updates that have occurred since this work was done. Key updates include:

- EirGrid planned improvements for the grid to accommodate 4GW of Offshore Wind by 2024. The required improvements to facilitate FOWA with an associated timeline. There is also planning for a centralised offshore transmission system where transmission assets will be planned, developed, owned and operated by EirGrid. These developments should be considered.

- Updated route to market recommendations should consider recent developments e.g. the Celtic interconnector will begin construction in 2026, allowing 700MW of electricity to move between the countries, facilitating the Irish Offshore Wind export market.
- Training needs and job creation could be reviewed in light of updated information and developments e.g. new courses and plans.
- A number of strategic development plans are in place/progress to ensure port infrastructure can support fixed and floating offshore wind projects e.g. the Port of Cork [42] and Shannon Foynes [43]. Rosslare Europort recently received funding to develop an ORE facility. WEI and GDG's recent report explores the current funding challenges and the potential options for the involvement of the Government and State entities such as the Ireland Strategic Investment Fund (ISIF) in developing Irish ports to support the offshore wind sector. [44] Green Atlantic @ Moneypoint is a multi-billion Euro programme of significant investments on the County Clare site over the next decade. This is part of their long-term plan to transform Moneypoint into a green energy hub including 1.4GW of FOWA of the coasts of Cork and Kerry. These developments should be taken into account along with a more extensive assessment of the supply-chain, specific to FOWA needs.

Analysis would build particularly on the OPFLOW project, providing for more detailed and FOWA focused policy recommendations to support development pre and post 2030. IDEA-IRL aims to undertake this work assessing:

- The likely impact of supporting a demonstration project.
- The suitable level of financial support and/or seabed leasing fee.
- Floating specific amendments to the Marine Planning regime.
- Realistic local content requirements.
- Supports, policies and programs to maximise local content.
- Strategic infrastructure and investment timelines.

15 Environmental Impact and Life-Cycle Analysis

15.1 Previous work

The EirWind project undertook a number of studies examining the potential environmental impact of offshore wind farms in Ireland including:

- D4.11 Initial report on methodology for the assessment of seabird vulnerability to offshore wind farms in Ireland. A Collision Vulnerability Index (CVI) and a Displacement Vulnerability Indec (DVI) assessed the population level vulnerability to potential collisions with offshore wind turbines for all seabird species in Ireland. It has provided a series of collision and displacement vulnerability maps for all seabirds found in Irish waters, Figure 15.1.
- D4.12 Initial results for the assessment of seabird vulnerability to offshore wind farms in Ireland where two Collision Vulnerability Indices were calculated, one accounting for a turbine sweep zone starting at 20 m above sea level, and one accounting for a turbine sweep zone starting at 40 m above sea level.
- D4.13 Impacts from Offshore Wind Farms on Marine Mammals and Fish – A review of the current knowledge
- D4.14 Final report on impacts of offshore wind farms on seabirds and marine mammals

These are available for download at https://www.marei.ie/project/eirwind/.

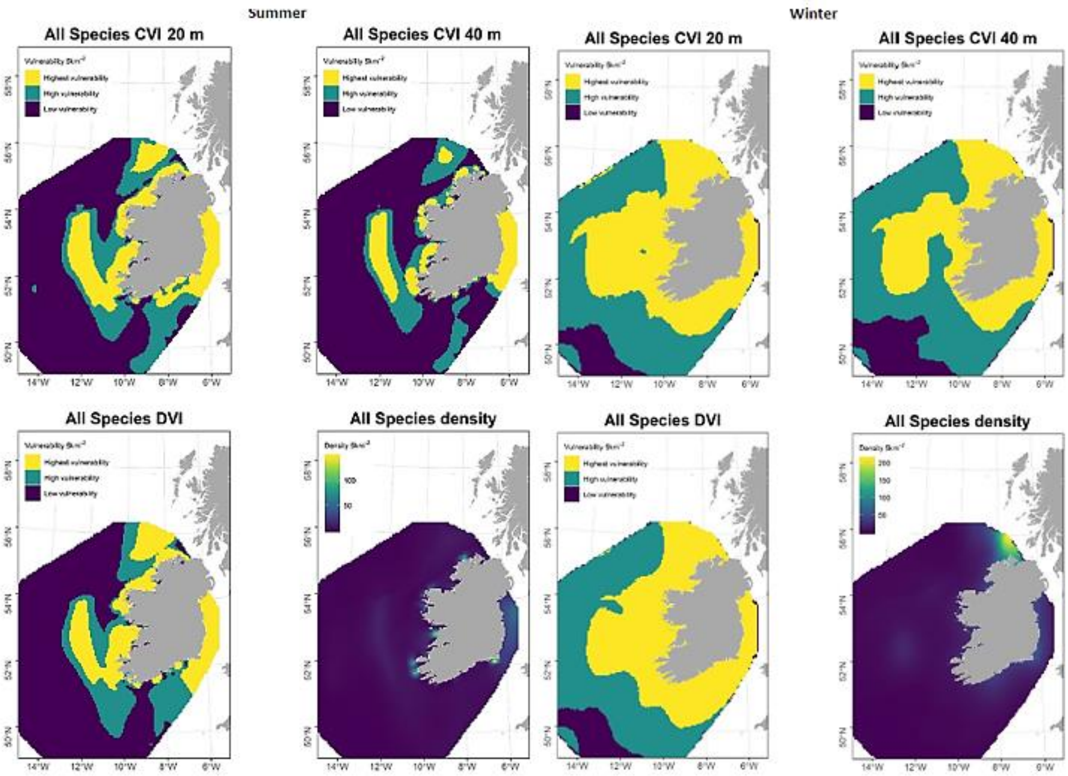

Figure 15.1: Seabird vulnerability to collision risk from the EirWind D4.11.

15.2 Data gap analysis

Further research should expand the above studies focused on the impacts on seabirds and marine mammals to examine FOWA specific impacts in areas such as noise, pollution and habitat. It could also include FOWA-specific Life-Cycle Analysis/Assessment (LCA) at all stages of a FOWA lifecycle from manufacturing, supply and use to the recycling or disposal of materials. IDEA-IRL intends to provide LCA input files for an open-source assessment model for the WP2 reference farms.

16 Conclusion

IDEA-IRL will significantly build on the work done in previous projects, particularly EirWind and OPFLOW. This deliverable has summarised the state-of-the-art, highlighting where information and studies need to be updated and key gaps in data exist. IDEA-IRL will seek to fill a number of these in collaboration with the IEA Task 49 IDEA. WP1-3 with gather additional data with stakeholder engagement through WP4; WP5 supply-chain survey; and the IEA task providing expert review and input. WP2 will employ array scale design tools developing reference farms that consider key potential FOWA innovations that could improve performance, reduce cost and accelerate commercial deployment. WP5 will conduct scenario-based modelling of Irish FOWA pathways to build a long-term roadmap for development from pre-commercial demonstrations to large-scale FOWA deployments.

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