Offshore wind potential in Ireland

A report for Department of the Environment, Climate and Communications

May 2025

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Executive summary

This document has been prepared by BVG Associates (BVGA), Gavin and Doherty Geosolutions (GDG), and AFRY for the Department of the Environment, Climate and Communications (DECC). Following the creation of the South Coast Designated Maritime Area Plan (SC-DMAP) in October 2024, DECC wishes to progress designating suitable areas for offshore development within Ireland's Maritime Area. To support this, we have undertaken preliminary analysis of the capacity of both fixed and floating offshore wind (OSW) that could practically be developed in different regions. This analysis establishes the areas of technical feasibility for OSW development and provides a high level assessment of potential areas for project development to inform planning; rather than an in-depth marine spatial planning process, which will be led by DECC as part of the DMAP development process. To complement this analysis, we also provide recommendations for supporting the OSW industry in Ireland. These include an assessment of case studies from existing floating OSW projects in other markets, a review of Ireland's supply chain readiness for both fixed and floating OSW, and the identification of opportunities for collaboration between Ireland and other countries to help support the OSW industry. For the avoidance of doubt, this report should not be considered a DECC policy paper, its purpose is to support decision making.

Capacity assessment

The analysis concluded the fixed and floating offshore wind capacities shown in Figure 0.1 and Table 0.1 are possible. "Existing planned capacity" in Table 0.1 includes all phase 1 projects and capacity planned under the South Coast DMAP. Figure 0.1 shows additional fixed and floating capacities we consider feasible, excluding existing planned capacity.

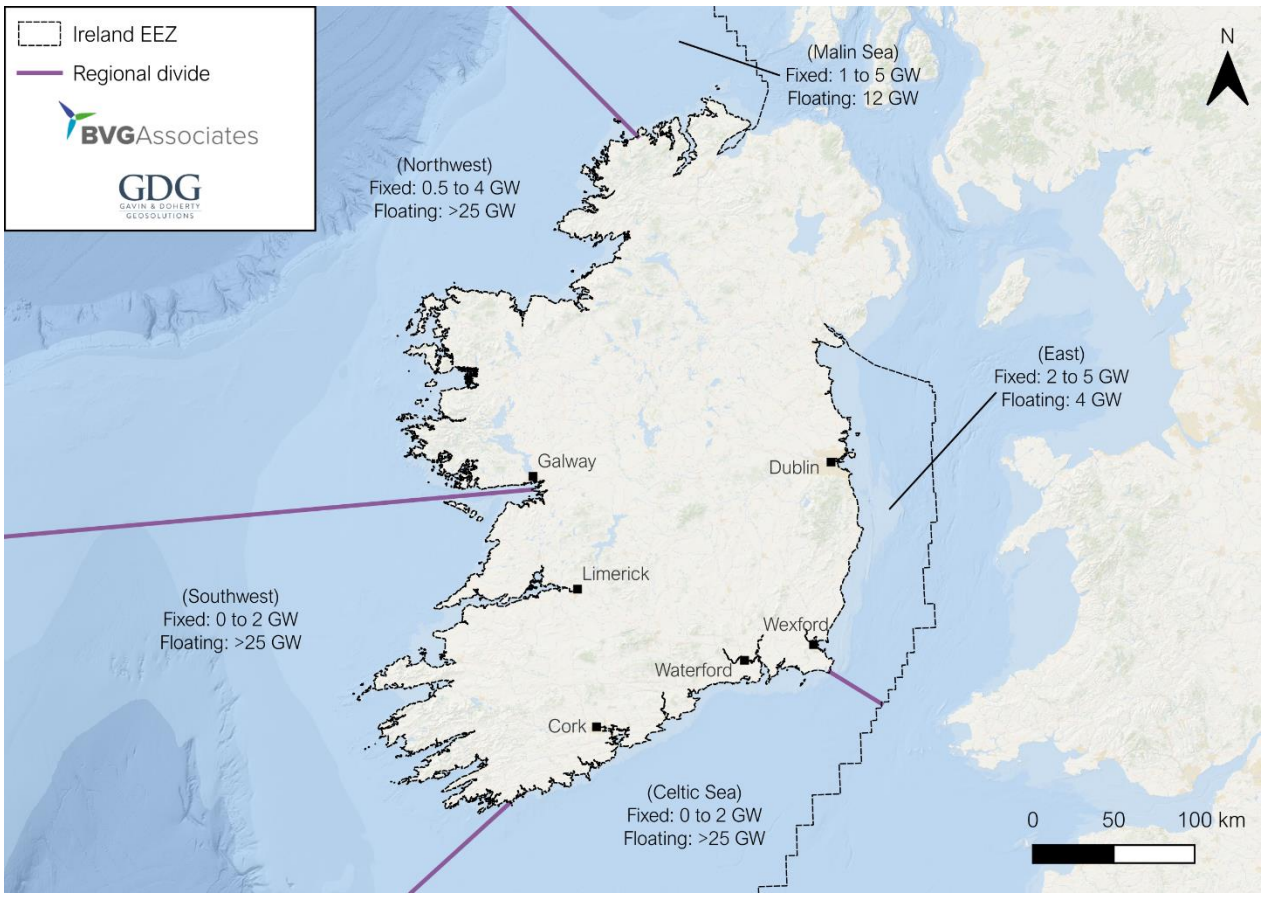

Figure 0.1 Fixed offshore wind regional capacities (excluding existing planned capacity).

Table 0.1 Offshore wind regional capacities.

Region	Existing planned capacity (GW)	Additional possible fixed capacity (GW)	Additional possible floating capacity (GW)
East	3.8	2 to 5	4
Celtic Sea	4.5	0 to 2	>25
Southwest	0	0 to 2	>25
Northwest	0	0.5 to 4	>25
Malin Sea	0	1 to 5	12
	8.3	3.5 to 18	>90

Fixed OSW: Short-Term Potential

Ireland's east coast emerges as the most viable near-term option for fixed OSW development. Its proximity to demand centres and shorter transmission distances could reduce offshore infrastructure costs, making it a practical choice for initial projects. However, further analysis and collaboration with EirGrid are necessary to confirm this potential.

The north coast offers higher fixed OSW capacity potential but faces challenges due to extensive and potentially significant grid infrastructure needs, due to the distance to large demand centres, or reliance on new flexible and responsive demand centres like hydrogen electrolysers. The Celtic Sea holds some potential but has been largely covered under the SC-DMAP process, leaving fewer opportunities for new deep water fixed OSW projects. Smaller regions, such as the southwest and northwest, are constrained by size and proximity to shore, potentially impacting their viability, although a number of smaller projects are possible.

Floating OSW: Long-Term Potential

Floating OSW offers greater spatial flexibility due to Ireland's large area of deeper waters, with the Celtic Sea likely the most favourable region for commercial-scale floating projects. Its more moderate metocean conditions enhance feasibility, while proximity to Great Britain (GB) and Continental Europe supports interconnection opportunities.

Despite this potential, floating OSW development faces significant challenges. Floating OSW in particular, must mature to withstand harsher conditions in the west coast's high-wind and wave environments. Pathfinder projects should be clear about what learning they are trying to gain to get the best results. This could be developing understanding of operating in difficult metocean conditions, or helping to develop and upskill the supply chain.

Pathfinder projects in the west could help mitigate risks and advance technical capabilities, but care should be taken not to slow down development of fixed or commercial-scale floating OSW as developments waits for learnings from the pathfinder project to be gathered. Ireland does not need to build pathfinder projects to help develop floating OSW technologies as this is already being done, or has already been done, in other countries. Reasons to develop pathfinder projects could be to:

- Provide opportunities for the participation and upskilling of domestic supply chain, in preparation for commercial-scale future projects
- Demonstrate the installation and operation of technologies in the challenging conditions of Ireland's west coast, to de-risk commercial-scale developments in the Celtic Sea and on the west coast, and
- Contribute to job creation in Ireland.

If a pathfinder is developed, delivery could further be sped up by prioritising development where data is already available, or where there is sufficient grid capacity for a small demonstrator site already available with limited upgrades or new transmission required.

Scalability should also be considered, allowing smaller demonstration projects (e.g. 200 MW) to expand to larger capacities (e.g. 500 MW or more) as understanding of the conditions, grid infrastructure and other enabling factors mature.

Floating OSW strategy: Fast follower over early mover

Ireland is better suited as a fast follower, rather than an early mover, in floating OSW. Fixed OSW technology is currently better established and more economic to implement. It is therefore the best strategic option in the near term. By building on technological advancements and cost reductions achieved by other nations, Ireland can efficiently scale deployment of floating OSW once the market matures. Strategic investments in port infrastructure, skills development, and development of a DMAP or DMAPs that can facilitate floating OSW as well as fixed, will position Ireland to capitalise on the mid-2030s opportunities while minimising risk and financial burden. In addition, Ireland will have built up significant expertise in delivering fixed OSW development in the near term, which will make it easier to deliver the more challenging floating OSW in the longer term.

This pragmatic approach balances ambition with feasibility, ensuring Ireland's competitiveness in the growing offshore wind industry.

Ultimately, Ireland's focus should remain on strategic readiness: enabling the west coast and Celtic Sea to host commercial-scale floating OSW projects once the technology and market conditions align, likely in the mid-2030s. **Capturing this opportunity requires action starting from now.** OSW development has a long lead time, and spatial planning to allow industry confidence and public understanding is crucial to ensure readiness to begin developing these projects. Identifying areas for future floating projects in the near term will allow a clear pipeline of projects to be seen, allowing strategic upgrade of the grid, supporting infrastructure and companies to prepare to support the industry. This pragmatic approach ensures Ireland remains competitive in floating OSW without incurring undue risk or financial burden.

Supply Chain development

Ireland's supply chain will play a critical role in supporting the country's ambitious OSW deployment targets of 5 GW by 2030, 20 GW by 2040, and 37 GW by 2050. A comprehensive analysis of Ireland's OSW supply chain highlights significant opportunities for domestic economic benefit and employment growth. However, realising these benefits requires targeted investments and strategic interventions to address infrastructure, skills, and competitive gaps.

Key opportunities identified include project development, consenting, engineering services, and operations and maintenance (O&M). These areas leverage Ireland's existing expertise and local advantages, particularly in long-term O&M, which offers stable economic opportunities over a wind farm's lifecycle. Additionally, potential exists for Irish participation in floating foundation assembly, marshalling, and select component manufacturing, such as synthetic ropes and towers. Nevertheless, high barriers to entry and strong competition limit Ireland's role in more complex manufacturing and installation phases, which will rely heavily on foreign expertise and infrastructure.

To enhance supply chain readiness, Ireland should focus on upgrading port infrastructure, fostering skills development, and supporting local firms through targeted investment incentives. Pathfinder floating OSW projects present a potential opportunity to build domestic capability and attract international expertise. However, these projects will require a confirmed pipeline of commercial-scale initiatives and scalable infrastructure upgrades to ensure long-term viability and competitiveness.

Government support, including clear strategic intent, industrial policy, and incentives, is essential to attract investment and grow Ireland's supply chain. While there may be limited ability to directly mandate the use of domestic suppliers, fostering a business-friendly environment and demonstrating strong governmental engagement can bolster investor confidence and local participation. By focusing on its strengths and leveraging early-stage projects as stepping stones, Ireland can position itself as a competitive player in the global OSW industry.

Collaboration opportunities

Collaboration with neighbouring regions, particularly GB, Northern Ireland, and European countries, offers significant benefits:

- GB and Celtic Sea:
  - Coordinated port investment could enable a multiport strategy for east coast and Celtic Sea projects, however this will require the cooperation of a number of private companies and the two governments.
  - Interconnections to GB create the possibility of hybrid[1] projects to connect into the interconnector, potentially alleviating grid constraint.
  - Enabling workforce mobility as much as possible will allow skills shortages to be alleviated.
- Northern Ireland:
  - Further shared transmission infrastructure could unlock the sea bed in the north of the island to supply energy to both jurisdictions.
  - Cross-border skills development could help to alleviate skills shortages.
- Europe:
  - Sharing R&D data and expertise for floating OSW can help strengthen Ireland's supply chain and reduce risks.
  - Interconnections to Europe create the possibility of hybrid projects to connect into the interconnector, potentially alleviating grid constraint and increasing energy security.
  - Shared training programmes could help to alleviate skills shortages.

Interconnection opportunities

Ireland's National Policy Statement on Electricity Interconnection outlines plans to develop its interconnectors to other jurisdictions.[2] Generally, it is more economically efficient to interconnect with closer markets due to the reduced cable length involved which lowers costs. From this perspective, Great Britain (GB) and France appear to be the most promising prospects for interconnection with Ireland.

Based on an assessment of underlying demand, many markets around Europe appear a good match for Irish export via interconnection, with GB a particularly attractive partner market given the high correlation of Irish exports with underlying GB demand. When examining residual demand however, which accounts for the impact of projected renewable generation in partner markets, there is no single market that is both large and exhibits a high correlation with Irish offshore exports.

Despite this, there is likely to be a case for additional interconnection, especially with GB and France, due to the advantages of geographically dispersed generation and access to different weather systems at different times on an hour by hour basis. This rationale was explored in more depth in AFRY and BVGA's previous *Offshore renewables surplus potential* study for DECC.[3] Additional interconnection to France is being actively explored by both countries.[4]

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[1] Hybrid projects are those connected to an interconnector, with the potential to export to more than one jurisdiction

[2] National Policy Statement on Electricity Interconnection, DECC, July 2023, available online at: https://www.gov.ie/en/publication/3d96f-national-policy-statement-on-electricity-connection-2023/

[3] Offshore renewables surplus potential WS2 – Electricity interconnection quantitative assessment report, AFRY and BVG associates, November 2023, available online at: https://www.gov.ie/pdf/?file=https://assets.gov.ie/280994/5b51e730-c63c-4055-9a81-69d4a0ac7ecd.pdf

[4] Ireland and France sign Joint Declaration of Intent on 'Energy Transition Cooperation', DECC, November 2023, available online at: https://www.gov.ie/en/press-release/0ce3f-ireland-and-france-mark-beginning-of-construction-work-on-celtic-interconnector-and-sign-joint-energy-declaration/#:~:text=The%20declaration%20provides%20a%20framework,climate%20neutral%20continent%20by%202050

Looking further into the future, there may be a case for interconnection to markets that are further afield, albeit previous economic analysis suggests the economic case for these interconnectors is not necessarily favourable. Of particular interest are Belgium and Spain, where state-backed stakeholders may be in a position to accept a lower return on their investment than the private sector would typically seek. Interconnection between Ireland and Belgium is being explored under a multilateral approach, including GB.[5]

Interconnection with Spain in particular, offers potential energy security benefits to Ireland due to its solar-heavy generation fleet, which is uncorrelated with Ireland's wind-focussed system.

[5] Ireland, Belgium and the UK increase their cooperation on interconnection and renewables, Department of the Environment, Climate and Communications, May 2024, available online at: https://www.gov.ie/en/press-release/505a1-ireland-belgium-and-the-uk-increase-their-cooperation-on-interconnection-and-renewables/

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1. Introduction

This document has been prepared by BVG Associates (BVGA), Gavin and Doherty Geosolutions (GDG), and AFRY for the Department of the Environment, Climate and Communications (DECC).

Following the creation of the South Coast Designated Maritime Area Plan (SC-DMAP) in October 2024, DECC wishes to progress designating suitable areas for offshore development within Ireland's Maritime Area. To support this, we have undertaken preliminary analysis of the capacity of both fixed and floating offshore wind (OSW) that could practically be developed in different regions. This analysis establishes the areas of technical feasibility for OSW development and provides a high level assessment of potential areas for project development to inform planning; rather than an in-depth marine spatial planning process, which will be led by DECC as part of the DMAP development process.

To complement this analysis, we also provide recommendations for supporting the OSW industry in Ireland. These include an assessment of case studies from existing floating OSW projects in other markets, a review of Ireland's supply chain readiness for both fixed and floating OSW, and the identification of opportunities for collaboration between Ireland and other countries to help support the OSW industry. For the avoidance of doubt, this report should not be considered a DECC policy paper, its purpose is to support decision making.

2. Locations for offshore renewable energy development around Ireland

Understanding potential OSW capacity in Ireland is key to enabling development. This section of the report outlines the methodology used for this assessment and presents the capacities calculated. This analysis is intended to be indicative to assist in planning. Establishment of DMAPs will require a full marine spatial planning (MSP) process, with appropriate stakeholder consultation included.

2.1. Methodology

2.1.1 Study area

To assess the OSW potential of Ireland, a study area first had to be defined. This study area represents the area for which data needs to be gathered. For this project, the study area was defined considering both fixed and floating OSW projects. Typical project examples representative of the Irish market were created to aid this analysis with the following parameters:

- A commercial-scale fixed OSW project with an installed capacity of approximately 1 GW project, to be developed in 2035, and
- A commercial-scale floating OSW project with an installed capacity of approximately 1 GW project, to be developed in 2035.

Further details of the assumptions used in each project are given in Section 2.1.3. Based on these example projects, the study area was defined as Ireland's coastline up to the edge of its Exclusive Economic Zone (EEZ), excluding the continental shelf extension, this allows us to assess the full extent of potential capacity within Irish seas. This area is shown in Figure 2.1.[6]

[6] The continental shelf includes the sea bed that extends beyond its territorial sea to the outer edge of the continental margin, or to a distance of 200 nautical miles. Article 76 - Definition of the continental shelf, UN, available online at: un.org/depts/los/convention_agreements/texts/unclos/part6

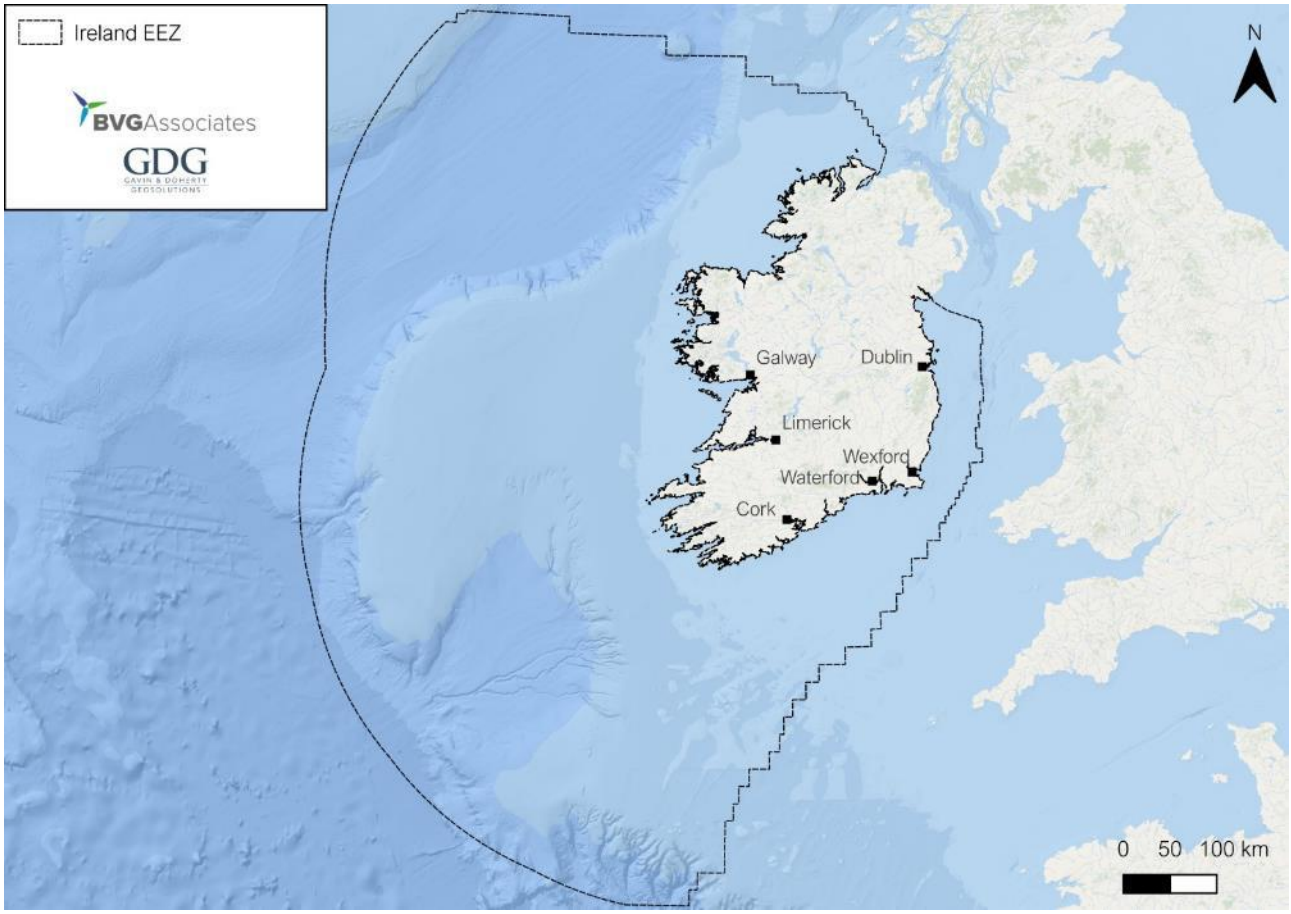

Figure 2.1 Study area.

2.1.2 Data gathering

To assess the potential OSW capacity within the study area, a wide range of data was gathered. This includes inputs to the levelised cost of energy (LCOE) analysis, such as wind speeds, and data on technical aspects potentially constraining to OSW, such as bathymetry. In addition, the assessment considered data on designated sites and protected areas which may be anticipated to be more sensitive to development, including OSW development, compared to non-designated and protected sites. This data is used to inform the technical feasibility assessment of the maritime area for offshore wind.

Metocean

Metocean data includes wind speed, wave, and tidal current data. This was gathered to inform the LCOE analysis, notably windspeed inputs to the energy production assessments, but also to highlight where more extreme conditions can be expected. Areas of higher mean windspeeds may more frequently experience windspeeds in excess of maximum turbine operable windspeeds (approximately 25 m/s for current technology) and experience wind and wave conditions that will pose a higher risk to the conditions of the turbines and associated structures. Extreme conditions impact cost, as they require more robust infrastructure and make installation, operations, and maintenance more challenging.

The windspeed data used was based on Global Wind Atlas' hindcast dataset at a 150 m height. This is shown in Figure 2.2.

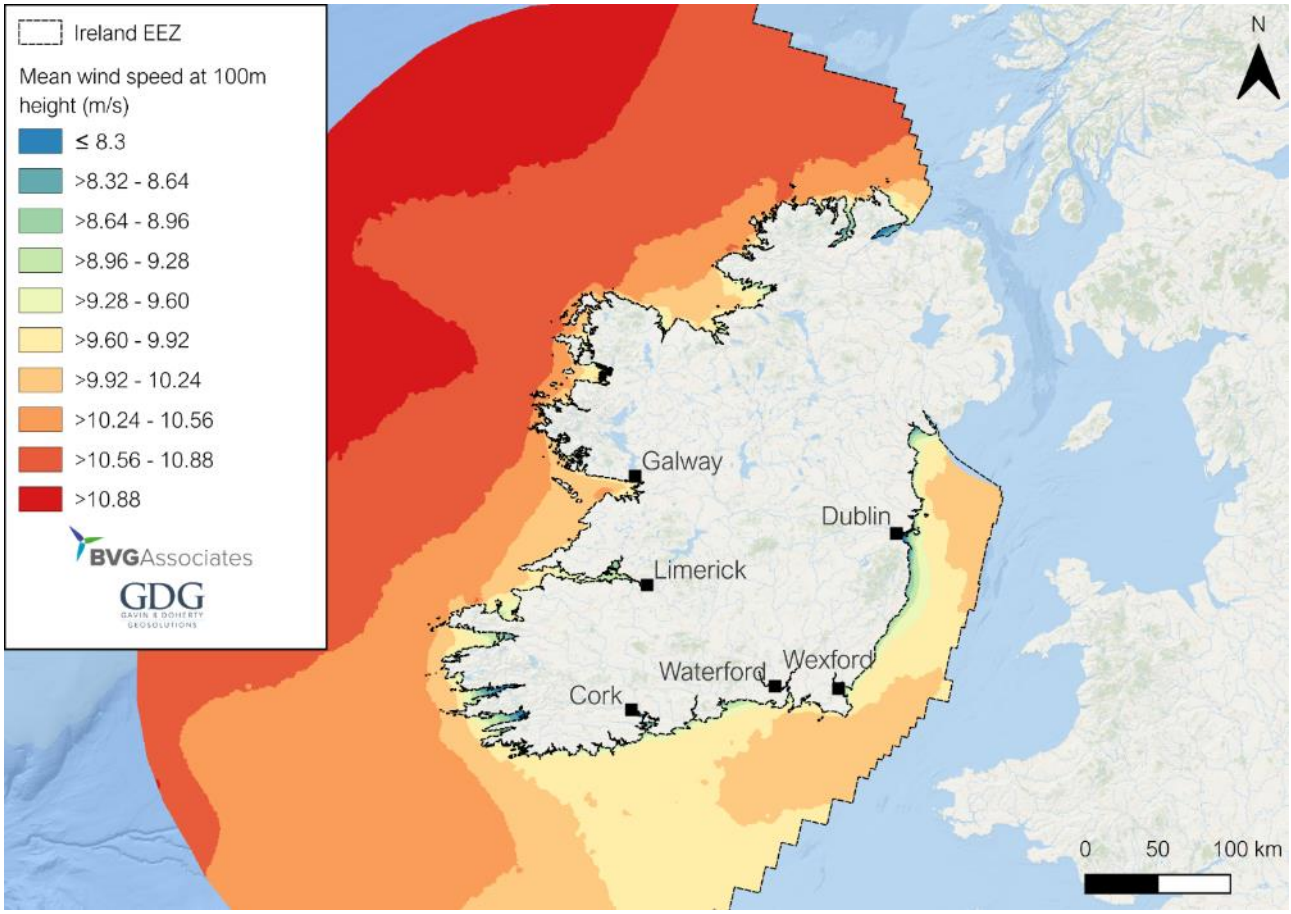

Figure 2.2 Mean wind speed data at 100m height.

Technical limitations

Technical limitations were also mapped. This includes limitations on where fixed and floating OSW can reasonably be placed, such as depths, but also where OSW development would not be possible as the sea bed is occupied by other infrastructure. Data assessed included:

- Bathymetry data, highlighting areas suitable for fixed or floating OSW projects (assumed at <80 m for fixed and 60-1000m for floating).[7]
- Shipwrecks
- Authorised aquaculture sites
- Telecommunication cables
- Interconnectors and cables
- Oil and gas exploration and activity
- International Maritime Organisation (IMO) routeing measures
- Traffic separation schemes
- Dredge and dumping sites
- Unexploded ordnance (UXO)
- Existing or under development windfarms (including the SC-DMAP zones and Merchant Phase 1 projects)

[7] These limits are economic rather than technical boundaries, and should be considered indicative only. The boundary between where fixed and floating is preferable may vary as technology evolves. The 1000m maximum depth limit applied to floating is not a technical maximum, but given abundant seabed availability at lower depths where deployment is more economic, simply represents a reasonable outer bound for this study.

- Offshore infrastructure such as harbours, marinas, anchorage, fishing infrastructure, buoys and beacons, and
- Internationally recognised marine boundaries.

Figure 2.3 and Figure 2.4 show the technical constraints mapped.

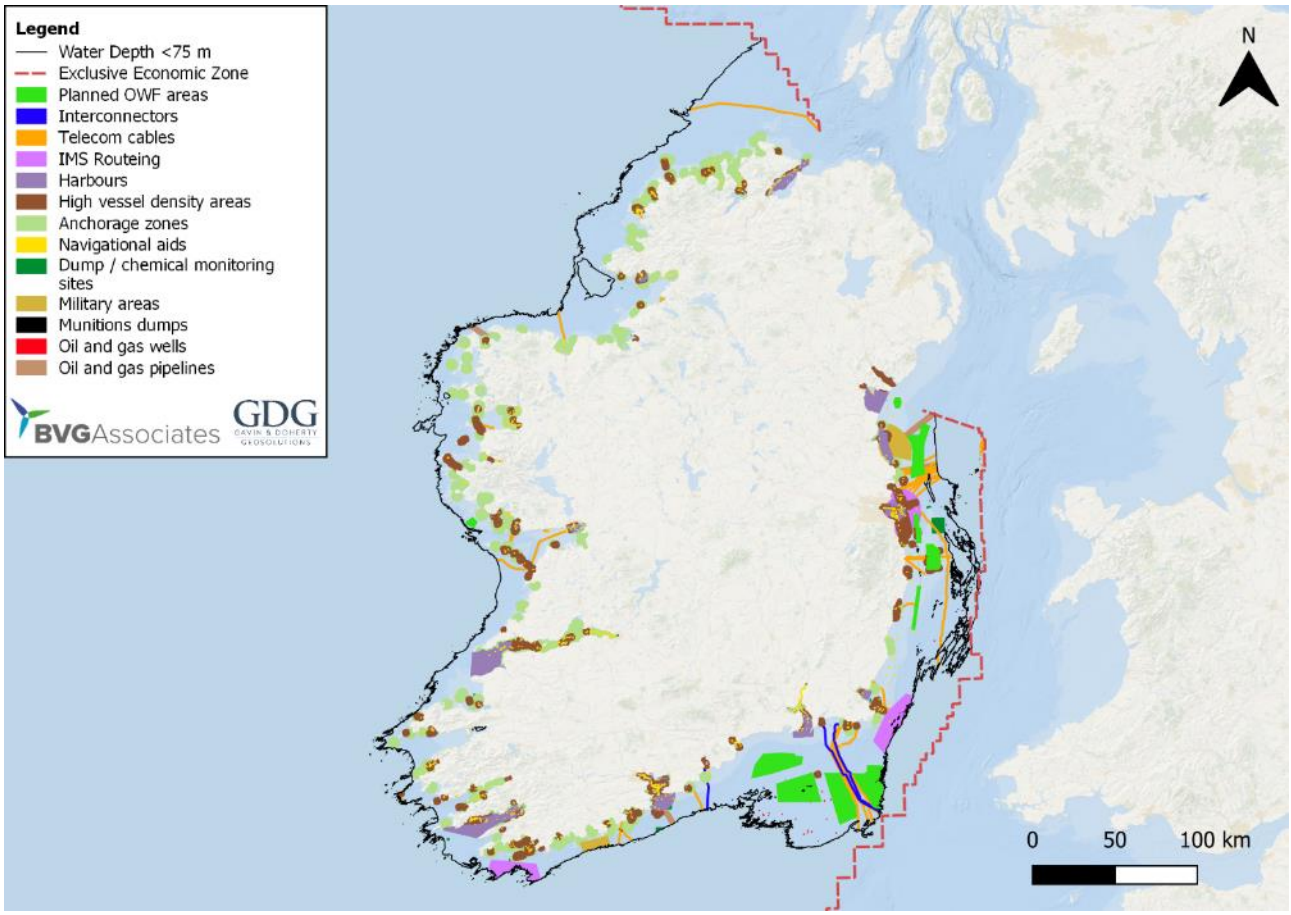

Figure 2.3 Fixed OSW technical limitations.

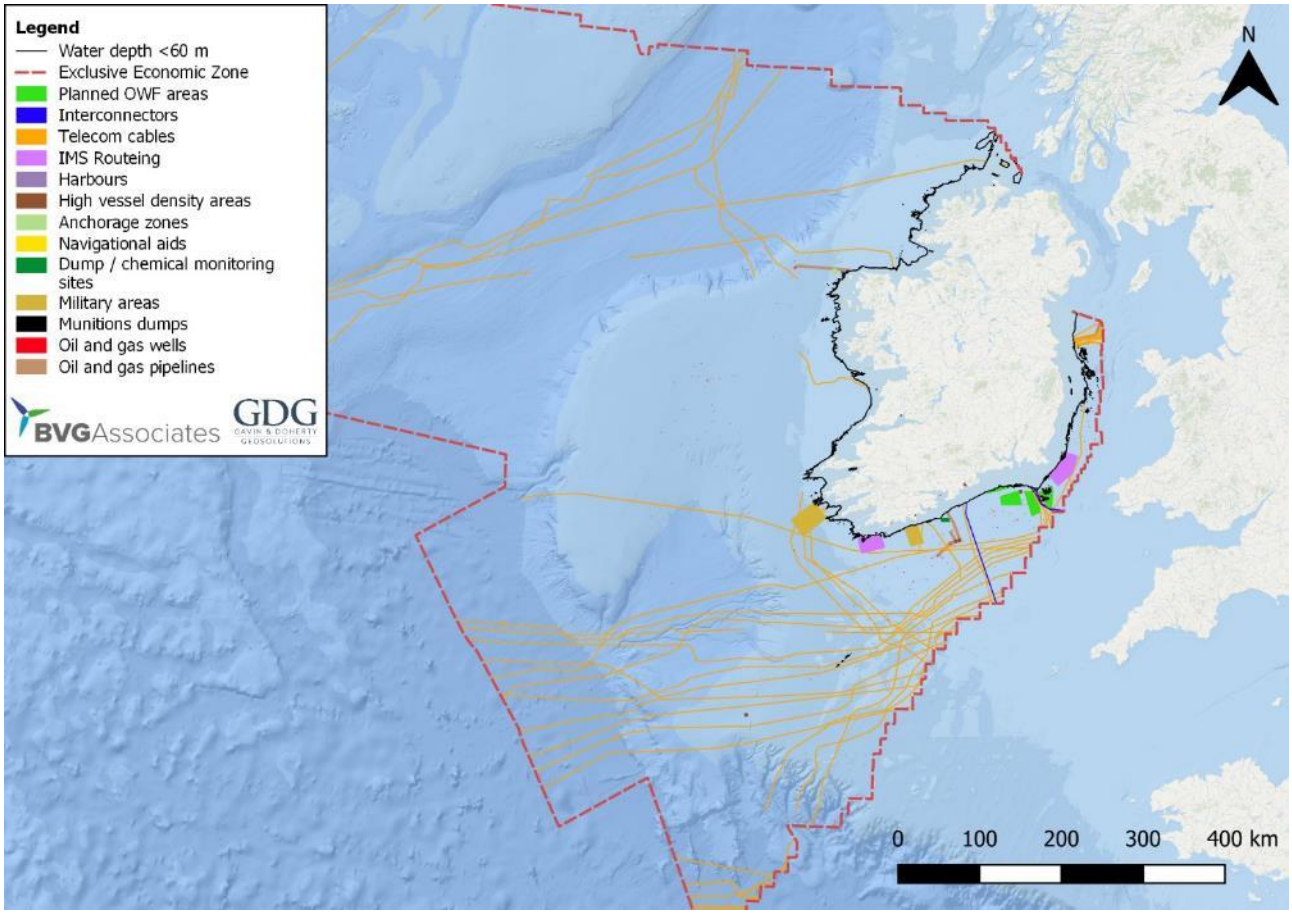

Figure 2.4 Floating OSW technical limitations.

Designated sites

As well as considering technical limitations, designated sites may also be less desirable for OSW development. We therefore gathered data layers for the following sites:

- Marine special protection areas
- Special protection areas
- Offshore special areas of conservation
- Special areas of conservation
- Ramsar sites
- United Nations Educational, Scientific and Cultural Organisation (UNESCO) Geoparks
- Biosphere
- World heritage sites, and
- Natural heritage areas.

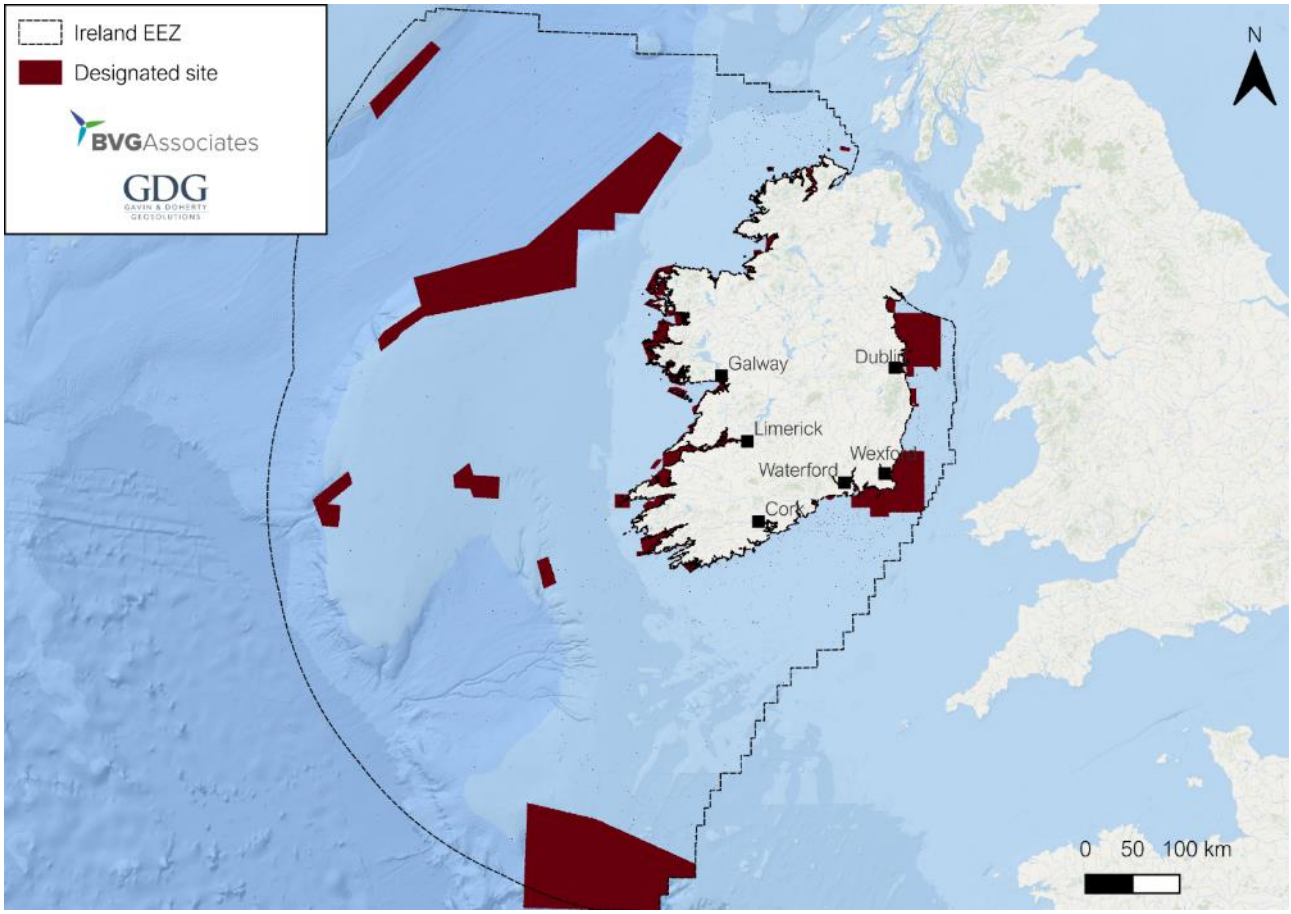

Figure 2.5 Designated sites.

In addition to technical limitations and designated sites, we also considered interference with other marine users when assessing potential OSW capacities. This should be assessed and consulted on in more depth as part of a DMAP development process.

2.1.3 Levelised cost of energy mapping

In addition to identifying areas with technical limitations and designated sites, it is important to identify the more economically attractive locations for offshore wind. A generic assessment of this is best delivered through the derivation of a spatial LCOE layer based on representative project assumptions, as discussed in Appendix A. Below we discuss the major impacting factors on LCOE and present our spatial analysis.

General levelised cost of energy trends

Figure 2.6 shows general LCOE forecasts for both fixed and floating OSW between 2030 and 2050. Fixed OSW is likely to remain below floating OSW, though the difference is anticipated to narrow over time.

It is expected that fixed OSW will steadily decrease in cost, likely as a result of technological advancements, economies of scale, and supply chain maturity. It will likely remain the more cost-effective option through to 2050 with LCOE predicted to decrease by about 32%.

Floating OSW will see a sharper decrease in cost, with LCOE reduction of approximately 50% between 2030 and 2050. Although it is projected to remain more expensive than fixed offshore wind, significant cost reductions can be expected between 2030 and 2040.

Overall, the LCOE for both types of technologies are expected to decrease, due to innovation and global competition.

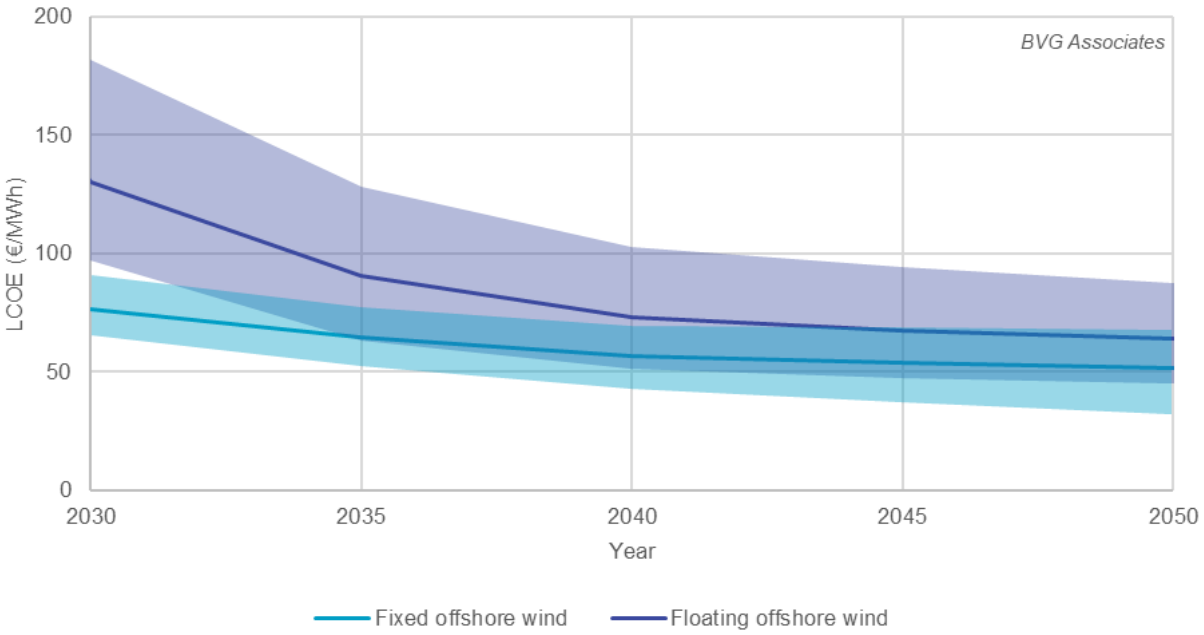

Figure 2.6 BVGA's LCOE forecast for floating and fixed offshore wind from 2030 to 2050.

Major contributors to levelised cost of energy

There are many factors which affect both the capital and operational costs of OSW development. The selection of offshore wind sites where the cost of energy is lower is important in ensuring Irish consumers' energy bills are minimised, as well as maximising the competitiveness of Irish energy on an international stage, enabling energy export. Some of the major factors which affect wind farms costs are discussed below.

- Depth – Deeper waters increase the costs of construction and installation significantly. In shallower waters, simpler and more cost-effective foundation designs, such as monopiles, can be used. However, as water depth increases, jacket structures become more common, which are more complex and expensive due to the need for multiple legs and cross-bracing to ensure stability. Additionally, deeper water projects necessitate larger, specialised vessels, as more standard vessels are not capable of handling the size of the components needed. The increased material and installation challenges directly drive up the LCOE by raising capital costs.
- Distance from shore – Offshore wind farms located further from the coast face higher costs due to the longer distances required for grid connection, installation, and Operations and Maintenance (O&M). One major expense is the longer export cables, and potential reactive compensation stations, needed to connect the wind farm to the onshore grid. These cables, especially high-voltage direct current (HVDC) systems necessary for far-offshore projects, are costly to manufacture and install. The further the wind farm is from shore, the more expensive and challenging these grid connections become. Additionally, longer transits for installation vessels increase transportation costs, as more fuel, time, and labour are required to move equipment and personnel to and from the site. Distance also impacts O&M costs, as vessels must travel greater distances for routine maintenance or repairs, leading to longer downtimes and higher costs for each visit. Finally, further offshore, more extreme metocean conditions are often found. While this can lead to higher wind speeds and increased energy production and lowering LCOE, it also requires more robust foundation and turbine designs to survive the increased loads, as well as higher maintenance costs due to the increased distance to visit the site. This adds to the overall operational costs, generally pushing the LCOE higher for wind farms located further offshore.
- Fixed vs. floating foundations – While fixed-bottom foundations are the standard for OSW in shallower waters, floating offshore wind technology is emerging as a solution for deep-water sites. However, it is currently a higher-cost option. Floating foundations are large and complex steel or concrete structures which

support wind turbines in a dynamic offshore environment. This makes them generally more expensive than fixed foundations. Floating foundations are still in the early stages of commercial deployment and have not yet been implemented at scale. As a result, floating OSW projects are subject to higher financing costs due to the increased risks associated with new and unproven technology. Investors and lenders typically demand higher returns to compensate for this risk, driving up LCOE. Floating turbines also introduce additional complexities, as the same challenges faced by fixed-bottom offshore wind – such as long cables, metocean conditions, and distance from shore – still apply. However, the potential to deploy floating turbines in deeper waters reveals new areas with stronger, more consistent wind resources, which could eventually lower costs as the technology matures. Despite this potential, the current higher capital costs, installation challenges, and financing risks make floating OSW projects more expensive than fixed-bottom ones.

- Turbine size – Turbine size plays a significant role in the LCOE of OSW projects. Larger turbines generate more electricity per unit, reducing the number of turbines needed to produce the same amount of power, leading to savings in installation and O&M costs. Fewer, larger turbines also mean lower cabling and infrastructure expenses. As a result, larger turbines typically contribute to a lower LCOE, making offshore wind projects more economically attractive and competitive as the industry scales up. Over recent years, there has been a clear trend toward larger turbines. Turbine capacities have increased from around 3 to 4 MW a decade ago, to models that now exceed 15 MW. While some manufacturers are asserting that this trend should slow or stop, to focus on optimising for existing sizes, others are planning even larger models for the near future. It is likely that the trend for increased size will continue in the near future. The industry shift toward larger turbines has helped to reduce LCOE and make offshore wind a more viable and commercial option for energy generation. Figure 2.7 shows BVGA's forecast of average turbine size in Europe.

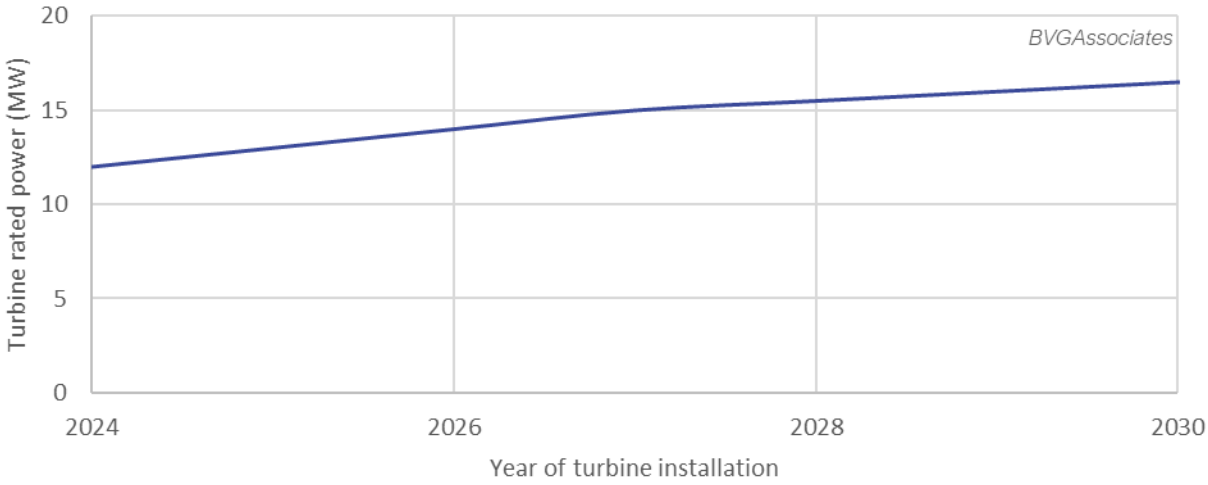

Figure 2.7 Forecast of turbine size in Europe.

2.2. Results

2.2.1 LCOE spatial analysis

Two LCOE maps were produced, for fixed and floating projects separately. These use comparable inputs aide from foundation choice to allow for easy comparison. Inputs are shown in Table 2.1.

Table 2.1 Representative projects for levelised cost of energy analysis.

Parameter	Units	Inputs used	
Commercial operation date	-	2035	
Project capacity	*MW*	1000	
Turbine rating	*MW*	18	
Foundation type	-	<75 m water depth: LCOE optimal choice between monopile and piled jacket	>75 m water depth: Steel semi-submersible + three-point synthetic and steel chain semi-taut mooring and piled anchors
Transmission type	-	LCOE optimal choice between HVAC and HVDC accounting for differences in CAPEX and transmission losses	
Offshore transmission distance	*km*	Nearest point to shore	
Onshore transmission distance	*km*	30	
Maintenance vessel strategy	-	LCOE optimal choice between crew transfer vessel or service operation vessel O&M strategies	
Analysis boundary limits	-	1000 m water depth 350 km from construction port Ireland Exclusive Economic Zone	
WACC (real)	-	6%	
Lifetime	*years*	34	

Projects at 75 m water depth are currently at the technological and logistical limitations of fixed offshore wind, however we have assumed technology developments post 2035 will allow fixed projects at this depth.

While future projects may vary in these assumptions, the locational trends of where higher/lower LCOE sites are, will not change. For example, the choice of floating foundation type may not be the dominant design by 2035 when projects are commissioned, however these assumptions remain valid in assessing the comparative spatial LCOE across Irish waters.

Notably, we have not included distance to specific grid connection points and cable landfall points as an input. Instead, this is approximated as distance to shore. As Ireland's grid is currently heavily constrained it is likely that new grid infrastructure will be required. We therefore could not assess where this infrastructure will be built, so a suitable proxy was used. It is likely in practice that the selection of offshore wind development zones through the marine spatial planning process will inform EirGrid's grid reinforcement plans.

The LCOE maps are shown in Figure 2.8 and Figure 2.9. A relative LCOE colour band, with the same range for both fixed and floating projects, is shown. Areas which score 1 represent the lowest LCOE and 10 the highest, with all other scores are linearly distributed between these values. The LCOE of red '10' areas are approximately 80 % more than the blue '1' areas. Therefore, each colour gradient represents an LCOE increase of approximately 8 %.

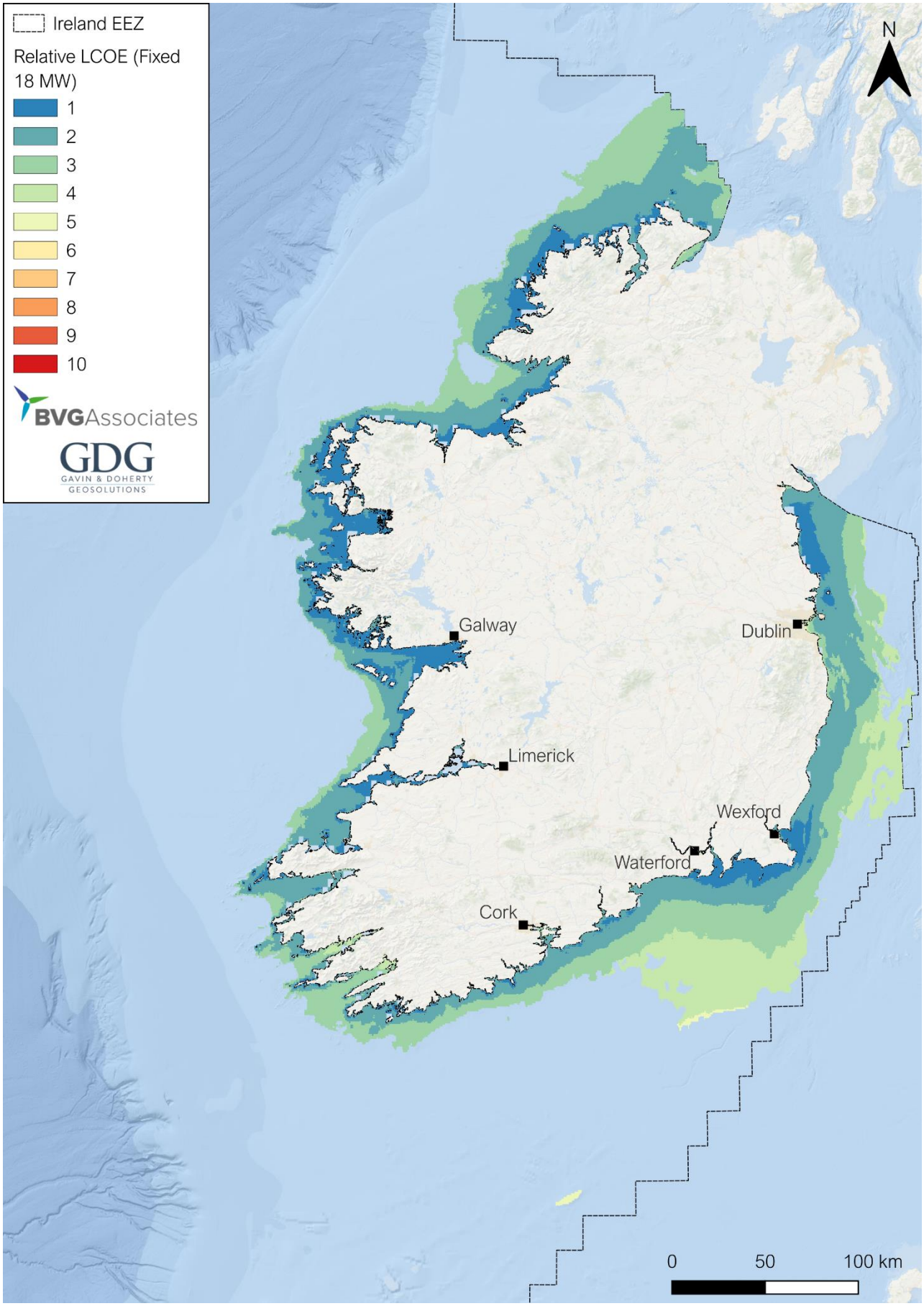

Figure 2.8 Fixed offshore wind levelised cost of energy map.

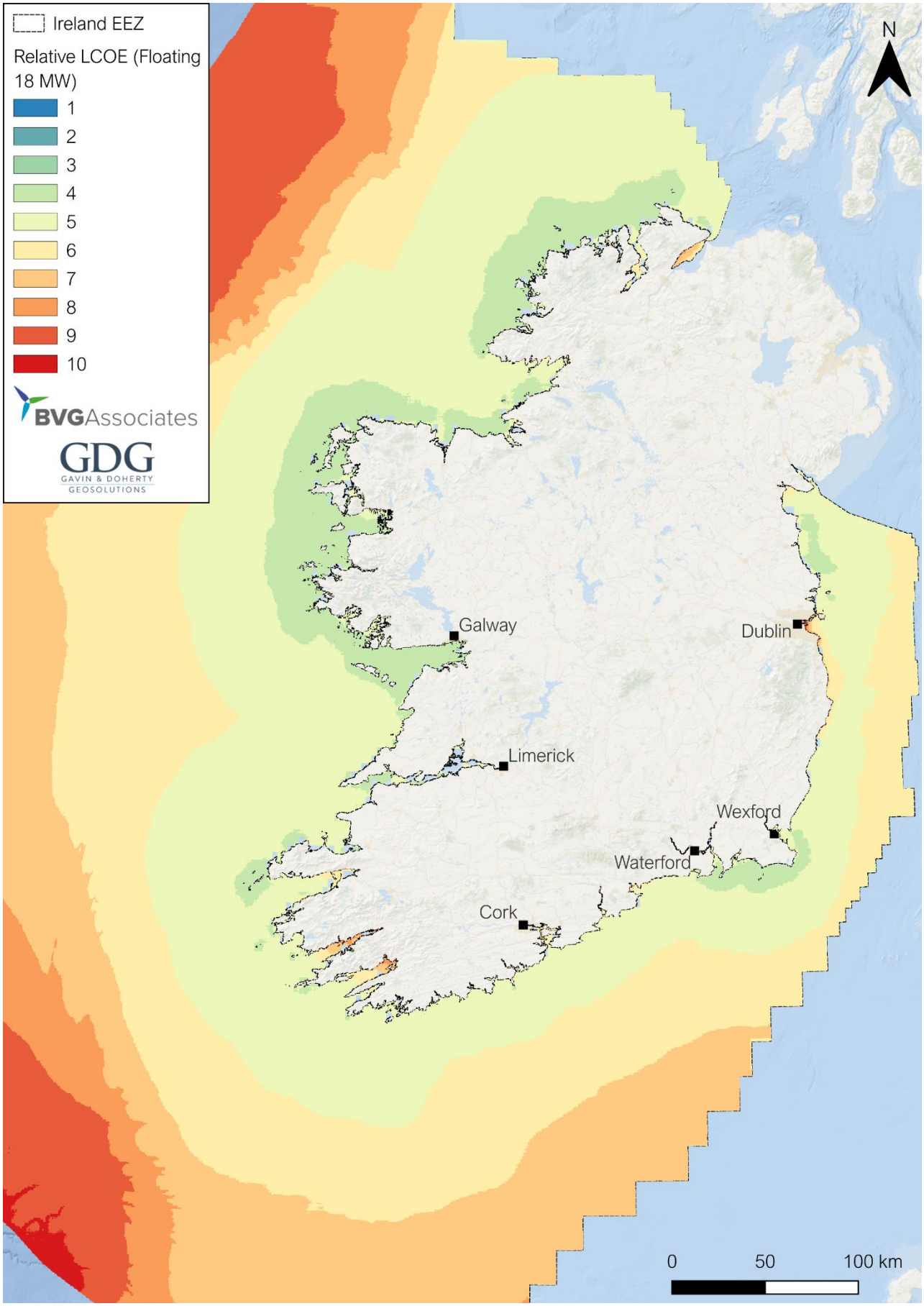

Figure 2.9 Floating offshore wind levelised cost of energy map.

Fixed OSW is cheaper than floating in all cases where fixed wind is technically possible. Floating OSW is approximately 10 to 25 % more expensive than fixed in areas where both are possible. Further offshore the floating OSW cost increases to a further 45 % compared to the most expensive fixed OSW area and 80 % compared to the lowest cost fixed OSW area.

The maps show lower LCOE for fixed OSW, but in a much reduced area due to the depth limit of fixed foundations. Floating is possible in a far larger area, but at a higher cost. It can be seen that lower cost sites are generally more prevalent in the west coast. This is due to the higher wind speeds that are found there, although this is offset going further offshore due to increased depths and longer transmission distances. Although these west coast sites display lower LCOE, these sites will have increased technical difficulty due to the more extreme metocean conditions caused by those higher wind speeds.

2.2.2 Capacity assessment

We considered technical constraints and LCOE together, to identify broad areas where both fixed and floating OSW could be developed around Ireland. We then applied appropriate densities (MW/km^2) of offshore wind capacity to the areas identified to define an approximate capacity which could be developed in each region.

We also separately considered on a general basis the potential limitations on development that could arise from protected sites and designated sites. Therefore, the resulting estimates are far less than if this analysis considered only technical constraints, such as water depth and existing hard infrastructure.

Where both fixed and floating OSW projects are possible, we have assumed a preference for fixed OSW due to its lower LCOE and more established technology. This means suitable areas for both are not double counted in the fixed and floating totals.

A relatively low density was applied compared to what is seen in practice within OSW sites. This was done because additional factors such as wake effects were not assessed. Instead, low densities were selected based on analysis of other markets to approximate the impact of these factors on potential OSW capacity within an area. The exact impact of these factors will be assessed at a DMAP stage. On a purely technical basis, Ireland's waters could theoretically accommodate 48 GW of fixed wind and 1300 GW of floating, but this level of OSW far exceeds demand, would not be cost effective, and does not consider the impact on other marine users.

Capacity estimates are shown in Figure 2.10 and Table 2.2.

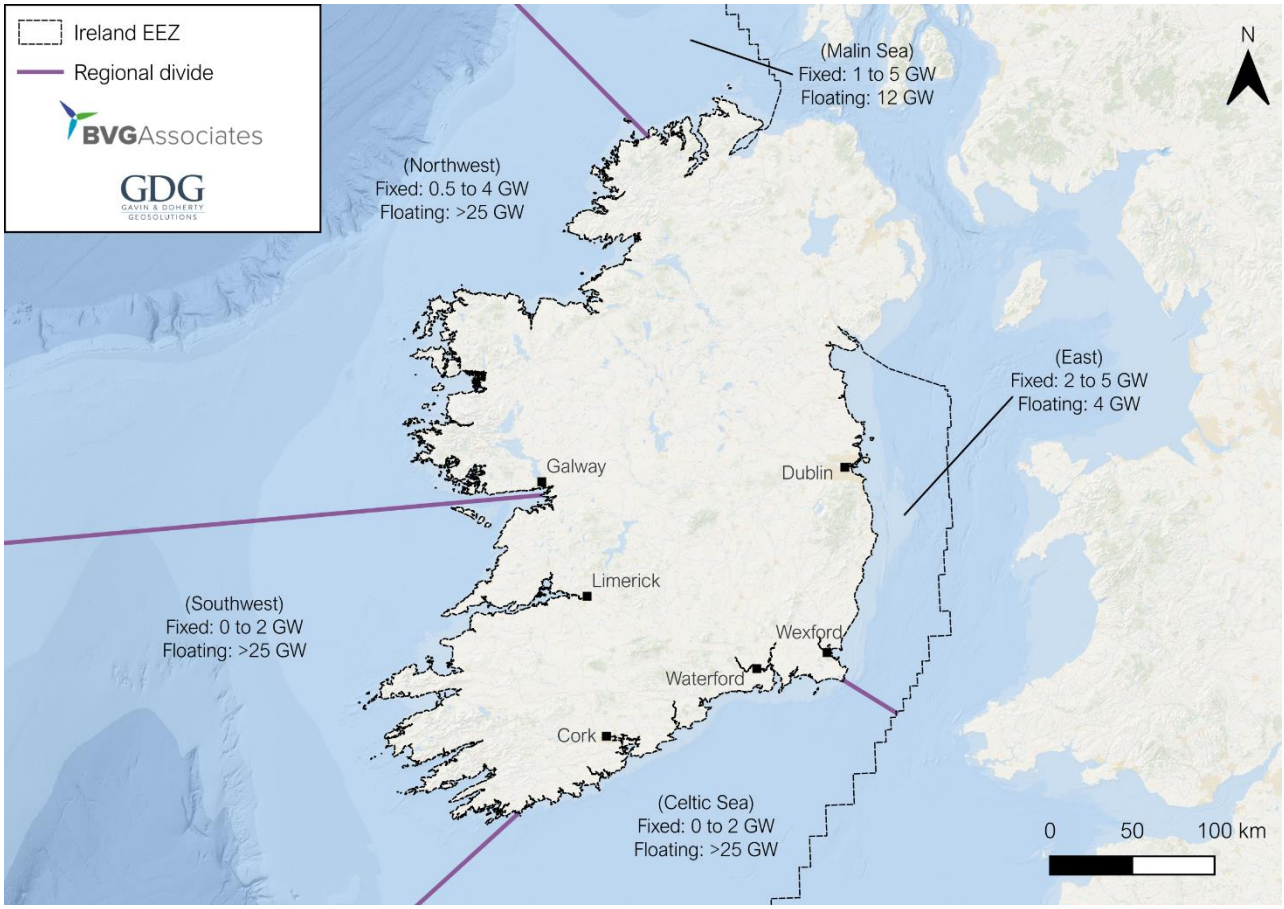

Figure 2.10 Fixed offshore wind regional capacities.

Table 2.2 Offshore wind regional capacities.

Region	Existing planned capacity (GW)	Additional possible fixed capacity (GW)	Additional possible floating capacity (GW)
East	2.6 (ORESS 1) 1.2 (other)	2 to 5	4
Celtic Sea	4.5	0 to 2	>25
Southwest	0	0 to 2	>25
Northwest	0	0.5 to 4	>25
Malin Sea	0	1 to 5	12
Total:	8.3	3.5 to 18	>90

This analysis demonstrates that fixed OSW capacity around Ireland is relatively spatially restricted, due to the limited extent of sea bed at suitable depths. However, despite being limited to certain areas, at 3.5 to 18 GW of additional capacity there is a significant amount of fixed wind potential in Ireland. For context, this would require between 230 and 1,200 fixed wind turbines, assuming a 15 MW capacity.

Regional floating OSW capacities reach tens of GW available in most areas. These values are not intended to be targets for Ireland to aim for; rather, indicators of where floating potential is more or less constrained.

2.2.3 Regional capacities

Figure 2.10 shows how regions have been designated.

East coast

In the east coast there is capacity for 2.5 to 5 GW of fixed OSW in addition to phase 1 projects. There is also capacity for approximately 4 GW of floating OSW. While Ireland could pursue both fixed and floating in the

region, the lower LCOE fixed areas should be prioritised as they will be delivered at a lower cost, and likely more quickly than floating OSW. Further, while there is sea bed space for both fixed and floating in the region, there are likely to be limitations on interconnection capacity that is unlocked in the region and there is less scope for pathfinder floating projects that can expand to commercial scale. It is therefore optimal for Ireland to concentrate on developing fixed OSW in this region.

Celtic Sea

The Celtic Sea has already been assessed for fixed OSW capacity as part of the SC-DMAP process, therefore the potential for fixed OSW (additional to that provided for in the SC-DMAP) is limited in the near term. However, if, as expected, deeper water fixed OSW technology becomes available after 2030, other deep water fixed sites could be unlocked in the Celtic Sea. Therefore, one or two more deep water fixed sites could be developed in this region, up to approximately 1.5 to 2 GW.

There is a very large area in the Celtic Sea that could be developed for floating OSW, with a theoretical capacity of over 25 GW possible. In general, the Celtic Sea has less extreme weather conditions than the west coast, where there is also a large floating OSW potential. Therefore, these regions in the Celtic Sea could be a suitable option for Ireland to develop its first commercial scale floating OSW projects, with suitable depths and high wind speeds.

Southwest coast

Off the southwest coast there are a few small areas where fixed OSW is theoretically possible, with a potential maximum capacity of 2GW. The fragmented nature of the sites and their proximity to the coastline may however reduce the potential of these sites. There are also grid constraint issues in this region. Although some small grid capacity is available, there is unlikely to be enough for commercial-scale projects without upgrades.

As with the Celtic Sea, there is a vast amount of area where floating OSW could be developed. If fully built out this could be over 25 GW of capacity. However, in this region metocean conditions are more extreme. While this means higher wind speeds and energy yield, it also means more difficult wave conditions, making installation and O&M more difficult and requires more robust structures. Therefore, it may be best to develop floating OSW sites in the Celtic Sea first, while the industry is developing and costs are likely to be lower. Sites in the southwest coast can then be developed later, once conditions are better understood. This also gives time for the relatively constrained grid in the region to be upgraded.

One area of opportunity for floating offshore wind in the southwest could be in developing smaller scale pathfinder projects (~200 MW). These could exploit the small grid capacity currently available in the region, although EirGrid are unable to guarantee connection until an application is submitted. There are a number of pre-commercial floating development projects being advanced in Europe and globally, therefore it is not strictly necessary for Ireland to first build a pathfinder project before commercial scale sites can be progressed. However, the pathfinder projects currently being progressed elsewhere in the Europe are in relatively sedate metocean conditions. To help qualify offshore wind technologies for Ireland's west coast, pathfinder projects in the west coast could help de-risk the technologies and processes required. The expertise developed in these projects could then potentially support commercial scale projects in harsh metocean conditions in Ireland and elsewhere.

Northwest coast

As in the southwest, there are a few areas where fixed OSW is feasible in the northwest. If all suitable areas were developed, the region could support approximately 0.5 to 4 GW of fixed OSW capacity, with around 2 GW being the most likely capacity. However, this will depend on consenting, cumulative impact, and grid availability.

Currently, the northwest is further from demand centres, although the development of new regional flexible and responsive demand centres (for example, via the 'Green Energy Parks' envisioned in *Powering Prosperity - Ireland's Offshore Wind Industrial Strategy*) could provide more potential for local usage of energy and reduce need for additional transmission infrastructure. Without new flexible and responsive demand, grid constraint is

likely to be limiting as any generation would need to be transmitted to other regions in Ireland for use. If other flexible and responsive demand centres are created in the northwest, such as data centres, then this could improve the business case for northwest wind farms.

As with other regions there is significant floating OSW potential, with over 25 GW possible. However, as with fixed OSW, there will need to be significant demand or grid infrastructure created for these floating sites to be economically feasible.

Malin Sea

There is a relatively large area in the Malin Sea suitable for fixed OSW projects, with 1 to 5 GW possible. There is also approximately 12 GW of floating OSW technically feasible in this area, although this is less than in other areas as it is limited by the EEZ boundary. As with the northwest, the economic feasibility of these sites will depend on grid or flexible and responsive demand infrastructure being built, as there is currently little demand and a constrained grid. These sites, though located within Republic of Ireland waters, could make landfall or connect onshore into Northern Ireland, sending the energy across the border and to closer demand centres. If this is possible, this may create a more appealing business case for northern projects. Opportunities for collaboration between Northern Ireland and Republic of Ireland are discussed further in Section 5.2.

2.2.4 Fixed offshore wind summary

The analysis showed that there is approximately 3.5 to 18 GW of fixed OSW potential around the Irish coastline, with the east and north having highest fixed capacity potential. However, the northwest coast and Malin Sea are currently much further from demand centres, making the grid infrastructure required to make them feasible more costly due to the transmission distances. Therefore, east coast sites are likely to be most suitable for near-term development. There are also suitable areas in the Celtic Sea, however this area has already been assessed as part of the SC-DMAP process, leaving only deep water areas, which are more technically difficult to develop. Further, with the SC-DMAP sites being developed, significant grid upgrades, or new flexible and responsive demand centres will be required. In the southwest and northwest, there are a few small areas suitable for fixed OSW development, but these tend to be relatively close to the coastline, potentially making consent more difficult. These are also small areas, limiting the size of project that can be developed and therefore limiting economies of scale and increasing cost. Therefore, to develop Ireland's fixed offshore wind capacity quickly, the east coast likely represents the best opportunity.

2.2.5 Floating offshore wind summary

Unlike fixed OSW, where suitable areas are relatively constrained by technical factors and designated sites, the deeper waters suitable for floating OSW unlock a vast area where projects could be developed. This gives Ireland the freedom to develop floating OSW projects where they deliver the best value. This value can consider LCOE for the sites, but also other benefits such as supply chain development, or interconnection and export opportunities. The only region where floating OSW is relatively constrained is on the east coast. Despite the fact that technically 4GW of floating offshore wind could be placed there, to do so along with a large build out of fixed wind is likely to introduce cumulative impacts which have not been considered in this analysis. Therefore, on the east coast, focussing on fixed OSW offers a better option. While some deeper water fixed OSW capacity in the east and Celtic Sea can be unlocked as technology develops, the vast majority of sea bed will still be too deep for these projects.

For commercial-scale floating OSW sites, the Celtic Sea likely offers the best option. This is because it has relatively more sedate metocean conditions compared to the west coast (although still more difficult than many other European sites), which will increase weather windows for installation and O&M and reduce loads on the structures. It also is best placed to interconnect to GB and continental Europe as it offers the shortest transmission distance. This is discussed further in Section 5.5. The grid in the Celtic Sea region is nevertheless constrained, with the fixed SC-DMAP sites likely to take up any capacity which is available. Therefore, significant

grid upgrades or new flexible and responsive demand centres will be required to make these sites economically feasible.

The best opportunities for floating OSW in Ireland therefore come from developing in the Celtic Sea, before moving clockwise round to the west coast as innovations in technology and installation and maintenance techniques enable deployment in more extreme conditions. Focussing on developing grid infrastructure in the south, and potential interconnection is the best way to unlock this potential.

Floating offshore wind pathfinder projects

Ireland does not need to build pathfinder projects to help develop floating OSW technologies as this is already being done, or has already been done, in other countries. Reasons to develop pathfinder projects could be to:

- Provide opportunities for the participation and upskilling of domestic supply chain, in preparation for commercial-scale future projects,
- Demonstrate the installation and operation of technologies in the challenging conditions of Ireland's west coast, to de-risk commercial-scale developments in the Celtic Sea and on the west coast, and
- Contribute to job creation in Ireland.

Ireland should be cautious that the time taken to develop and gather learnings from pathfinder projects do not slow down development of commercial scale projects. In particular, commercial-scale developments in the less-extreme metocean conditions in the Celtic Sea are not dependent on pathfinder projects, so care should be taken not to impede the progress of these.

In the southwest and northwest, if pathfinder projects are deemed desirable, to ensure any learnings can feed into the development of commercial-scale projects, such projects should begin progressing as soon as possible. Delivery could further be sped up by prioritising development where data is already available, or where there is sufficient grid capacity for a small demonstrator site already available with limited upgrades or new transmission required.

Engagement with EirGrid indicates that there may be some limited capacity on the Irish west coast to integrate one or two floating pathfinder projects without requiring additional grid reinforcement, though a full feasibility study would be required to confirm this, and any spare capacity cannot be reserved until a project is in a position to submit a grid connection application. The grid in the Celtic Sea remains highly constrained, bearing in mind the need for reinforcement to integrate South Coast DMAP projects. Alternative offtake, such as hydrogen, could be an option to circumvent grid constraints, though such a solution would add additional cost and complexity to a pathfinder project.

If a pathfinder project is developed, it would also be advantageous for sites to include the potential for future scalability. Allowing a smaller 200 MW site to increase its capacity to over 500 MW at a later date, especially if aligned with grid infrastructure or hydrogen production potential. Building an initial smaller project would allow for reduced financial risk, faster deployment, proof of technology, and flexibility, making future expansion more efficient and cost-effective. However, the viability of such expansion will depend on local conditions and the readiness of associated infrastructure. Ultimately, a pragmatic approach, focusing on fast-tracked, data-informed, and adaptable development sites, will best position Ireland to advance its offshore wind ambitions.

Government should be mindful that while there may be advantages to pursuing floating pathfinder projects in Ireland, as described above, the development of such projects would have resource and timing implications for the wider Irish offshore wind sector. This would likely cause knock-on impacts on Ireland's offshore wind deployment trajectory.

3. Context for supporting floating offshore wind in Ireland

This section discusses the existing Irish policies for offshore renewables, providing context for development of floating OSW projects. It then provides case studies of floating OSW development from other countries, and finally draws conclusions from these on how Ireland can maximise the benefits from a floating OSW industry.

3.1. Current Irish policy context

3.1.1 National policy context

Ireland's offshore wind policy has evolved significantly in recent years, aligning with the country's ambitious climate and renewable energy goals. Central to this, is the Irish Government's target to install 7 GW of offshore wind by 2030, 20 GW by 2040 and 37 GW by 2050, with the aim of contributing to a wider goal of net-zero emissions by 2050. Several key policy frameworks and legislative developments are shaping the offshore wind industry and impacting project development timelines.

1. National Marine Planning Framework (NMPF): The NMPF was made in 2021 in compliance with the Maritime Spatial Planning Directive 2014/89/EU. It sets the overarching framework for decision-making within the maritime area that is consistent, evidence-based and sustainable for the marine area. The NMPF is a parallel document to the National Planning Framework (NPF) and it recognises the importance of integration and co-ordination with the land planning regime at national, regional and local levels. In future, it will be equally important in turn that national, regional and local terrestrial plans are consistent with the NMPF – as they will be required to do so under the Planning and Development Act 2018.
2. The National Planning Framework (NPF): The NPF is a national document that will guide at a high-level strategic planning and development of land for the country over the next 20+ years, so that as the population grows, that growth is sustainable (in economic, social and environmental terms). The NPF recognises the importance of integration between land and marine planning and the shared aims and overlapping areas of co-ordination and activity across the two regimes. It contains six national planning objectives that are specific to the marine sector. The NPF is currently under review.
3. Offshore Renewable Electricity Support Scheme (ORESS): This scheme provides financial backing for offshore renewable energy projects. The first ORESS auction (ORESS 1) took place in 2023, with four projects securing funding. The next ORESS auction, ORESS 2.1, is expected to take place in 2025, and will offer support for development of the 'Tonn Nua' area identified in the SC-DMAP. The state aid approval for the ORESS scheme expires at the end of 2025, and Government has committed to developing a successor scheme, to be operational by 2026.[8]
4. Maritime Area Planning (MAP) Act 2021: This Act establishes a comprehensive framework for the regulation of offshore developments in Ireland. A central feature of the MAP Act is the creation of the Maritime Area Regulatory Authority (MARA), which is tasked with regulating maritime area consents (MACs) and regulating offshore developments. Further, the MAP Act has allowed Ireland to pursue a "plan-led approach" where key areas are allocated for development in a coordinated and sustainable manner. This differs from the "developer-led approach" used to facilitate the first ORESS auction described above. ORESS 2.1, as well as any successor scheme, are expected to follow the plan-led approach defined in the MAP Act.
5. Designated Maritime Area Plans (DMAPs): To facilitate the "plan-led approach", the DMAP process has been established to streamline the development of offshore wind and other maritime projects. The DMAP process establishes a structured approach to spatial planning in Ireland's maritime areas, identifying and designating specific zones that are suitable for development while balancing environmental protection,

[8] Department for Environment, Climate and Communications, *Future Framework for Renewable Energy*, May 2024, available online at https://www.gov.ie/en/publication/0566b-future-framework-for-offshore-renewable-energy/

economic activity, and community interests. The SC-DMAP has recently been adopted by Government, designating four Maritime Areas within which offshore wind farms could be developed. These four Maritime Areas aim were approved by the Oireachtas in late 2024 and the DMAP was subsequently adopted by the Minister and now holds the status of a statutory spatial plan.

6. The Climate Action Plan (CAP) sets Ireland's strategic framework for achieving net-zero emissions by 2050, outlining targets and policy measures, including a goal of at least 5 GW of offshore wind by 2030. The CAP is required to be prepared, and updated on an annual basis, under the Climate Action and Low Carbon Development Act 2015, amended 2021. The CAP requires a 51% reduction in greenhouse gas emissions by the end of 2030, compared to 2018, through the national carbon budgeting approach.
7. The National Energy and Climate Plan (NECP): Ireland's NECP is a collation of policies set out to meet EU climate and energy targets. The plan outlines targets and milestones, but as offshore wind projects typically have a 7 to 10 year development cycle, the fast-tracking required to meet 2030 goals may create a squeeze on timelines for developers.

3.1.2 European policy context

EU policy is also critical to Ireland's offshore wind ambitions. Key initiatives include:

Policy

1. Offshore Renewable Energy Strategy (ORES): The EU's Offshore Renewable Energy Strategy aims to deploy 300 GW of offshore wind by 2050. It emphasizes cross-border cooperation, innovation, and the development of grid infrastructure to enable large-scale integration of offshore renewable energy.
2. Action Plan for Grids: The European Commission has outlined strategies to modernize and expand grid infrastructure, ensuring the transmission capacity required to handle increasing renewable energy outputs. This includes enhancing cross-border connections and creating smarter, more adaptive grids to integrate OSW efficiently.
3. Draghi Report - Internal Energy Market: This report emphasizes the importance of advancing a single internal energy market in the EU. It highlights the need for further interconnection and harmonization of regulatory frameworks to enhance regional cooperation and optimise renewable energy generation and distribution.

Legal requirements

1. Revised TEN-E Regulation: The Trans-European Networks for Energy (TEN-E) regulation, revised in 2022, prioritizes projects that support energy transition and security, including cross-border interconnectors and renewable energy integration. This framework facilitates the planning and financing of infrastructure needed for a more interconnected and resilient energy grid in Europe.

Regional collaboration initiatives

1. Regional Maritime Spatial Planning Cooperation: Encouraged under the EU Maritime Spatial Planning Directive, this framework supports cross-border coordination in planning maritime activities. This is critical for managing overlapping interests in offshore wind development areas and fostering regional cooperation.
2. North Seas Energy Cooperation (NSEC): Ireland participates in NSEC, a platform for regional collaboration on the development of OSW and grid infrastructure in the North and Irish Seas. NSEC supports coordinated spatial planning, regional cost-benefit analyses, and the development of shared projects to maximise efficiency and sustainability.
3. Cross-Border Renewable Energy (CB RES) Projects: The EU promotes CB RES projects to enhance regional collaboration and financing opportunities for renewable energy developments that cross national boundaries. These projects benefit from streamlined approvals and potential funding under the EU's Innovation and Modernization Funds.

Research and funding programmes

1. Horizon Europe: This is the EU's flagship research and innovation program, providing funding for advancing renewable energy technologies, including OSW and grid integration solutions.
2. Potential New Funding Mechanisms: Initiatives such as the European Green Deal Investment Plan and the Connecting Europe Facility (CEF) provide opportunities to secure funding for infrastructure projects that support the integration of OSW into the EU energy grid.

3.2. Case studies from other countries

Floating OSW has not yet been developed at commercial scale, yet there are several small-scale demonstration projects from which Ireland can learn how to maximise the available benefits. Three case studies are provided below.

3.2.1 Case study 1 – WindFloat Atlantic

Project specification

WindFloat Atlantic is a floating offshore wind farm located 18 km off the coast of Viana do Castelo, Portugal, in the Atlantic Ocean. With a total installed capacity of 25 MW, it became operational in 2020, marking the first floating offshore wind farm to employ a semi-submersible foundation. WindFloat Atlantic follows the success of the WindFloat 1 prototype, a 2 MW demonstration turbine. The project covers an area of 17 km^2, with sea depths ranging to 100 m. Each year, the project is expected to reduce carbon dioxide (CO2) emissions by 39,000 tones and supply electricity to 25,000 households in Portugal.[9] The site experiences high waves, with significant wave height exceeding 10 m and maximum wave heights of 20 m, with average wind speeds along the Atlantic coast ranging from 7 to 10 m/s.[10]

The project was developed by Windplus SA, with ownership shared between Ocean Winds (a joint venture between EDP Renováveis and Engie) (65.17%), Repsol SA (14%), and Tokyo Gas Co, Ltd. (21%).

Technology

The WindFloat Atlantic wind farm features three MHI Vestas V164 turbines, each with a capacity of 8.4 MW and a rotor diameter of 164 m, mounted on floating semi-submersible platforms designed by Principle Power. This is shown in Figure 3.1. Weighing 3,500 tonnes each, the platforms each consist of three interconnected vertical columns, one of which supports the wind turbine. Each column base is water-filled, and an active ballast system redistributes the water during periods of stress (high waves) to maintain stability.

The platforms are anchored to the sea bed using catenary mooring lines and drag-embedded anchors. The inter-array cables are approximately 3 km long and operate at 66 kV, while the export cable, at 150 kV and 18 km in length, delivers the power to shore.[11]

[9] WindFloat Atlantic, Ocean Winds, September 2024, available at: https://www.oceanwinds.com/projects/WindFloat-atlantic-project/

[10] WindFloat Atlantic, EDP, September 2024, available at: https://www.edp.com/en/innovation/windfloat

[11] 4C Offshore, WindFloat Atlantic project details, September 2024, available at: https://www.4coffshore.com/

Figure 3.1 Diagram of Principle Power's Wind Float design used in WindFloat Atlantic. Image courtesy of Principle Power.

Route to market

WindFloat Atlantic operates under Portugal's regulated tariff structure, supplying electricity to the national grid and earning revenue through the Feed-in Tariff (FiT) mechanism. This system guarantees a fixed price of €168/MWh for the electricity generated by the wind farm over a 20-year period.[11]

The project's route to market also benefited from substantial public financial support from European programmes (see below), which helped bridge the cost gap for WindFloat Atlantic as an early-stage, high-risk project. By combining regulatory support with public funding and innovation-focused investment, the project achieved a successful route to market.

Financing

In recognition of being the first of its kind, the project was funded through a series of investments, primarily from innovation support programmes. The European Investment Bank contributed €60 million through the InnovFin Energy Demonstration Project programme and an additional €29.9 million via the NER300 programme, both aimed at funding innovative low-carbon demonstration projects at the pre-commercial stage. The Portuguese Government provided €16 million in funding, which included up to €6 million from the Portuguese Carbon Fund and €10 million from the Environmental Fund.[11]

Key companies in the supply chain also benefited from various funding mechanisms. Principle Power and KIC InnoEnergy announced a partnership which includes a €4 million investment from KIC InnoEnergy to support the design of the platform. The total cost of delivering the project is estimated at around €139 million.[11]

Delivery and key milestones

WindFloat Atlantic was preceded by the successful deployment of the WindFloat 1, a demonstration site that became operational in 2011. This site operated for five years, producing more than 17 GWh with operational even with waves of 17m and proving the viability of floating OSW technology. Development of the full-scale WindFloat Atlantic began in 2016, with final investment decisions made in 2017.

Following this, planning and development for the full-scale WindFloat Atlantic project started in 2016, with consent and financing agreements. In 2017, the final investment decision was made.

Fabrication of two of the foundations took place at the Navalria shipyard in Portugal, while the third was built at the Fene shipyard in Spain. The turbines were assembled at the Port of Ferrol, Spain, before being transported to the site. Installation of the floating platforms took place in phases. The first unit was connected to the grid in December 2019, followed by the second unit in January 2020. The installation of the third platform was delayed due to weather conditions and COVID-19 circumstances, but it was successfully installed and grid-connected in July 2020, marking the full operational status of the project.[11]

Socioeconomic impact

As the first of its kind, the project contributed to the development of the supply chain for floating offshore wind technology in Portugal and throughout Europe. Following success in this project, Principle Power's WindFloat platform was later used in the Kincardine offshore wind farm (50 MW) and is planned to be used in future offshore developments, including Erebus (Pembrokeshire, Wales – 50 MW) and Le Éoliennes Flottantes du Golfe de Lion (Leucate, France - 30 MW).[12] Additionally, both ASM Industries (now CS Wind) and JDR Cables, part of the project's supply chain, have since become key suppliers for other offshore wind farms across Europe.

By July 2024, four years after commencing commercial operations, Ocean Winds reported that the project had created 1,500 direct and indirect jobs.[13]

Community impact

Since becoming operational, the WindFloat Atlantic team has actively engaged with local communities, universities, schools, and training centres to raise awareness and educate about floating offshore wind technology. For example, in 2022 and 2023, the project team participated in Ocean Winds' educational program, "Wind Experts," which aimed to teach local schools in Viana do Castelo about climate change and offshore wind.[14] Additionally, the O&M base has opened its doors to various engineering representatives and community members, allowing them to learn more about the project, the activities of the port, and the different companies operating in the area.[15]

O&M performance

The WindFloat Atlantic project is expected to have an operational life of 25 years, with its O&M base located at the commercial port of Viana do Castelo. As of July 2024, the wind farm had generated a total of 320 GWh of energy since it began operations in 2020, achieving 78 GWh in 2022 and 80 GWh in 2023.[16]

[12] Principle Power, WindFloat Atlantic, October 2024, available at: https://www.principlepower.com/projects/windfloat-atlantic

[13] Ocean Winds, Wind Float Atlantic news and articles, September 2024, available at: https://www.oceanwinds.com/news/uncategorized/after-four-years-of-operations-ocean-winds-announces-that-the-windfloat-atlantic-project-achieves-a-total-cumulative-production-on-320gwh-surpassing-the-anticipated-figures/

[14] "Ocean Winds announces the winner of its educational program 'Wind Experts' in Viana do Castelo, Portugal" WindFloat Atlantic Wind Plus, May 2024, available at: https://www.WindFloat-atlantic.com/ocean-winds-announces-the-winner-of-its-educational-program-wind-experts-in-viana-do-castelo-portugal/

[15] "WindFloat Atlantic opens Its doors to the local community for the second consecutive year!" WindFloat Atlantic Wind Plus, June 2024, available at: https://www.WindFloat-atlantic.com/WindFloat-atlantic-opens-its-doors-to-the-local-community-for-the-second-consecutive-year/

[16] "After four years of operations, WindFloat Atlantic project achieves a total cumulative production on 320GWh, surpassing the anticipated figures" WindFloat Atlantic Wind Plus, September 2024, available at: https://www.windfloat-atlantic.com/after-four-years-of-operations-windfloat-atlantic-project-achieves-a-total-cumulative-production-on-320gwh-surpassing-the-anticipated-figures

In addition to its energy generation capabilities, the project has also demonstrated minimal environmental impact. Ongoing environmental assessments revealed that over 270 marine species coexist with the wind farm without significant adverse effects on marine mammals or endangered bird species.[17]

To date, throughout its four years of operation, the project has encountered no significant operational issues beyond routine maintenance tasks. In February 2021, there was a minor cable array failure however this was repaired by within two months.[18] In 2022, O&M activities included both preventive and corrective measures, accumulating over 18,000 work hours. Notably, during Storm Ciaran in 2023, the project withstood waves of up to 20 meters and wind speeds reaching 139 km/h.[19] Since start of operations, the wind farm's overall monthly availability consistently exceeded 90%, with several months approaching 100%.[20]

3.2.2 Case study 2 – Kincardine

Project specification

Kincardine floating offshore wind farm (Kincardine) is a 50 MW development located 15 km off the southeast coast of Aberdeenshire (Scotland), in the Aberdeen Bay. The site area covers 110 km^2, with water depths ranging from 60 to 80 m. It experiences larger operational wave heights between November and March (1.5 m to 7 m) and smaller heights (0 to 1.5 m) between May and September. The average wind speed at the site ranges between 8.79 and 9.45 m/s.[21]

Upon its completion in 2021, Kincardine became the largest floating offshore wind farm in the world. It generates enough electricity to power 55,000 homes in Scotland, reducing CO_2 emissions by 94,000 tonnes annually compared to fossil fuel generation.[22]

The development of Kincardine was started in 2014 by Kincardine Offshore Windfarm Ltd (KOWL), which was responsible for its first two years of development. In 2016, the company was acquired by Cobra Group. From this point, Cobra Wind, a subsidiary of Cobra Group, was responsible for the delivery of the project, including its construction, installation, and operation.

Technology

Kincardine includes five Vestas V164 turbines, each with a capacity of 8.4 MW and a blade length of 82 m, mounted on steel semi-submersible floating foundations, designed by Principle Power. Weighing approximately 3,000 tonnes each and featuring a triangular footprint of about 70 m on each side, the platforms are constructed from three interconnected vertical columns, with one column specifically supporting the wind turbine. Each column's base is water-filled, and an active ballast system redistributes the water during periods of stress, such as high waves, to ensure stability.[23]

[17] Ocean Winds, Wind Float Atlantic news and articles, September 2024, available at: https://www.oceanwinds.com/news/uncategorized/after-four-years-of-operations-ocean-winds-announces-that-the-windfloat-atlantic-project-achieves-a-total-cumulative-production-on-320gwh-surpassing-the-anticipated-figures/

[18] 4C Offshore, WindFloat Atlantic key milestones, September 2024, available at: https://www.4coffshore.com/

[19] "WindFloat Atlantic closes 2022, reaching 78GWh" WindFloat Atlantic Wind Plus, January 2023, available at https://www.windfloat-atlantic.com/windfloat-atlantic-closes-2022-reaching-78gwh/

[20] "WindFloat Atlantic thrives in the face of a record storm" WindFloat Atlantic Wind Plus, November 2023, available at: https://www.windfloat-atlantic.com/windfloat-atlantic-thrives-in-the-face-of-a-record-storm/

[21] Kincardine Offshore Windfarm Environmental Statement, Scottish Governments Marine Directorate, March 2016, available at: https://marine.gov.scot/data/kincardine-offshore-windfarm-environmental-statement-and-appendices

[22] Floatation Energy, Kincardine Offshore Wind Farm, 30 August, 2024 available at https://flotationenergy.com/kincardine-once-the-worlds-largest-floating-wind-project/

[23] Adnan Durakovic, "Final Kincardine Floating Wind Platform Leaves Spain", OffshoreWIND.biz, Available at: https://www.offshorewind.biz/2021/05/10/final-kincardine-floating-wind-platform-leaves-spain/

Figure 3.2 Installation of Principle Power's semi-submersible Wind Float design at Kincardine. Image courtesy of Principle Power.

These foundations are anchored to the sea bed with four mooring points using a catenary configuration with steel chains and Drag-Embedment Anchors.[24] The inter-array cables span a total length of 30 km, with an export cable extending approximately 15 km offshore and 17 km onshore.

Financing

Kincardine was largely financed through private investment by French corporate and investment bank Natixis, which provided £380 million through a 'Certified Climate Bond' deal. This voluntary labelling scheme supports investment aligned with the Paris Climate Agreement and marked the first Climate Bonds Certification for a floating offshore wind project.[25]

Route to market

Kincardine was supported by the UK Government's previous revenue support mechanism, known as Renewable Obligation Certificates (ROCs), the UK scheme to incentivise early renewable energy projects, which has subsequently been closed to new participants. This system awarded generators ROCs based on their net monthly renewable electricity production, which could be sold to suppliers to meet their renewable energy obligations. Kincardine receives 3.5 ROCs/MWh of electricity generated.[26] The exact value of these ROCs varies according to market conditions, anchored to a 'buy-out price' which in 2024 to 25 is £64.73 (€78 EUR) per ROC. This represents the amount suppliers will need to pay for each ROC they do not present towards compliance

[24] Cornwall Flow Accelerator: Innovation in Low Carbon Design and Manufacturability, Offshore Renewable Energy Catapult on behalf of Cornwall Flow Accelerator, January 2022, available at: https://cms.ore.catapult.org.uk/wp-content/uploads/2023/01/RPT-CFAR-OC-031-11012023-WP4-Task-4-Anchoring-and-Mooring-compressed.pdf

[25] Climate Bonds Initiative, Climate Bond Certification, available at: https://www.climatebonds.net/certification/get-certified

[26] Charlie Allen, "Deploying Floating Offshore Wind Test and Demo Projects in the Celtic Sea What Lessons Can we Learn from Kincardine" Marine Energy Wales, August 2024, available online at https://www.marineenergywales.co.uk/floating-offshore-wind/deploying-floating-offshore-wind-test-and-demo-projects-in-the-celtic-sea-what-lessons-can-we-learn-from-kincardine/

with their 2024 to 25 obligation. At the buy-out price, the value of Kincardine's 3.5 ROCs would be approximately £194 (€235 EUR) per MWh,[27] though in practice prices may vary according to supply and demand of ROCs.

Prior to becoming operational in 2018, the power generated by the wind farm was sold to Statkraft under an eight-year power purchase agreement, starting in 2021. This agreement covered 100% of the project's electricity output, with fixed terms for the entire duration. The revenue earned from this power purchase agreement is additional to that which Kincardine earns through the sale of ROCs.

Delivery and key milestones

Project development began in 2014 with the establishment of KOWL. An environmental statement was submitted in March 2016, with subsequent revisions to turbine capacity, leading to the final amendment submitted in September 2016. Following submission, Cobra acquired ownership of KOWL, and in early 2018, the Scottish Government granted final approval for its construction.

The first 2 MW turbine was installed and connected to the grid in October 2018, with its foundation fabricated at Navantia's Fene yard in Spain, and the turbine manufactured at MHI Vestas' factory on the Isle of Wight, before final assembly at the port of Dundee. In 2019, the fabrication of the remaining five foundation units and 9.5 MW turbines began at the same locations. Once completed, due to the size and complexity, they were shipped to the Port of Maasvlakte in Rotterdam for second phase of assembly. This phased approach allowed gathering of data for the successful deployment of the larger turbines, including site-specific motion and monitoring data, proof of concept for the larger turbines, and site-specific ornithological data.

The remaining five turbines were installed at the site in stages over a two-year period. The first two of the five turbines, KIN-03 and KIN-04 were installed in the winter of 2020. KIN-02 and KIN-01 were towed to the site in the spring of 2021, with the final turbine was installed in the summer of 2021. All five began generating power in 2021.

Socioeconomic impact

The initial cost estimate for constructing the Kincardine project was £250 million at the time of the planning application. As the project developed, the cost increased to £350 million (€420 million) by 2018 and was close to £500 million (€600 million) by 2020.[28]

To date, no retrospective economic impact assessment has been made publicly available since commencement of the project's full operation in 2021. As part of the environmental statement (ES)[21] submitted as part of the planning application, the socio-economics chapter assessed the likely job creation in Aberdeenshire. It was estimated that 40 jobs would be created for activities supporting turbine installation at the port in Aberdeenshire, including roles for engineers and small boat operators, and 20 jobs for the installation of onshore cabling. At that time, the O&M phase was expected to employ up to 10 staff for project management and offshore maintenance support.

This assessment was based on professional judgment, and a predicted operational model which may vary in practice. The assessment does not include any indirect jobs that would be generated within the supply chain. Additionally, as a result of changes to project expenditure, job estimates provided prior to construction may not fully reflect the extent of the project's economic and employment impacts. Socio-economic impacts at decommissioning stage were not assessed within the ES, though there may be economic benefits associated with this phase at the end of the wind farm's operational life.

[27] Ofgem, "Renewables Obligation (RO) buy-out price, mutualisation threshold and mutualisation ceilings for 2024 to 2025", available online at https://www.ofgem.gov.uk/publications/renewables-obligation-ro-buy-out-price-mutualisation-threshold-and-mutualisation-ceilings-2024-2025

[2828] David McPhee, "Worlds largest floating wind farm off Aberdeenshire delated by six months," Press and Journal, 13 October 2020, available online at: https://www.pressandjournal.co.uk/fp/news/aberdeen-aberdeenshire/2561968/worlds-largest-floating-wind-farm-off-aberdeenshire-delayed-by-six-months/

Before starting construction, in early 2017, Cobra Wind engaged with Scottish Enterprise and tier one contractors to run events that introduced smaller tier two and tier three suppliers to the project.[29] These events aimed to inform local businesses about opportunities during the different phases of project delivery. Although it is challenging to directly attribute the success of these initiatives, they are recommended as a route for increasing local involvement and subsequent impact.

Major supply chain contracts were generally awarded to non-UK companies, including Vestas for turbine manufacturing, Navantia for fabrication, and Boskalis for transportation and installation of the turbines.

O&M performance

The operational life of Kincardine is expected to be 25 years, with the O&M base located in the port of Aberdeen.

In May 2022, one of Kincardine's floating OSW turbines (KIN-03) experienced a technical failure that required the replacement of a major component. During this period, when KIN-03 required major maintenance, the port of Aberdeen was already occupied as a marshalling area for other North Sea projects. This significantly complicated the schedule, as the availability of the quay and its facilities had to be coordinated with these other projects.

As a result of the quay's unavailability, the turbine and its floating base had to be disconnected in Scotland and towed to the Maasvlakte terminal in the port of Rotterdam. After the repair was completed, the turbine was towed back and reconnected. The entire process required 17.2 net vessel days, a significant loss of generating time and therefore project revenue.[30]

The distance to the wind farm played a role, as the longer distance increased the towing time, leading to more transit and loss of generating time.

Industry learning

To be suitable for O&M maintenance in floating offshore wind, a port needs sufficient space and a deep-water quay. Floating offshore wind O&M port requirements typically include jetties for crew transfers vessels (CTVs) or service operation vessels (SOVs). CTVs typically require 35 m of space per vessel and a minimum draft of 3 m. SOVs typically require 100 m of quayside per vessel and minimum draft of 7 to 8 m.[31] It must also be equipped with a high-capacity crane with enough height to handle large floaters and reach the elevation of the turbines.

The issues with the repair of KIN-03 revealed important lessons for the industry especially in O&M performance. Towing the turbine to Rotterdam, a considerable distance from the wind farm, raised transit expenses, and prolonged periods of turbine inactivity.

This experience highlights the importance of selecting maintenance ports closer to the wind farm to minimise towing time and costs. It also emphasises the need for ports with readily available facilities to avoid delays and logistical challenges.

[29] European Offshore Wind Deployment Centre (EOWDC) (Aberdeen Offshore Wind Farm): Socio-Economic Impacts Monitoring Study, Oxford Brooks University on behalf of Vattenfall, 2020, available at: https://group.vattenfall.com/uk/contentassets/c66251dd969a437c878b5fec736c32aa/aberdeen-project----technical-report-final-october-2020.pdf

[30] Lesson learned from heavy maintenance at the world's first commercial floating wind farm, Spinergie (2023), available at: https://www.spinergie.com/blog/lessons-learned-from-heavy-maintenance-at-the-worlds-first-commercial-floating-wind-farm

[31] Guide to a Floating Offshore Wind Farm, BVG Associates on Published on behalf of the Offshore Renewable Energy Catapult, The Crown Estate and Crown Estate Scotland, May 2023, available at https://guidetofloatingoffshorewind.com/

3.2.3 Case study 3 – Hywind Tampen

Project specification

Hywind Tampen is an 88 MW floating offshore wind farm located approximately 130 km off the Norwegian coast in the North Sea. Once fully operational in 2023, Hywind Tampen became the world's largest floating offshore wind farm, surpassing earlier projects like Kincardine, and marking it the first wind farm in the world to supply electricity to oil and gas platforms. Situated between the Snorre and Gullfaks platforms, Hywind Tampen is estimated to meet about 35% of their annual electricity power demand, reducing CO_2 emissions from these platforms by an estimated 200,000 tonnes annually.[32]

The wind farm covers a total area of around 39 km², with water depths ranging from 260 to 300 m.[33] Equinor is both the developer and operator of Hywind Tampen, holding a 42% ownership stake. The remaining ownership is divided among partners from the Gullfaks and Snorre offshore fields. This includes Petoro (30%), OMV (9.5%), Vår Energi (9.3%), INPEX Idemitsu (4.8%), and Wintershall Dea (4.3%).

Technology

Hywind Tampen features 11 Siemens Gamesa wind turbines (SG 8.0-167 DD model), each with a maximum capacity of 8.6 MW. These turbines have a rotor diameter of 167 m and blades measuring 81.5 m in length. They are mounted on floating concrete spar structures, a technology originally developed for the oil and gas industry. Each spar structure is approximately 20 m tall, weighs 9,000 tonnes, and contains heavy ballast in the keel to ensure vertical flotation.[33]

They are anchored to the sea bed using a shared system consisting of 19 suction anchors, each weighing approximately 120 tonnes, and 33 mooring chains. Unlike traditional mooring systems, which require individual anchors for each turbine's mooring line, this shared system connects multiple mooring lines to a single anchor point. This design equates to 1.7 anchors per turbine, representing a saving of 14 anchors when compared to a traditional 3-line mooring system.[34] Hywind Tampen is currently the only commercial wind farm to implement this system.

The inter-array cables cover a total length of approximately 27.5 km, forming a loop to connect the wind turbines, which then links to two static export cables supplying power to the Snorre and Gullfaks platforms. Each export cable is approximately 14.5 km in length.[33]

[32] Equinor, Hywind Tampen, September 2024, available at https://www.equinor.com/energy/hywind-tampen

[33] 4C Offshore, Hywind Tampen project details, September 2024, available at: https://www.4coffshore.com/

[34] Floating Offshore Wind Anchor Review, Offshore Renewable Energy Catapult in partnership with ARUP, January 2024, Available At: https://fowcoe.co.uk/wp-content/uploads/2024/03/FOWCoE-Report-Anchor-Review-PN000585-RPT-005-MA03.pdf

Figure 3.3 Illustration of the Hywind Tampen array. Image courtesy of Recharge.

Financing

The project received financial support from Enova, a Norwegian Government enterprise, amounting to NOK 2.3 billion (€195 million), and from the NoX fund, providing NOK 566 million (€48 million).[33]

Total project cost for the project was estimated at approximately NOK 7.4 billion (€630 million), an increase from the initial estimate of NOK 5 billion made during the planning phase.[33] Despite these cost increases, Hywind Tampen achieved significant improvements compared to Hywind Scotland, the world's first floating offshore wind farm, with an investment cost approximately 35% lower per installed megawatt when adjusted for price changes since 2016/2017.[35]

Route to market

Hywind Tampen's route to market involved supplying electricity directly to offshore oil and gas platforms, with the Gullfaks and Snorre fields being ideal choices due to their high energy demands and proximity to wind resources. Equinor, the largest stakeholder in Hywind Tampen, is also a partner in both fields (51% in Gullfaks and 33.3% in Snorre). In 2019, the Gullfaks and Snorre fields received extensions to their production licenses until 2036 and 2040, respectively. These extensions were crucial for the successful realisation of the Tampen project, enabling up to 20 additional years of operation beyond the original plans.

Delivery and key milestones

Development of the project began in 2018, with Equinor and partners assessing the feasibility of supplying electricity to offshore oil and gas fields. Financing agreements were secured the same year, followed by feasibility and planning studies in 2019. In 2020, the Norwegian Ministry of Petroleum and Industry granted project consent.

Construction commenced in 2021 with the fabrication of the concrete spar structures that took place in Aker Solutions yard, Stord, located on the west coast of Norway. Siemens Gamesa were responsible for the manufacturing of the turbine, which occurred at various locations across Europe before all components were transported to the Wergeland Base in Gulen, Norway, for assembly.

[35] Equinor, "The world's largest floating offshore wind farm officially opened," 23 August 2023, available at: https://www.equinor.com/news/20230823-hywind-tampen-officially-opened

By June 2022, seven of the 11 wind turbines had been assembled and towed to the installation site. Offshore work was completed in August of 2022, and power production began in November, delivering electricity to the Gullfaks A platform in the North Sea. The remaining four turbines were assembled in late 2022 and towed for connection in June 2023.[33]

The initial schedule anticipated that commissioning would be complete by September 2022. However, supply chain challenges, particularly in the global steel market, delayed the delivery of the final four tower sections. In August of 2023, commercial operation of Hywind Tampen started.

Socioeconomic impact

To date, no retrospective economic impact assessment has been made publicly available since commencement of the project's full operation. However, in 2023, Equinor reported that 60% of the contract values for the project were awarded to Norwegian suppliers.[36]

Aker Solutions (formerly Kværner AS), a significant recipient of these contracts, conducted the front-end design engineering (FEED) and secured the engineering, procurement, and construction (EPC) contract for the 11 concrete foundations. These contracts are expected to involve around 250 full time equivalent (FTE) years from Aker Solutions and generate approximately 800 FTE years in ripple effects for suppliers and the public sector over the period from development to installation.[37]

A study conducted by Multiconsult estimated that in total, Hywind Tampen could generate up to 3,000 FTE years within Norwegian businesses and the supply chain over the construction and operational period.[37] Although the socioeconomic impacts during the operational phase were not assessed, potential economic benefits are anticipated throughout the project's lifespan due to O&M jobs and energy generation.

O&M performance

Hywind Tampen began operating in August 2023. While operational data is not yet available, the project is expected to align with the lifespans of the Gullfaks and Snorre fields, with decommissioning anticipated for 2040. There is potential for an eight-year extension of its operational life, leading to an estimated production period of around 20 years.

[36] Equinor, “The world's largest floating offshore wind farm officially opened,” 23 August 2023, available at: https://www.equinor.com/news/20230823-hywind-tampen-officially-opened

[37] Equinor “Construction starts on the world's largest floating offshore wind farm” October 2020, available at: “https://www.equinor.com/news/archive/20201001-contruction-start-hywind-tampen

3.3. Conclusions for Ireland

Table 3.1 provides a summary of the technical factors of each project.

Table 3.1 Case studies technical summary.

Parameter	WindFloat Atlantic	Kincardine	Hywind Tampen
Commercial operation date	2020	2021	2023
Project capacity	25 MW	50 MW	88 MW
Turbine rating	8.4 MW (MHI Vestas V164)	8.4 MW (Vestas V164)	8.6 MW (Siemens Gamesa SG 8.0-167 DD)
Main substructure design	Floating semi-submersible platforms	Floating semi-submersible platforms	Floating concrete spar structures
Distance from shore	18 km	15 km	130 km
Significant wave height	10 m	1.5 - 7m	10 m
Average wind speeds	7 to 10 m/s	8.79 to 9.45 m/s	10 m/s

Examples of floating OSW development from around the world can offer Ireland valuable knowledge and context to inform its ambitions.

3.3.1 Financing, cost and route to market

Early floating OSW projects, like Kincardine and WindFloat Atlantic, benefited from guaranteed pricing mechanisms such as ROCs and FiT schemes. These frameworks helped provide revenue stability and improved investor confidence in an uncertain environment. In Ireland, the current ORESS scheme or a comparable successor will be important for incentivising investment and supporting the growth of capacity within Ireland's offshore wind pipeline.

The high initial costs of floating OSW, as seen with WindFloat Atlantic and Hywind Tampen, show the need for significant public funding to address gaps that private investment alone may not meet. Both projects relied heavily on government support – WindFloat from European and Portuguese grants, and Hywind Tampen from a local government enterprise. It is likely Ireland will need similar early-stage financial backing to address high upfront costs and the uncertainties of a new technology.

The case studies also showed that all three projects exceeded their initial cost estimates and faced delays. Although there have been successful efforts to reduce the costs of floating OSW to date, there is still a long way to go. The technology is still relatively immature compared to fixed-bottom installations, and there is a steep learning curve. The supply chain is less developed, and companies are still learning how to optimise design, construction and operation practices. Although cost overruns are likely, planning for contingencies can help to reduce risks. While some time delays may be unavoidable, anticipating potential areas of delay and implementing strategies can help minimise their impact. In the context of Ireland, the particularly challenging metocean conditions could be the cause of delay and additional cost, if not properly understood and accounted for in project planning.

3.3.2 Technology and project scale

Selecting the right floating technology requires both technical and environmental understanding. Projects like Kincardine and WindFloat Atlantic used semi-submersible platforms, chosen for their commercial readiness, suitability to shallower water environments, and adaptability to available infrastructure. In comparison, deeper water sites like Hywind Tampen allowed for spar substructures. Spar substructures require deep water, typically

in excess of 70 m, at the integration location, along the tow-out route and at the final deployment zone, which are likely to make them unsuitable for use in Ireland.[38] When choosing the floating technology, it's important to consider factors such as metocean conditions, sea bed characteristics, environmental conditions and specifications of available port infrastructure.

The Atlantic Ocean off Ireland's west coast has metocean conditions that are more challenging than most existing floating OSW sites. There will need to be careful consideration of the implications this has on technology selection, and pathfinder projects or test sites can play a role in developing industry understanding. Projects in the calmer conditions in the Celtic Sea will likely be able to take a lot of learnings from the existing demonstration projects.

Kincardine and WindFloat Atlantic addressed the untested nature of the technology by first installing a 2 MW demonstration turbine. For west coast Ireland, this approach could have its benefits, as it would allow for collection of site-specific data and proof of concept in Atlantic metocean conditions. However, successful demonstration projects require clear objectives and well-defined outcomes, including considerations of scalability in both site selection and technology. By installing a demonstration turbine in a location suitable for further development and selecting easily scalable technology, any lessons learned can be applied to prospective commercial projects.

3.3.3 Supply chain

The economic benefits of floating OSW development can be significant, as demonstrated by Kincardine, WindFloat Atlantic, and Hywind Tampen. However, the extent to which these benefits are realised will depend on the scale of the project, geographical factors, and specific technology requirements. Larger projects may encourage higher local content as they are more effective in building the business case for investment in local infrastructure and capability. Similarly, the level of local involvement will depend on the region's existing capabilities to fulfil contract requirements.

Hywind Tampen was able to capitalise on existing Norwegian supply chain strengths, with 60% of the contract values for the project secured locally (in Norway). Ireland does not have the history of marine engineering and vibrant oil and gas sector to draw on to achieve these high levels of local content. When selecting technology type and assessing site suitability, Ireland should also consider its supply chain capabilities. While Ireland's supply chain may not be as developed as those in other European countries, there are still significant opportunities for Irish participation. Raising awareness of the technical requirements of floating OSW prior to development can better-position suppliers for involvement.

3.3.4 O&M

Kincardine's selection of an O&M port proved costly, highlighting the importance for careful port choice early in the process. While large-scale operational failures are not inevitable, identifying a capable O&M port with sufficient capacity can minimise their impact if they occur. Typically, O&M ports are chosen for their proximity to the site and their capacity to meet operational specifications. This approach minimises transfer times and reduces the risk of delays in adverse weather conditions.

Floating OSW projects in Ireland are expected to have high-capacity factors during operations, but it's unclear how metocean conditions will impact this, and a lack of suitable weather windows to perform routine maintenance or major repair could significantly impact downtime, in turn impacting project revenues and LCOE. Any west coast project should aim to understand the impact on O&M as well as technology.

[38] Offshore Renewable Energy Technology Roadmap, BVG Associates and Beauchamps on behalf of SEAI, June 2024, available online at https://www.seai.ie/sites/default/files/publications/ORE-Technology-Roadmap.pdf.

4. Supply chain readiness

This section presents assessment of the supply chain readiness of Ireland and its potential strengths and weaknesses.

4.1. Supply chain capability review

To maximise the domestic economic benefit of Ireland's ambitious offshore wind deployment programme, it is imperative that Ireland's supply chain is supported to maximise its participation, opening opportunities for additional economic and employment benefits associated with the development, installation, operation and decommissioning of wind turbine generating assets.

For the purposes of the recently published reports *Ireland offshore wind skills analysis*,[39] *Offshore renewable energy export potential for Ireland,*[40] and the SEAI *Offshore Renewable Energy Technology Roadmap*,[38] BVGA conducted a comprehensive assessment of the capability of the Irish supply chain. We identified key areas of opportunity for Irish participation and derived projections of the domestic economic and employment impacts associated with the pursuit of Ireland's offshore wind deployment ambitions of 5 GW by 2030, 20 GW by 2040 and 37 GW by 2050. These reports each contained a series of recommendations to accelerate deployment of offshore wind in Ireland towards the government's states ambitions, and to maximise local economic benefit.

This report does not seek to repeat that analysis, but to summarise and build upon its findings to identify further relevant recommendations, with specific reference to the role of potential pathfinder floating OSW projects in building capability within the domestic supply chain.

This report should be read in conjunction with these preceding analyses, whose findings and recommendations remain relevant.

4.1.1 Summary of supply chain capability analysis

For *Building our Potential,* we conducted an in-depth triage of key cost centres which make up the lifecycle of a fixed and floating OSW farm, assessing the likelihood of local participation in each area.[39]

Building on this initial triage, we conducted an in depth assessment on each supply chain category where Irish participation was deemed 'likely' or 'possible' to establish a projection of Irish value capture and employment across these areas. For each area, we considered:

- Track record and capacity of Irish firms in OSW
- Capability in parallel sectors, such as construction, electricity generation and transmission or oil and gas.
- The benefit of local supply
- Current skills availability
- Investment risk, and
- Size of opportunity.

Below, we summarise in narrative form the findings of this analysis. For further detail on the results and methodology, please refer to *Building our Potential*.[39]

Development and project management phase

There is a strong opportunity for Ireland to participate in the development and project management project phase. In all cost categories, there are capable, locally established firms providing the kind of professional

[39] *Building Our Potential: Ireland's Offshore Wind Skills and Talent Needs*, BVG Associates on behalf of Green Tech Skillnet, January 2024, available online at https://www.skillnetireland.ie/insights/building-our-potential-irelands-offshore-wind-skills-and-talent-needs

[40] *Offshore renewable energy export potential for Ireland, Workstream 4: Export viability, policy considerations, trade and investment opportunities,* BVG Associates on behalf of DECC, January 2024, available online at https://www.gov.ie/en/publication/0566b-future-framework-for-offshore-renewable-energy/

services such as engineering, project management, environmental, geotechnical and geophysical surveys, resource assessment and development and consenting services which are required in this phase of the project lifecycle. The benefit of using local suppliers, who are on hand to carry out in-person work and who understand the local marine and legislative environment, is often strong. Barriers to entry of local firms are low relative to other cost categories.

Challenges to maximise local participation are likely to centre around the availability of relevant local skills to service the Irish pipeline. Where there is a lack of local availability of relevant skills, developers may choose to contract activities to non-Irish partners.

Manufacturing phase

While there are opportunities for Irish participation in the manufacturing phase, these are currently limited given the intricacy of manufacturing key turbine components, need for specialised workforce and high barriers to entry associated with these activities.

Across Northern Europe, there is an established supply chain for these components, with proven manufacturing track record and suitable infrastructure such as fabrication and marshalling ports, required for producing nacelles, blades, array and export cables, turbine electrical systems, and monopile foundations. In contrast, Ireland faces a shortage of relevant skills and infrastructure to carry out these complex manufacturing operations, in addition to a smaller project pipeline compared to larger European countries. This limits the attractiveness for Ireland as a destination for the significant inward investment needed to develop manufacturing facilities and the specialised skills they require.

There are opportunities for Irish participation in the manufacturing phase, though all require significant additional investment to unlock. In particular:

- There is a strong case for conducting assembly of floating foundations in Ireland, as the expense incurred in towing these components from overseas is high. Having the capability to do so locally will depend on securing investments in upgrading the capability of Irish ports.
- Tower manufacture may represent an opportunity for Ireland, as it is less complex than manufacture of other major components such as turbines and nacelles, and there are cost benefits to locating production close to deployment areas. An Irish tower manufacturing facility is therefore a possibility; however, Ireland is likely to face fierce competition for such internationally mobile investments which are highly sought after across Europe.
- In the case of synthetic mooring systems, the lack of an established supply chain for this product, coupled with existing Irish capability in synthetic line and net manufacture presents an opportunity for local Irish production. However, as with towers, competition for investment will be considerable, especially from countries who have active oil and gas sectors and can leverage these transferrable capabilities to manufacture mooring systems.

Installation phase

The installation phase for offshore projects presents little opportunity for local participation and will largely depend on foreign expertise. This phase demands experienced marine contractors with specialised training, high-cost, purpose-built vessels, and well-equipped port infrastructure. Europe's leading marine contractors are largely based in Belgium and Netherlands, and their vessels and crews travel around Europe from project to project, delivering the relatively brief installation phase and then moving onto the next.

Within Ireland, as within many markets, there is a lack of experienced domestic companies and a lack of suitable vessels required to undertake installation tasks such as installing monopiles and jackets, installing turbines, or attaching blades. It is unlikely that Ireland will be able to provide such services, given the very high capital and skill requirements which make entry to this market highly challenging.

Irish ports are likely to participate in installation activities such as component staging as well as marshalling and integration of floating turbines and foundations. Using local ports can reduce costs and speed up installation,

especially for floating OSW projects. However, infrastructure upgrades to Irish ports are necessary to unlock these activities, otherwise demand could shift to nearby European ports. This is further discussed in GDG's 2022 national port study.[41]

In addition to participation of Irish ports, it is likely that the majority of onshore works such as onshore cable and substation construction work will be carried out by Irish civil contractors, as Ireland has strong capability in this area.

Operations, and maintenance phase

The O&M phase of a wind farm represents a major economic opportunity for Irish supply chain. The majority of O&M services are almost always provided from the nearest viable port, as minimising transit time to the project site is a key concern in reducing operational costs. Port infrastructure requirements are less onerous than in the installation phase, meaning that Irish ports should be able to participate with less need for additional investment. It is therefore likely that the majority of routine maintenance and operations activities will be carried out by Irish service providers operating out of Irish ports. However, major repairs on key components will likely still be performed by original manufacturers or installers.

The O&M phase stretches over the 30+ year lifetime of the asset, resulting in stable, long-term contracts being the norm, in contrast with other stages which last only 2 to 5 years.

Decommissioning phase

Decommissioning activities will likely be carried out by the same equipment as installation with specialised contractors who conduct installation activities. It is unlikely Irish service providers will be able to participate in these activities, for the same reasons outlined previously, though there will likely be opportunities for Irish ports to participate in providing staging and logistical services. Circularity is a key factor in decommissioning with recycling of components being increasingly important. Much of the steel used could be recycle and reused, while many blade manufacturers are switching to recyclable composites. Increasingly we are seeing lifetimes of wind farms extended as turbines and structures are lasting longer than expected. Similarly, there is an increase in wind farms being repowered, with new turbines and components at the end of life to continue to produce power, although specific permitting considerations will need to be taken into account.

4.1.2 Conclusions of supply chain analysis

Our economic analysis found a domestic GVA benefit of approximately €40 billion and 450,000 FTE years of employment directly associated with the delivery of Ireland's 37 GW offshore wind deployment ambition.[42] This includes within its scope the goods and services acquired as part of the project's lifecycle, from initial planning through construction and operation to decommissioning. It does not include the economic benefit associated with the sale, usage or export of the electricity produced by Ireland's offshore wind fleet, nor does it include any consideration of the economic benefit of carbon emissions reductions.

These figures assume that Ireland delivers interventions to capture the specific additional opportunities for local participation identified in preceding reports, chiefly:

- Investment in port infrastructure to deliver fixed installation capability and three ports with capacity to support assembly and integration of floating offshore wind foundations, operational from 2032.
- Investment in a local tower manufacturing facility, operational from 2030.
- Investment in a local synthetic rope and mooring line manufacturing facility, operational from 2032.

[41] National Port Study, GDG on behalf of Wind Energy Ireland, September 2022, available online at: https://windenergyireland.com/images/files/final-national-ports-study.pdf

[42] Figures consistent with analysis presented in Scenario 2 of the *Offshore Renewable Energy Technology Roadmap*, and the 37GW scenario of the *Offshore renewable energy export potential for Ireland* report (excluding impacts of hydrogen and interconnection)

- Ongoing action to support organic growth within areas of existing capability, through support for skills development and capacity building.

Overall, to best capture economic advantage from OSW Ireland should focus on the supply chain areas where it can best compete:

- Project development
- Consenting and engineering services
- O&M services
- Floating foundation assembly, marshalling, and integration services
- Select component manufacturing (e.g., towers, synthetic rope), and
- Digital services, including cyber security, across all project phases, building on Ireland's strong tech sector.

Securing the necessary investments to grow Irish capability to realise these benefits is a complex challenge. Above all else, securing supply chain investment depends upon the market's confidence in Ireland's clear strategic intent to deploy OSW at scale, continuously over a long period. This can be signalled through statements of ambition, backed up by bankable frameworks. This includes clear, timely and predictable frameworks for leasing, permitting, offtake and grid connection. However, other criteria and policy levers can also play an important role in securing such investments, especially in the context of an internationally competitive investment landscape. These include:

- A clear and targeted industrial strategy for OSW
- Investment incentives such as investment grants, tax incentives or preferential financing arrangements, and
- Relevant targeted skills development and R&D support to foster industrial clusters and growth of local expertise.

A first step in addressing this is outlined in Powering Prosperity - Ireland's Offshore Wind Industrial Strategy, which sets out measures to enable companies in Ireland to play a major role in the development of Irish projects, as well as supporting companies in Ireland to increase their activities in overseas markets. It also includes actions designed to support the Irish research, development and innovation sector to reach the cutting edge of future ORE developments, enhancing Ireland's reputation for research and innovation that supports globally competitive enterprises operating at the technological frontier.[43]

Implications for pathfinder floating offshore wind projects

Ireland is currently limited in its manufacturing capabilities to capture a significant proportion of the floating OSW supply chain. While Ireland has potential to contribute meaningfully to specific elements of the supply chain, it faces challenges in securing the necessary infrastructure and expertise to compete on a global scale without significant intervention. Initial floating OSW pathfinder projects in Ireland will likely need to rely heavily on expertise and manufacturing from other countries. This will include importing components and services due to the lack of domestic production capacity and experience. While some Irish companies may play a role in these projects, this approach could in many areas involve higher costs and potentially slower delivery timelines due to Irish providers' comparative lack of expertise. However, it provides an invaluable opportunity for these companies to develop expertise and capabilities that could be leveraged in future commercial-scale projects.

While some supply chain elements, such as synthetic rope manufacturing, could be attracted to Ireland, pathfinder projects alone are unlikely to provide sufficient demand to justify investment in new facilities. A confirmed pipeline of commercial-scale projects, coupled with supportive government policy, will be necessary to attract international companies to establish operations in Ireland. This could include joint ventures with Irish firms or the establishment of new manufacturing facilities.

[43] Powering Prosperity – Ireland's Offshore Wind Industrial Strategy, Department of Enterprise Trade and Employment, March 2024, available online at: https://enterprise.gov.ie/en/publications/powering-prosperity.html

To support supply chain growth, Ireland's port infrastructure will be critical. This is especially important for capturing the floating foundation assembly, marshalling and integration activity which has potential to deliver significant economic benefit to Ireland, while also representing the lowest cost solution for floating OSW deployment.

Ports upgrades with pathfinder projects in mind should be careful to make sure they are not limiting options for commercial-scale projects, ensuring scalability and long-term viability. Such upgrades should focus on flexibility, accommodating a range of supply chain needs, without becoming overly specialised for early-stage projects. This approach will enable Ireland to adapt as the industry matures and diversifies.

The best way to build Ireland's supply chain will be to focus on the areas where expertise already exists, where there is lack of industry elsewhere, such as in synthetic rope manufacturing, and where expertise can be attracted from international supply chains. By fostering this combination of imported expertise and domestic capability building, Ireland can position itself as a more competitive player in the floating OSW industry. This approach, supported by robust infrastructure and a clear pipeline of projects, has the potential to attract both Irish and international companies to invest in the sector.

Pathfinder floating OSW projects in Ireland could be used as an effective stepping stone to build Irish supply chain capability. If choosing to pursue a pathfinder project or projects, the best outcomes can be achieved by:

- Ensuring that before proceeding to deploy a pathfinder project, the right domestic port capabilities are in place to support assembly, marshalling and integration of floating OSW foundations and turbines, to maximise this most salient opportunity for Irish participation and learning.
- Recognising that pathfinder projects, unless backed up by a solid and pipeline of commercial scale floating offshore wind projects, are unlikely to result in significant investment in increased domestic supply chain capability.
- Noting that in practice, developers will typically choose the lowest cost and lowest risk supply chain partners to deliver their projects, irrespective of whether they offer Irish content. Government's ability to specify use of Irish suppliers is highly restricted due to EU and WTO trade agreements. In this context, it is not possible to guarantee a high level of local content or usage of specific domestic suppliers.
- Nevertheless, government intervention to promote use of Irish suppliers and investment in the supply chain can be impactful in growing investor confidence, driving supply chain growth by demonstrating firm government engagement and a business-friendly environment. Agencies such as Enterprise Ireland and IDA Ireland are active in this area, building upon Ireland's strong expertise and track record in attracting Foreign Direct Investment.

5. Ireland's floating offshore wind collaboration opportunities

5.1. Collaborative development in the Celtic Sea

5.1.1 Offshore wind in the Celtic Sea

In early 2024, The Crown Estate (TCE) launched Leasing Round 5 (LR5) targeting up to 4.5 GW of floating offshore wind in the Celtic Sea. The Celtic Sea was chosen for its favourable wind conditions, proximity to energy users and deep waters, positioning the UK to establish a new floating offshore wind industry. TCE plans to launch the second stage of the invitation to tender process for LR5 in Spring 2025. The UK Government has indicated there is potential to unlock a further 12 GW of offshore wind capacity in the Celtic Sea by 2050.[44]

In August 2024, GB's National Grid Electricity System Operator (now National Energy System Operator) outlined recommendations to facilitate the connection of TCE's planned 4.5 GW of floating offshore wind by 2035 as part of their holistic network design.

TCE has identified two key investment areas to accelerate offshore wind development in the Celtic Sea:

- Ports to support the construction, assembly, integration and delivery of offshore wind turbines, and
- The UK's OSW supply chain, including manufacturing, R&D and training facilities to strengthen its capabilities and capacity.

Recognising revenue uncertainty and volatility in these early investments, TCE plans to co-invest with aligned partners to expedite deployment in the UK.

Further, industry in the French Celtic Sea is also pursuing floating OSW, with the 250 MW South Brittany floating offshore wind auction winners announced in May 2024. France is also planning for a second 500 MW floating project in the region to be auctioned in 2025 or later. Both projects will share a grid connection. While collaboration with France in the Celtic Sea is possible, this report section focusses on GB opportunities.

5.1.2 Collaboration opportunities

Offshore wind in the Celtic Sea presents opportunities for Ireland and the UK to collaborate, contributing to development, energy security and economic growth. This region is set to become a key area for floating OSW, offering potential to share opportunities between both nations.

Examples of collaborations

Collaboration between nations regarding offshore wind has historically been rare, with competition for local supply chain generally being the bigger concern. However, as the industry matures, and governments begin to take a more holistic view of their energy infrastructure, opportunities for collaboration may increase. Some examples of existing international collaborations are given below.

In 2017, the North Sea Wind Power Hub (NSWPH) was formed by Denmark, the Netherlands and Germany. The NSWPH aims to create shared, centralised offshore energy hubs for connecting large offshore wind farms to multiple countries via a shared grid. This initiative plans to establish its first hub in early 2030.

Similarly, The North Seas Energy Cooperation (NSEC) is a coalition of countries aiming to support collaboration in renewable energy production, including development of an offshore grid. Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden and the European Commission are currently members of the corporation. The UK withdrew in 2020 due to its exit from the European Union, however it signed a memorandum of understanding to continue cooperation. The NSEC's aim is to optimise the integration of

[44] HM Treasury, November 2023, https://www.gov.uk/government/publications/autumn-statement-2023/autumn-statement-2023-html#fnref:158.

offshore wind into the European energy market, enhance energy security, and reduce costs by encouraging cross-border projects and sharing best practices in offshore wind development.

In 2023, six ports from Belgium, Denmark, France, Germany, the Netherlands and the UK committed to working together to accelerate offshore wind deployment in Europe. These ports acknowledged that port capacity is a bottleneck in achieving Europe's ambitious target of 65 GW of offshore wind target by 2030. Although ports compete with each other, this collaboration aims to share capacity, foster learning, optimise processes and develop innovations to accelerate offshore wind deployments.

Hybrid interconnectors, where wind farms connect directly into interconnectors between countries, have not been built to date, but are being considered by a number of countries. For example, Denmark is currently developing two energy islands to act as offshore connection points for a number of offshore wind farms. The two energy islands will generate excess wind power, allowing Denmark to export surplus electricity to neighbouring countries. To aid this, Denmark has established political agreements with neighbouring countries to jointly connect the energy islands to their grids. These agreements will guide cooperation between system operators and international partners as they explore potential connection designs.[45]

Potential collaborations between Ireland and the UK

Construction ports

In 2022, GDG and Wind Energy Ireland assessed the suitability and upgradability of Irish ports to support offshore wind projects.[46] GDG concluded that no ports in Ireland are currently suitable for offshore wind deployment. In the Irish and Celtic Seas, Belfast is the only port that currently has the capabilities to supply offshore wind farms in the region. However, plans are in place to deliver upgrades to Irish ports, such as Cork (which began construction in November 2024), Rosslare and Shannon Foynes, while there are also plans to develop mainland UK Celtic Sea ports such as Port Talbot and Milford Haven which could service Irish projects. It's important to note these are only plans currently, with no firm commitments yet being made. These ports are well positioned to support Irish and UK Celtic Sea projects, which may be crucial given the scale and technological needs of floating OSW. However, securing finance to upgrade ports can be difficult, due to the long lead times for construction, and the need for a long term bankable offshore wind pipeline to guarantee returns on investments.

In Ireland, under National Ports Policy, Irish Commercial State Ports operate on an independent commercial basis and do not receive exchequer funding. Securing investment for Irish Commercial State Ports could be supported through funding and financing streams, such as the Connecting Europe Facility and the Irish Strategic Investment Fund.

If funding could be supplied, coordinated port upgrades could be supported by government to ensure a holistic approach is taken and the maximum benefits can be secured.[47] Due to scale of port facilities required to support marshalling, assembly, integration and installation of large scale floating offshore wind farms, a multi-port strategy may be employed to facilitate delivery.[48] The need for many ports to service UK and Ireland's floating OSW pipeline means there is likely to be opportunity for ports on both sides of the Irish sea to coexist and mutually benefit, enhancing opportunities for collaboration to de-risk delivery.

Ireland and UK could partner to develop and upgrade construction ports in strategic locations like Cork or Port Talbot, optimising logistics and sharing capacity through greater coordination and reducing costs for regional

[45] Denmark's Energy Islands, Danish Energy Agency, accessed October 2024, available online at: https://ens.dk/en/our-responsibilities/offshore-wind-power/denmarks-energy-islands

[46] National Port Study, GDG on behalf of Wind Energy Ireland, September 2022, available online at: https://windenergyireland.com/images/files/final-national-ports-study.pdf

[47] Offshore Renewable Energy Technology Roadmap, BVG Associates and Beauchamps on behalf of SEAI, June 2024, available online at: https://www.seai.ie/renewable-energy/ocean-energy/ocean-energy-technologies/ocean-policy-and-funding/offshore-renewable-energy

[48] Floating wind: Anchoring the next generation offshore, RenewableUK, October 2024, available online at https://www.renewableuk.com/news-and-resources/publications/floating-wind-anchoring-the-next-generation-offshore/

projects. Collaboration would support the assembly, deployment, and maintenance of turbines in the Irish and UK Celtic Sea, ensuring smoother project delivery and boosting regional economies.

Though capable ports on both sides of the Celtic Sea is beneficial in terms of de-risking project delivery, collaboration on port developments is likely to be challenging in practice, as ports operate in a competitive commercial environment in which open cooperation is difficult. The UK and Irish Governments could play a leading role as trusted convenors of international collaboration groups, bringing together ports and developers to find mutually beneficial multi-port delivery strategies. Each government is nevertheless likely to wish to prioritise their domestic supply chain, making successful collaboration challenging to implement.

Interconnection

An opportunity for Ireland and GB lies in developing an interconnected offshore grid. By pooling resources, both countries can ensure that energy is efficiently exported and shared, enhancing energy security. A shared grid would allow for surplus electricity generated by offshore wind farms to flow between Ireland and GB, helping balance supply and demand and potentially allowing both countries to export electricity to Europe.

This collaboration could also bring economic and environmental benefits. For example, developing a hybrid interconnector with multiple offshore wind farms connecting to a single interconnector with a single landfall in each country, minimises the need for multiple individual radial connections, reducing the overall infrastructure footprint and delivering cost efficiencies for each project. Landfall of export cables can be an area where environmental sensitivities can be particularly high, therefore reducing the number of incoming cables is particularly attractive from an environmental consenting perspective. This in turn reduces consenting costs as less studies and surveys are required. Areas closer to GB and Europe, such as the east and southern coasts, are particularly attractive for interconnector development. Section 5.5 discusses interconnection in more detail.

An alternative opportunity could be in cross-border connection. Here the same principles as interconnection apply, except the project is located in one jurisdiction and connects only to a single other. For cross border connection, the same benefits and drawbacks apply, however the jurisdiction hosting the wind farm will not be able to benefit from the green power created. Therefore, it is more likely to be an option for later projects, when Ireland's internal demand is already met.

Analysis in Section 2.2.2 shows 2 GW of fixed projects (in addition to the 4 to 5 GW from the SC-DMAP) and 10s of GW of floating OSW which could be developed in the Irish Celtic Sea. These could be connected to GB market, either via a hybrid interconnector, or via transmission back to the Irish grid and then onto an interconnector.

Countries with a growing offshore wind industry face increasing pressures to optimise spatial efficiency and reduce impacts on other regional industries. An interconnected offshore grid offers an alternative connection point for future wind farms. It also improves energy efficiency by reducing transmission losses as high voltage direct current technologies are likely to be used. Additionally, this initiative will support both countries in achieving their climate and energy targets by promoting renewable energy and reducing carbon emissions.

Interconnection opportunities are discussed in more depth in Section 5.5 and in AFRY and BVGA's report *Offshore Renewables Export Surplus WS2 –Electricity Interconnection Quantitative Assessment Report*.[49]

Research and innovation

Collaboration on R&D and innovation has the opportunity to improve efficiency, reduce costs, and strengthening supply chains in both regions. The Offshore Wind Centre of Excellence, as set out in Powering Prosperity (Action 25), should collaborate with the UK's equivalent body, ORE Catapult, to drive innovation

Key collaboration opportunities could include:

- Joint Testing & Demonstration – Shared access to test sites to accelerate technology validation.

[49] Offshore Renewables Export Surplus WS2 – Electricity Interconnection Quantitative Assessment Report, AFRY and BVGA on behalf of DECC, November 2023, available online at: https://consult.decc.gov.ie/en/system/files/materials/509/Economic%20Analysis%20WS2.pdf

- Grid Integration R&D – Research on subsea interconnectors and smart grids to enhance market integration.
- Advanced Materials & Manufacturing – Development of lightweight, durable components for cost reduction.
- Skills & Workforce Development – Joint training programmes to address industry skills gaps.

5.1.3 Barriers to collaboration

While offshore wind development in the Celtic Sea offers significant opportunities for collaboration between Ireland and the UK, there are several challenges and barriers that must be addressed to make cross-border cooperation successful. These barriers range from competitive dynamics between developers to logistical and regulatory hurdles. The main challenges are presented below.

Competition for resources

As demand for port services increases, Irish and UK developers may compete for access to key facilities like ports, or for people and skills. Ports with deepwater access and specialised equipment to handle large-scale offshore wind components will be critical and, if not managed carefully, a lack of suitable available infrastructure can lead to project delays and increased costs.

O&M ports need to be located as close to wind farms as possible to reduce downtime and excessive journey times for crew. Using shared O&M ports is therefore unlikely as they will be poorly positioned for at least one of the two markets.

Construction ports offer more opportunity for collaboration than O&M ports, as infrastructure requirements are more onerous and proximity to project site is less critical. However, developers will often enter into exclusive arrangements with ports, to guarantee facilities are available for when they need them. A more complex arrangement will be needed if multiple ports are to be used. Although the increased port infrastructure requirements associated with floating OSW relative to fixed make a multi-port strategy more likely, a decision on whether to pursue a multi-port option for construction will ultimately be made by the developer. Any increased complexity may deter some, preferring to keep to a single port. If Ireland and the UK were to share installation ports, it may lead to disagreements over location and control, as each party may want to prioritise infrastructure in their own country.

Further, the mechanism for facilitating coordinated investment in ports between the two nations is currently unclear, and progressing such collaboration arrangements could be challenging in the context of each country's desire to maximise its own share of project spend. Further, ports are generally private entities not owned by governments, with their own interests and plans. Coordinating cooperation between these companies, who may be in competition with each other, could be challenging.

Prioritising internal economic benefit

Cross-border investment in infrastructure, such as ports or interconnection, is unlikely to be feasible. Governments will be reluctant or unable to invest in infrastructure outside their domestic markets due to the lack of direct economic benefits, preferring to maximise internal job and value creation over a shared approach, even if it is more efficient. For example, politically it is likely untenable for the UK Government to support upgrades in Cork when Port Talbot also requires investment, making such cross-border investments improbable.

A potential solution could be a coordinated joint investment package benefitting both UK and Irish ports; however, this approach risks adding complexity to an already challenging issue without clear advantages.

Regulatory frameworks and permitting processes

Offshore wind projects are subject to rigorous permitting and environmental assessments, which differ between countries. This introduces additional complexity in terms of negotiating new regulatory and financial frameworks for shared infrastructure.

While permitting for interconnectors is well understood, additional complexities are caused by hybrid interconnectors with wind farms connected directly to the interconnector. While technically feasible, no offshore wind farm has been connected to a hybrid interconnector to date. Therefore, there are likely to be significant

regulatory and consenting difficulties in developing a first of a kind hybrid interconnector. Issues such as how to account for the power delivered to each market, who would pay for any curtailment, and doubling of permitting requirements for grid connection are all likely to increase development cost and complexity which will be passed on to consumers. Further, developments that span both countries may need to comply with the environmental laws and regulatory processes of both countries, introducing delays and additional costs. This is however beginning to be addressed through the Offshore Wind Delivery Taskforce (OWDT) to develop an offshore bidding zone framework and action plan for grids, which will aim to support permitting acceleration.

Differing objectives and priorities

Ireland and the UK may have differing priorities when it comes to energy security, renewable energy targets, innovation and economic goals. While there is currently a memorandum of understanding between the UK and Ireland governments, the long term nature of offshore wind and interconnector development does not necessarily mean this collective effort will be continued as governments change.[50] Without a coordinated vision, joint projects risk becoming hindered by political and regulatory disagreements.

Further, a key challenge is caused by UK-EU trading relationship which may impact on viable collaboration, this may need additional effort to overcome.

5.2. All Ireland approach

Using our analysis of the OSW capacities around the Republic of Ireland, this section will present the potential to export energy to and from Northern Ireland, including assessment of the current grid constraint. It will also discuss the potential for sharing of skills and supply chains between the two countries.

5.2.1 Energy sharing

The electricity grids of Northern Ireland and the Republic of Ireland are integrated with the single electricity market, allowing for the seamless exchange of power across the island within a unified wholesale market. This cross-border connection is supported by two main 275 kV transmission lines. Additionally, the North-South Interconnector project, under development, aims to further strengthen the grid by adding a new 400 kV link, enhancing the island's capacity for renewable energy transmission and cross-border electricity flows. This link is planned to be commissioned by 2026.

Despite the existing and planned interconnections, the electricity links between Northern Ireland and the Republic of Ireland face constraints. Limited capacity on the two main existing cross-border transmission lines can result in bottlenecks. The North-South Interconnector is expected to alleviate some of these constraints, with 1,500 MW of additional capacity, but this could quickly become used up if higher volumes of renewable energy are developed on either side of the border, requiring transmission.[51]

Our analysis shown in Section 2 estimates a potential capacity of up to 5 GW of fixed OSW and 12 GW of floating OSW in the northern region. Offshore wind farms in this region have the potential to be built in Irish waters, but export to Northern Ireland, either through Irish landfall and onshore connections, or direct offshore connection and landfall in Northern Ireland.

Connection of Irish offshore wind farms directly to demand centres in Northern Ireland could help Northern Ireland access Irish offshore wind energy generation without adding additional pressure on cross-border transmission lines. It does however mean that wind farms in the northern region on Irish sea bed may not be able to supply Irish consumers while there are grid and interconnection constraints.

[50] Energy transition, offshore renewables and electricity interconnection cooperation: GB - Ireland memorandum of understanding, GB Department of Energy Security and Net Zero, September 2023, available online at: https://www.gov.GB/government/publications/energy-transition-GB-ireland-memorandum-of-understanding

[51] North-South 400KV Interconnection Development, EirGrid, 2017, available online at: cms.eirgrid.ie/sites/default/files/publications/North-South-Interconnector_Comparative-Assessment-of-Transmission-Techno....pdf

Figure 2.10 shows that while the wind farms would be very close to Derry/Londonderry, there is still a significant onshore distance that would need to be covered to reach Northern Ireland's main demand centre in Belfast. There may be significant upgrades required to Northern Ireland's grid to be able to do this.

5.2.2 Skills sharing

Building our Potential identified the skills shortages for OSW in Ireland. We have compared this to the skills availability in Northen Ireland and provided a qualitative summary of the potential Northern Ireland had in helping to fulfil these skills gaps.[39,52]

Table 5.1 Skills sharing between Republic of Ireland and Northern Ireland.

Phase	Skill/Role	Republic of Ireland (ROI) skills shortage	Northern Ireland (NI) opportunity to support
Development and project management	Management skills and senior roles	Difficulty in hiring EIA and other environmental management type roles due to lack of offshore expertise and experience	NI will possess some of these skills from existing offshore wind developments in the country, however, these numbers will be small because of the size of NI and its OSW market
	Electrical skills	Short supply of electrical engineering knowledge for large-scale energy systems, particularly offshore	NI has some electrical engineering capability, although a shortage still likely
	Engineering skills	Marine, civil, structural, geotechnical, and mechanical engineering are bottlenecks despite Irish capability	NI has a reasonable level of engineering design and consultancy expertise, particularly from its heritage in shipbuilding, that could support ROI
Manufacturing	Skilled trade workers	Severe global shortage of skilled trade workers such as welders, fabricators, and electrical technicians	There is a global shortage of skilled trade workers, however NI has a long history in these fields with companies such as Harland and Wolff, and a significant aerospace industry based there and able to manufacture a range of components
	Offshore qualifications	Greater shortage of workers with qualifications required to work offshore	While NI suppliers could support port side activities of turbine and foundation installation, there is less expertise in offshore construction
	Construction management skills	Struggling to hire for construction management roles; shortage likely to intensify	NI personnel could help boost ROI's construction management skills, with a strong construction management base in the country
Operations, maintenance and service	Maritime training	Potential shortfall due to growth in offshore wind capacity; lack of offshore wind experience and skills	NI has a large maritime industry which may be able to help support the maritime training of ROI workers
	Health and safety expertise	Shortage of offshore health and safety expertise; current training	NI's history of maritime and industrial expertise leads to

[52]The Clean Revolution Building Northern Ireland's Offshore Wind Industry, BVG Associates on behalf of Renewable NI, available online at: https://renewableni.com/wp-content/uploads/2022/09/The-Clean-Revolution-%E2%80%93-Building-Northern-Irelands-Offshore-Wind-Industry.pdf

	schemes aimed at onshore activities	strong expertise in health and safety
Electrical skills	Lack of electrical expertise, particularly in high voltage and DC systems, presenting a major bottleneck	NI has some high voltage and DC systems capability although a shortage still likely

5.2.3 Port sharing

As discussed in Section 5.1.2, while there are plans to upgrade a number of ports around Ireland, currently the country has no ports suitable for the development of offshore wind farms. However, on the island of Ireland, Belfast port has the available size and infrastructure to be able to support both fixed and floating OSW installations, although a height restriction due to the nearby airport precludes it from conducting floating turbine integration activities. It has already acted as the installation port for the Walney Extension offshore wind farm in the Irish Sea and could continue to support wind projects around both the UK and Republic of Ireland. In the near term, while Republic of Ireland ports are still building their capacity, Belfast Harbour could help deliver offshore wind projects which will help the Republic of Ireland meet its 2030 targets.

5.3. Scotland and wider UK skills sharing

Ireland, Scotland, and the wider UK have ambitious renewable energy targets, with offshore wind playing a pivotal role in the energy transition for each region. Collaboration in skills sharing across these regions presents a strategic opportunity to bridge skill gaps, leverage strengths, and meet industry demand. While each country has its own strengths in offshore wind expertise, they also face unique challenges.

5.3.1 Scotland

Scotland is a recognised leader in the offshore wind sector, with historical expertise developed from North Sea oil and gas activities, seven offshore windfarms currently operating in Scottish waters, and a pipeline of over 30 GW of planned projects. This provides a wealth of skills in engineering, marine operations, and project management, especially for challenging offshore environments. Scotland also boasts established research institutions and training programs focused on renewables. However, Scotland also has large ambitions for its offshore wind industry, so may compete for a limited workforce. Ireland, through the Department of Enterprise, Trade and Employment, is already leading efforts to foster collaboration between Scottish and Irish supply chain. This has included running showcase events and trade missions.[53] Initiatives such as these are a good first step in creating collaboration opportunities.

5.3.2 Wider UK

The UK has the second largest installed offshore wind capacity in the world, and the largest in Europe. This is supported by a wide range of engineering firms, consultancies, and academic institutions focused on renewable energy research. Despite this strength, the UK's offshore wind industry faces a skills gap due to a fast-paced expansion of the industry.[54] Increased cooperation Ireland could help balance workforce demands while offering opportunities for cross-border training and knowledge exchange, especially in new technologies and operational efficiencies. However, competition for limited personnel is also likely.

[53] Ireland and Scotland collaborate to advance the offshore wind opportunity, Department Enterprise Trade and Employment , June 2024, available online at: https://enterprise.gov.ie/en/news-and-events/department-news/2024/june/12062024.html

[54] Offshore Wind Skills Intelligence Report, Offshore Wind Energy Council, Jun 2023, available online at: https://www.renewableuk.com/media/hgzfsc2r/owic-offshore-wind-skills-intelligence-report-2023-executive-summary.pdf

5.3.3 Opportunities for Skills Sharing and Collaboration

Workforce Mobility and Training Initiatives

Ireland, Scotland, and the wider UK could benefit from "skills passports", workforce mobility frameworks, allowing skilled workers to move between regions to meet project demands. Creating standardised training programs and certifications for the offshore wind industry across these regions would enable greater flexibility and shared competencies. For example, developing joint apprenticeship programs or exchange opportunities would allow workers to gain hands-on experience in diverse offshore environments, enhancing their technical and safety skills.

Cross-Border Research and Development

Pooling resources for R&D can accelerate technological advancements that benefit all regions. Collaborative efforts in floating OSW technologies could reduce costs and create scalable solutions that work in deeper waters where wind speeds are higher. In particular we recommend a cross-border data sharing initiative is enacted, where data from Ireland's plan-led surveys is made available to UK research institutions to support their analysis; in turn UK institutions could share data from floating OSW R&D institutions, such as the ORE Catapult, which may help Ireland develop its projects and supply chain. Data from the demonstration projects discussed in Section 3.2 could also be shared, but it should be recognised that these are developed and owned by private companies who have commercial interests to consider.

The UK and Ireland could also pool resources to help fund new innovation, if parties from both countries are involved. A similar approach was previously run by Innovate UK with the US' National Offshore Wind Research and Development Consortium.[55]

Supply Chain Integration and Resource Allocation

Supply chain coordination between the UK and Ireland presents an opportunity, albeit with significant challenges. Lessons from the aviation industry suggest that cross-border collaboration can facilitate more strategic coordination of supply chain activities, leading to a collaborate rather than compete system. In particular, the coordinated supply of components for Airbus between the UK, Germany, Spain, and France could offer a model for shared supply chain in OSW. However, the OSW supply chain is composed of a complex network of private companies producing a diverse range of components, with limited oversight from any single entity, making such collaboration difficult to implement. As a result, direct government intervention in OSW is inherently challenging, given the decentralised and market-driven nature of the supply chain. Globally, countries typically compete to attract supply chain facilities in order to secure investment, jobs, and economic benefits. Despite potential opportunities, Ireland and the UK are unlikely to break this dynamic.

While agreements to fund and support specific areas of the supply chain are a possibility, the long-term direction of the industry is likely to be driven by market forces.

5.4. Other collaboration opportunities – Norway, France, Portugal and Spain and other EU, UK or international

As well as collaboration opportunities with Scotland and the wider UK, other European markets offer opportunities for Ireland. Collaboration with other European countries presents opportunities for knowledge exchange, technological advancement, and resource sharing.

Similar opportunities for collaboration as between the UK and Ireland, exist for other European countries and Ireland. These include:

- Ports sharing

[55] UK-US Offshore Wind Collaborative R&D, Innovate UK, October 2023, available online at: https://apply-for-innovation-funding.service.gov.uk/competition/1731/overview/e61c2b8e-d856-4965-bc1c-e54f07b25dee

- R&D collaborations, and
- Workforce sharing.

Interconnection is also a key area for collaboration which is discussed in more detail in Section 5.5. A summary of collaboration opportunities for each of these countries is presented below in Table 5.2 to Table 5.4.

Table 5.2 Ireland-France collaboration summary

Opportunity	France	
	Opportunity	Challenge
Ports	While UK ports are closer and therefore likely to be more viable for supporting Irish projects, Ireland and France could partner to develop and upgrade some of the closer ports, allowing Irish wind farms to use a multi-port strategy.	Many ports in Northern France already have the capability to support OSW projects, there is a risk that if Irish ports are not developed in time, or with the right capabilities, then the wind farm developers will look to use French ports instead.
R&D	France has several floating OSW demonstration projects and a number of floating OSW test sites operating or in development, including, Sainte-Anne du Portzec, SEM-REV, and Mistral, all operated by OPEN-C. These test and demonstration sites could have valuable information to share with Ireland. Academic institutions are also involved in R&D of offshore wind in France, with several universities and research centres such as Ifremer and France Energies Marines working in the field. Ireland should approach the companies and institutions involved in these sites to identify what can be learnt, potentially offering shared innovation and research opportunities, such as shared innovation funding.	Floating OSW demonstrator projects are owned by private companies who have commercial interests to consider and may not be willing to share data.
Workforce	Creating standardised training programs and certifications for the OSW industry between France and Ireland would enable greater flexibility and shared competencies. This could include developing a centralised job database so workers can easily see opportunities in other countries.	France also has large OSW ambitions. It is possible that Irish workers could leave to work on French projects, leaving developers to compete for skills, driving up cost.

Table 5.3 Ireland-Norway collaboration summary

Opportunity	Norway	
	Opportunity	Challenge
Ports	Opportunities and challenges for Norwegian and Irish port collaboration is limited due to distance from Norway to Ireland.	
R&D	Norway has several floating OSW demonstration projects and a number of floating OSW test sites operating or in development, including Hywind Tampen, Utsira Nord, and METCentre. These test and demonstration sites could have valuable information to share with Ireland. Academic institutions are also involved in R&D of offshore wind in Norway, with several universities and research centres such as SINTEF and the University of Bergen working in the field. Ireland should approach the companies and institutions involved in these sites to identify what can be learned, potentially offering shared innovation and research opportunities, such as shared innovation funding.	Despite being owned by the Norwegian government, Equinor, which owns Hywind Tampen, has commercial interests to consider and may not be willing to share data. Any shared innovation funding is likely to require funding to both Irish and Norwegian innovators, potentially giving advantage to overseas companies.
Workforce	Creating standardised training programs and certifications for the OSW industry between Norway and Ireland would enable greater flexibility and shared competencies. This could include developing a centralised job database so workers can easily see opportunities in other countries. Norway has a number of OSW clusters which are willing to engage and collaborate with Ireland. Some Irish supply chain companies have already engaged with the Norwegian Offshore Wind Cluster.	While Norway has more limited OSW ambitions compared to other countries, it is possible that Irish workers could leave to work on Norwegian projects, leaving developers to compete for skills, driving up cost.

Portugal and Spain have a very similar set of opportunities for collaboration so have been grouped together.

Table 5.4 Ireland-Portugal/Spain collaboration summary

Opportunity	Portugal and Spain	
	Opportunity	Challenge
Ports	Limited opportunity. Portugal and Spain are unlikely to provide construction ports for Irish fixed OSW projects, however they do have experience in building floating foundations which could in theory be towed to Irish projects. This is unlikely however to represent a cost-effective solution, and it would be preferable for Irish projects to use closer ports.	Spain and Portugal's head start in floating OSW ports could lead to a risk that if Irish ports are not developed in time, or with the right capabilities, then the wind farm developers will look to use these ports instead, adding cost versus a local solution and leading to lower Irish economic benefit.
R&D	Portugal and Spain have several floating OSW demonstration projects and test sites operating or in development, including WindFloat Atlantic in Portugal, operated by Principle Power, and the BiMEP (Biscay Marine Energy Platform), and PLOCAN (Oceanic Platform of the Canary Islands) in Spain, managed by entities such as EVE (Ente Vasco de la Energía) and PLOCAN itself. These test and demonstration sites could have valuable information to share with Ireland. Academic institutions are also involved in R&D of offshore wind in Portugal and Spain, with organizations such as WavEC Offshore Renewables in Portugal and Tecnalia and PLOCAN in Spain actively working in the field. Ireland should approach the companies and institutions involved in these sites to identify what can be learned, potentially offering shared innovation and research opportunities, such as shared innovation funding.	WindFloat Atlantic is owned by a consortium of private companies who have commercial interests to consider and may not be willing to share data. Any shared innovation funding is likely to require funding to both Irish and Spanish or Portuguese innovators, potentially giving advantage to overseas companies who already have a head start in the industry.
Workforce	Creating standardised training programs and certifications for the OSW industry between Spain, Portugal and Ireland would enable greater flexibility and shared competencies. This could include developing a centralised job database so workers can easily see opportunities in other countries.	Spain and Portugal also have their own OSW ambitions. It is possible that Irish workers could leave to work on these projects, leaving developers to compete for skills, driving up cost.

In addition to the country-specific collaboration opportunities described above, there are also a number of EU-wide opportunities Ireland could seek to be further involved with. These include:

- ROMEO an initiative supported by the EU's Horizon 2020 programme, which aims to develop technologies to lower the O&M costs of OSW projects. In particular, this initiative may provide useful support for addressing O&M in Ireland's west coast regions.
- SET-Plan (Strategic Energy Technology Plan) aims to accelerate the development of new technologies focussing on OSW innovation and cost reduction. Ireland could participate in working groups focused on renewable energy integration and offshore grid advancements.
- European Energy Research Alliance (EERA) focuses on aligning European research in renewable energy, including offshore wind. The EERA Joint Programme on Wind Energy includes subprogrammes relevant to floating OSW and harsh marine environments, which could benefit Ireland's west coast developments.

5.4.1 Summary

Ireland can leverage international cooperation to strengthen its position in the OSW industry. Establishing standardised training programs and certifications across these nations would enhance workforce flexibility and shared competencies, ensuring a pool of skilled workers capable of operating in any of the countries. A centralised job database, accessible to workers in all participating countries, could facilitate skills mobility and match supply and demand across the region.

In port infrastructure, while Irish ports need to remain competitive within the EU, a multi-port strategy optimised in collaboration with other nations could create efficiencies and reduce logistical bottlenecks. Implementing such a strategy may face challenges due to the private ownership of many port operators, but coordinated efforts at a national and EU level could help overcome this barrier.

Collaboration on R&D offers significant potential benefits, particularly in advancing floating OSW technologies. Data sharing remains a challenge as intellectual property is often held by private companies. However, Ireland should proactively engage with stakeholders to explore opportunities for knowledge exchange, potentially securing insights to accelerate its own OSW advancements.

5.5. Hybrid and cross border generation interconnection opportunities

5.5.1 Interconnection and Transmission

There are a number of options for transmission of energy from an offshore wind farm, including radial connections (point-to-point links connecting the wind farm to the onshore grid) and hybrid connections that connect one or more offshore wind farms to an onshore grid or multiple regions or countries. Radial connections represent the current status quo. They generally rely on established technologies and involve one jurisdiction. This leads to fewer planning and permitting challenges, but restricts the flexibility of the generating unit as its output is dependent on the status of a single connection point. Hybrid connections are a newer concept and have greater flexibility by virtue of being connected to multiple regions or countries. This means they can also act as a transmission link between national grids, making them better-suited to large-scale projects that can benefit from being connected to multiple grids.

5.5.2 Method

The analysis below compares expected Irish OSW generation to demand in several potential partner markets.

The projections of wind generation are based on representative turbine types and deployment of capacity up to 37 GW by 2050, off the east coast (5.6 GW by 2050), in the SC-DMAP (4.5 GW), other parts of the Celtic Sea (11.4 GW), the southwest (11.1 GW), the northwest (2.3 GW) and the Malin Sea (2.1 GW). Using a database of historical wind speeds in these areas, we produced hourly generation profiles by region that are aggregated to

produce a projection of Irish offshore wind generation. This generation was then compared to Irish residual demand (demand less projected Irish onshore renewable generation from solar and wind (39.4 TWh in 2030, 56.6 TWh in 2040 and 71.1 TWh in 2050)) and any offshore generation that can be used to satisfy Irish demand was removed. What results is an estimate of the offshore generation available for export.

This generation has then been compared to the underlying and net-demand profiles of Belgium, France, Germany, GB, Netherlands and Spain. Demand in these markets has been taken from a previous study conducted by BVGA and AFRY to support DECC's Future Framework for Offshore Renewable Energy.[56] Net-demand removes the renewable generation as well as '*always on'* generation in each country and thus represents the level of demand that could be met by imported Irish offshore generation.

5.5.3 Results

The potential use of excess offshore generation when compared to underlying demand in neighbouring countries is universally 100% apart from Belgium (Table 5.5a). The correlation of Irish offshore exports with underlying demand is highest for GB and modest for all other countries, albeit all show a positive correlation (Table 5.5b). When changing the basis of the analysis to residual demand, the volume of Irish exports that can be consumed by each countries declines significantly (Table 5.5c), with only Germany able to offtake a majority of Irish offshore exports on an enduring basis. We also find the correlation of Irish offshore exports with local residual demand deteriorates significantly, with all countries displaying small negative correlations (Table 5.5d).

5.5.4 Conclusions

Ignoring the presence of domestic renewable generation in the assessed countries, it would appear that Irish offshore exports could be consumed by any of the identified markets, with GB a particularly attractive partner market given the high correlation of Irish exports with underlying GB demand. However, when considering the impact of domestic renewables generation in partner markets, there is no single market that is both large and exhibits a high correlation with Irish offshore exports, and particularly not the closest countries, GB and France, that would offer the cheapest interconnection.

With that said, we do not view the lack of correlation as a fundamental issue, as in reality, what matters is the hour-by-hour conditions on the grid. This is clearly exemplified in previous work by BVGA and AFRY which suggested there are good reasons to believe the economics of some additional interconnection from Ireland to other countries (particularly GB and France) are favourable.[57] Given the location of the SC-DMAP and the presumed timing of these projects commissioning, we recommend that government explore additional hybrid or radial connections from these to one or both of GB and France.

Looking further into the future, there may be a case for interconnection to markets that are further afield, albeit previous economic analysis suggests the economic case for these interconnectors is not necessarily favourable. Of particular interest are Belgium and Spain, where economic returns on interconnectors to these countries may be acceptable to the countries/state-owned stakeholders involved, who may have distinct objectives from private sector investors. For example, analysis of Belgian interconnector internal rates of return (real, pre-tax, unlevered) in 2040 (5%) and 2050 (5.5 to 7.9%) would suggest a rate of return that might be acceptable for projects that are Transmission System Operator (TSO) led and could offtake surplus energy from 2040.[55] For Spain, the economic case is less clear, with internal rates of return (IRRs) of 3.2% in 2040 and 3.6 to 5.8% in 2050, dependent on the level of interconnection.[55] However, the prominence of solar generation in Spain could be complementary to a wind dominated system like Ireland (Figure 5.1), which in turn suggests there may be security of supply advantages of interconnection to Spain that are not easily factored into a project IRR.

[56] Offshore renewables surplus potential WS1 – Market Analysis, AFRY and BVG associates, November 2023, available online at https://www.gov.ie/pdf/?file=https://assets.gov.ie/280993/186e66ba-555d-4412-b5b7-55fe15697167.pdf

[57] Offshore renewables surplus potential WS2 – Electricity interconnection quantitative assessment report, AFRY and BVG associates, November 2023, available online at https://www.gov.ie/pdf/?file=https://assets.gov.ie/280994/5b51e730-c63c-4055-9a81-69d4a0ac7ecd.pdf

Notwithstanding this context, under The National Policy Statement on Electricity Interconnection 2023 Ireland is open to both commercial and TSO developed interconnector projects, subject to appropriate feasibility and cost benefit analyses.

Table 5.5 Comparison of Irish offshore wind exports with demand

Irish OSW exports vs. underlying demand							
5.5a	% of exports covered			5.5b	Correlation		
	2030	2040	2050		2030	2040	2050
BEL	100%	99%	84%	BEL	15%	30%	31%
FRA	100%	100%	100%	FRA	18%	28%	28%
GBR	100%	100%	100%	GBR	13%	42%	50%
GER	100%	100%	100%	GER	15%	27%	25%
NET	100%	100%	98%	NET	8%	29%	28%
SPA	100%	100%	100%	SPA	7%	14%	16%

Irish OSW exports vs. residual demand							
	% of exports covered				Correlation		
5.5c	2030	2040	2050	5.5d	2030	2040	2050
BEL	94%	71%	50%	BEL	-4%	-16%	-16%
FRA	85%	67%	57%	FRA	5%	-1%	0%
GBR	78%	56%	48%	GBR	-27%	-28%	-20%
GER	98%	85%	81%	GER	4%	-6%	-6%
NET	93%	56%	39%	NET	-4%	-14%	-16%
SPA	89%	81%	59%	SPA	0%	8%	10%

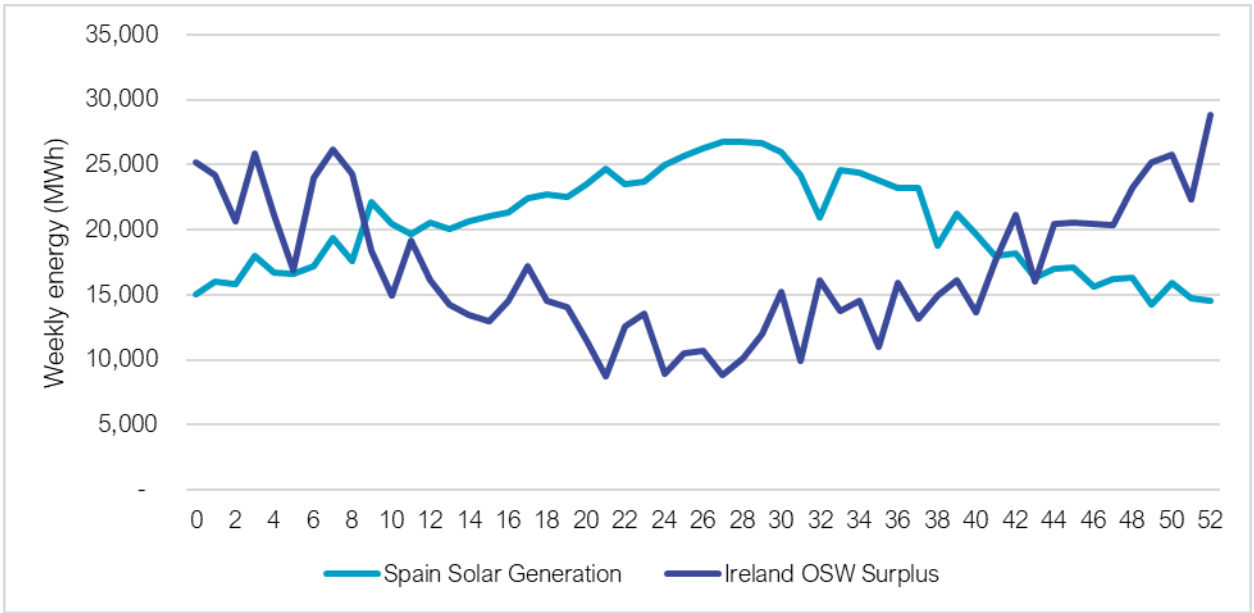

Figure 5.1 Weekly average OSW surplus exports and Spain solar generation in 2025

6. Conclusions

6.1. Location and sequencing

The fixed and floating regional capacities our analysis identified are shown in Table 6.1.

Table 6.1 Regional capacities.

Region	Existing planned capacity (GW)	Fixed capacity (GW)	Floating capacity (GW)	Floating consideration
East	3.8	2 to 5	4	Fixed wind should be prioritised - there is plenty of floating OSW capacity in other regions.
Celtic Sea	4.5	0 to 2	>25	Significant floating OSW capacity possible, likely to provide the best opportunities for Ireland's first commercial scale floating OSW projects.
Southwest	0	0 to 2	>25	Significant floating OSW capacity possible, the impact of more extreme metocean conditions on installations and O&M in particular likely need to be understood before commercial scale projects are developed, therefore commercial scale projects should either follow smaller scale demonstration projects in the region, or large scale deployment in the Celtic Sea.
Northwest	0	0.5 to 4	>25	Significant floating OSW capacity possible, however long distances to demand centres may make the grid infrastructure required to support projects in this region costly. Floating OSW is less feasible in this region unless significant grid upgrades or new flexible and responsive demand centres are developed.
Malin Sea	0	1 to 5	12	Unnecessary to develop floating OSW in this region as fixed wind should be prioritised and there is plenty of capacity in other regions.

Fixed OSW technology is currently better established and more economic to implement than floating OSW and is therefore the best strategic option in the near term. For fixed OSW, the analysis indicates that the east coast offers the most viable near-term opportunities. Its proximity to demand centres and shorter transmission distances are likely to reduce infrastructure costs, however this should be confirmed by further analysis and engagement with EirGrid. Other regions, such as the north coast, have higher potential capacity but likely require extensive and costly grid infrastructure to connect to demand centres, or development of new flexible and responsive demands such as hydrogen electrolysers or data centres. The Celtic Sea also offers some potential, but the area has already been largely addressed under the SC-DMAP process, leaving fewer opportunities for fixed projects. Smaller areas of potential in the southwest and northwest are constrained by size, proximity to shore, and likely consenting challenges, limiting their commercial viability.

In contrast, floating OSW offers significantly greater spatial flexibility, with deeper waters around Ireland providing vast potential development areas. While the east coast remains best-suited to fixed OSW, the Celtic Sea stands

out as the most favourable region for commercial-scale floating projects. Its relatively moderate metocean conditions, compared to the west coast, improve installation and operational feasibility, while its proximity to GB and continental Europe presents valuable interconnection opportunities. However, grid constraints mean that substantial grid upgrades or new flexible and responsive demand centres will be required to enable floating OSW development at scale. Over time, as technologies mature and experience is gained, floating OSW developments could expand westward, using more of the sea bed and high wind speeds available.

6.2. Technology strategy

While there is ample area to deploy floating offshore wind in Ireland, the technology is not yet demonstrated at a commercial scale. This means any early projects will come with increased risk and cost for Irish consumers. The areas suitable for fixed OSW should therefore be prioritised in the near future, with commercial scale floating OSW introduced slightly later, when the technologies have matured.

Further, despite the large area for potential development on the west coast, the harsh conditions mean new technologies, or O&M and installation techniques may be required to exploit the region. Therefore, these harsh conditions should be de-risked as much as possible before commercial scale developments in the region. This could either be done by starting development in the Celtic Sea, where conditions are comparatively milder, before working round the coast towards the west; or by developing pathfinder projects on the west coast to develop understanding of regional conditions. Pathfinder projects may also allow supply chain development and advancement of technical capability for operating in harsher environments. Floating OSW pathfinder projects however should be sure not to interfere with the development of commercial-scale OSW. The development of a floating pathfinder DMAP could be expedited by potentially using locations with existing data or available grid capacity to fast-track delivery. Scalability should also be considered, allowing smaller demonstration projects (e.g. 200 MW) to expand to larger capacities (e.g. 500 MW or more) as understanding of the conditions, grid infrastructure and other enabling factors mature. In addition, Ireland will have built up significant expertise in delivering fixed OSW development in the near term, which will make it easier to deliver the more challenging floating OSW in the longer term.

6.3. Supply chain

Ireland has significant potential to contribute to the fixed and floating OSW supply chain, but its current manufacturing capabilities, and size of its pipeline relative to other European countries, are probably insufficient to capture a large share of the market. If early pathfinder projects are developed, they will likely rely on a combination of international expertise, imported components, and Irish participation. Given the competitive commercial environment in which such a project is likely to be delivered, it makes sense for Ireland to focus on developing supply chain in areas where the logic for local supply is strong, and therefore Irish suppliers have the best prospect of participation. This includes:

- Project development, consenting and engineering services
- Select component manufacturing, such as towers or synthetic rope
- O&M services
- Floating foundation assembly, marshalling and integration services, and
- Digital services, including cyber security, across all project phases.

To maximise long-term opportunities, Ireland must invest strategically in its port infrastructure, ensuring it can support both pathfinder and commercial-scale floating OSW projects. Ports should focus on upgrades that offer flexibility and scalability, enabling them to meet the evolving needs of the industry. Additionally, a clear pipeline of commercial-scale projects and supportive government policies will be essential to attracting international manufacturers and supply chain players to establish operations in Ireland. By combining imported expertise with domestic capability building and infrastructure development, Ireland can lay the groundwork for a competitive and sustainable floating OSW sector.

6.4. Collaboration

There are many opportunities for Ireland to collaborate on fixed and floating OSW development.

The Celtic Sea represents a significant opportunity for Ireland and the UK to align their efforts in fixed and floating OSW development. As highlighted in Section 5.1, strategic cooperation on port upgrades, interconnection, and encouraging ease of skills mobility, could help overcome bottlenecks and deliver large-scale OSW projects. However, many barriers to cooperation also exist. Enabling cooperation of private ports, competition for limited resources and market share, regulator complexities and conflicting national priorities could all limit the opportunities for collaboration.

To help establish and maximise the benefits of this collaboration Ireland should:

- Open dialogue with the UK Government to identify opportunities for separate, but coordinated port investments
- Encourage dialogue between Irish and UK Celtic Sea ports to discuss how a multi-port strategy could work
- Continue to develop interconnection opportunities, and
- Ensure skilled OSW workers from both countries are able to continue to work across borders, potentially enabled by a shared skills/jobs directory.

Cross-border cooperation between Northern Ireland and the Republic of Ireland can also support OSW development. Integrated electricity transmission, enhanced grid infrastructure, and shared skills and resources are key to overcoming current challenges, particularly in the face of grid capacity limitations. Northern Ireland's port capabilities and workforce expertise can complement the Republic of Ireland's OSW goals and help to enable projects.

To explore the potential for cooperation, Ireland should:

- Understand the regulatory requirements which may allow offshore wind farms in the north of the island to export energy to Northern Ireland, and
- Establish a working group with Northern Ireland's Department of the Economy (which manages energy policy in Northern Ireland) to discuss how to encourage cooperation.

Collaboration between Ireland, Scotland, and the wider UK in offshore wind offers mutual benefits, particularly in workforce development. Scotland and the UK's OSW expertise provides opportunities to share skills and knowledge. However, competition for a limited workforce remains a challenge. To encourage skills sharing between the countries, Ireland should:

- Work to establish shared training programs and job mobility frameworks to help address skills shortages, and
- Aim to set up resources for joint R&D funding on floating OSW technologies which aim to reduce costs and accelerate innovation.

In addition to the UK and Ireland, other European nations like France, Norway, Portugal, and Spain offer valuable opportunities for collaboration. In particular, working across borders on R&D of floating OSW technologies which aim to reduce costs in more extreme metocean environments could provide significant benefits for all countries.

6.5. Should Ireland be an early mover or fast follower in floating offshore wind?

Ireland's position in the floating OSW sector suggests that a fast-follower strategy would be more effective than pursuing an early-mover approach, unless accompanied by substantial investment and risk-taking. While Ireland's extensive offshore resources offer substantial potential for floating OSW, several factors make it challenging to lead the industry at this stage.

Ireland's floating OSW pipeline is modest when compared to the broader European market, which already includes countries with advanced projects, established supply chains, and significant industrial capacity. In many ways, this head start from other countries already positions Ireland as a fast-follower, with projects such as the

UK's Greenvolt receiving a Contract for Difference in September 2024.[58] While there may be benefits to Ireland's R&D ambitions, long term capability, and job creating, unlike nations with existing heavy industry or marine engineering expertise, Ireland lacks the industrial base and large ports needed to rapidly scale floating OSW manufacturing or deployment. Additionally, as a high-wage, service-oriented economy, Ireland is unlikely to attract large-scale manufacturing activity without offering significant financial incentives. Even with substantial investment, capturing a meaningful portion of the global floating OSW supply chain would be uncertain.

Given these realities, Ireland is better-positioned to adopt a fast-follower approach. This would involve focusing efforts on unlocking Ireland's fixed OSW opportunity, especially on the south and east coasts, while driving forward development of enabling technologies and infrastructure for the challenging conditions of the west coast and Celtic Sea, ensuring the country is ready to capitalise when floating OSW becomes more commercially established, and benefit from cost reductions already achieved by projects in other markets. By supporting pathfinder projects, investing in grid upgrades, and enhancing supply chain readiness, Ireland can position itself to deploy floating OSW projects efficiently and at scale once the market matures.

An early-mover strategy would require significant public investment to subsidise industry growth and infrastructure, with no guaranteed return. For Ireland, such a strategy may not yield proportionate economic benefits given the limited scale of its domestic market and supply chain potential. Instead, a fast-follower approach allows Ireland to benefit from the technological advances and cost reductions achieved by early movers, while still playing a significant role in the industry's long-term development.

Even as a fast follower, there are many areas of the floating OSW supply chain in which Ireland could enjoy significant participation, with associated economic and employment benefits. To maximise these benefits, Ireland should prioritise:

- Investment in port infrastructure to deliver assembly, marshalling and installation capability.
- Ongoing action to support organic growth within areas of existing capability, especially in project development and O&M, through support for skills development and capacity building.
- Ongoing vigilance, for opportunities to capture further inward investment, for example in tower or synthetic mooring line manufacturing, backed up by appropriate investment incentive schemes.

Ultimately, Ireland's focus should remain on strategic readiness: enabling the west coast and Celtic Sea to host commercial-scale floating OSW projects once the technology and market conditions align, likely in the mid-2030s. **Capturing this opportunity requires action starting from now.** OSW development has a long lead time, and spatial planning to allow industry confidence and public understanding is crucial to ensure readiness to begin developing these projects. Identifying areas for future floating projects in the near term will allow a clear pipeline of projects to be seen, allowing strategic upgrade of the grid, supporting infrastructure and companies to prepare to support the industry. This pragmatic approach ensures Ireland remains competitive in floating OSW without incurring undue risk or financial burden.

[58] Green Volt CfD Boosts UK Floating Wind, ReNews, September 2024, available online at: https://renews.biz/95461/green-volt-cfd-boosts-uk-floating-wind/

7. Recommendations Summary

The recommendations stated throughout the report are gathered and summarised below:

Commercial project recommendations

- Ireland's near-term OSW strategy should prioritise commercial scale fixed OSW, with commercial scale floating OSW introduced slightly later, when the technologies have matured.
- The most immediate opportunities for commercial scale fixed OSW projects are on the east coast due to proximity to demand centres and shorter transmission distances, however there are still significant grid challenges.
- Although fixed OSW deployment should be prioritised in the near term, deploying floating OSW from the mid-2030s requires action starting from now. Identifying sites early through marine spatial planning will build investor confidence and public understanding and facilitate development of supporting infrastructure and supply chain.
- Grid is a key issue for commercial scale projects. Government should prioritise enabling EirGrid to develop the grid infrastructure required.

Floating pathfinder recommendations

- If floating pathfinder projects are deemed desirable, to ensure any learnings can feed into the development of commercial-scale projects, such projects should begin progressing as soon as possible.
- Ensure that before proceeding to deploy a pathfinder project, the right domestic port capabilities are in place to support assembly, marshalling and integration of floating OSW foundations and turbines, to maximise this most salient opportunity for Irish participation and learning.
- Recognise that pathfinder projects, unless backed up by a solid pipeline of commercial-scale floating OSW projects, are unlikely to result in significant investment in increased domestic supply chain capability.

Supply chain

- Concentrate on developing the areas where expertise already exists, or there is a clear opportunity to compete in, such as development and project management, environmental assessments, and localised services, such as installations, port infrastructure and O&M expertise.
- Ensure ports upgrades with pathfinder projects in mind are not limiting options for commercial-scale projects, ensuring scalability and long-term viability. Such upgrades should focus on flexibility, accommodating a range of supply chain needs without becoming overly specialised for early-stage projects. This approach will enable Ireland to adapt as the industry matures and diversifies.

R&D

- Establish a cross-border data sharing initiative, where data from Ireland's plan-led surveys is made available to the UK and continental European research institutions to support their analysis, in turn these institutions could share data from floating OSW R&D institutions
- Approach the companies and institutions involved in the UK and continental European floating demonstration sites to identify what can be learnt, potentially offering shared innovation and research opportunities, such as shared innovation funding.
- Aim to set up resources for joint R&D funding on floating OSW technologies which aim to reduce costs and accelerate innovation.

Interconnection

- Given the location of the SC-DMAP and the presumed timing of these projects commissioning, government should explore additional hybrid or radial connections from these to one or both of GB and France.

Collaboration

- Understand the regulatory requirements which may allow offshore wind farms in the north of the island to export energy to Northern Ireland.
- Establish a working group with Northern Ireland's Department of the Economy to discuss how to encourage cooperation.
- Work to establish shared training programs and job mobility frameworks to help address skills shortages across Europe.
- Proactively engage stakeholders across Europe for R&D data sharing to accelerate OSW advancements, despite intellectual property challenges.
- Collaborate with port operators and EU counterparts to implement a multi-port strategy, addressing private ownership challenges.

Appendix A Levelized cost of energy modelling

BVGA Cost model background

BVGA's cost model is built on information that has been obtained through commercial work, research, direct industry engagements, and our own experience as industry experts.

The first version of the model was created around 2012 to support the UK Government in understanding how the costs of offshore wind energy were likely to change over the coming years. The model has been evolving since.

The model is a combination of top-down approaches, such as the known cost of foundations for a particular project, and bottom-up, such as calculating the physical dimensions of a jacket foundation and estimating cost based on the associated costs of steel and labour. The underlying data points are obtained from a wide variety of sources, including:

- Published data
- BVGA projects where we have the rights to use data in an anonymised way
- Hundreds of direct industry engagements by BVGA staff, and
- Internal modelling by BVGA staff using data provided by industry.

We implement a constant process of re-assessing the underlying cost functions. The responsibility to keep individual models up to date is devolved to subject experts throughout our wider team. The model undergoes at least one complete review annually and is checked against all known project-level LCOE data points from capacity auctions around the world.

BVGA Cost model inputs and assumptions

General

The BVGA cost model has over 20 input parameters and produces estimates for over 30 cost items.

It can run in "project" mode, where it estimates costs for a specific project, or in "area" mode, where a number of inputs are provided as GIS layers rather than singular values, thus calculating an LCOE GIS layer, as used in this LCOE spatial analysis.

The LCOE model estimates costs for future years and for diverse geographies, talking account of local and regional supply chain impacts. It is also able to model the impact of changing prices of commodity items.

Some high-level explanations of the assumptions that underlying the calculations are provided in the following sections.

Development phase costs

Development costs are built mostly bottom-up using our knowledge and experience of the process globally.

The general process, particularly the split between pre- and post-consent, follow that of the UK regarding overall timing and general consenting needs.

It includes, but is not limited to, the following items:

- Project Management
- Stakeholders Engagement
- Technical Delivery Team
- Consent Applications
- Land Option Agreements
- Environmental Impact Assessment
- Desktop Studies

- Resource Assessments and Metocean Surveys
- Geo-Surveys
- Concept Engineering Designs
- Front End Engineering Designs
- Geotechnical Completion Campaign
- Detailed Engineering Designs, and
- Supply Chain.

Turbine

Turbine costs are derived from industry engagement. Turbine costs scale with turbine rating. Costs are scaled using an exponent method, with rotor, tower and nacelle cost exponents being used to scale the costs for those components individually.

Foundation

Foundation costs are driven by a bottom-up model validated through ongoing industry engagement.

We calculate dimensions of both monopile and jacket foundations based on depth, overall site conditions (including soil type) and turbine mass (using turbine capacity as a proxy).

These are converted to cost using an estimated global steel price per tonne, which makes up around 40% of total delivered cost.

Array cables

Array cable costs are built from understanding the cost of a typical cable. This cable is assumed to be a three-core copper HVAC cable, 66 kV, XLPE insulated with copper conductors of 800 mm^2 (50% of total length) and 300 mm^2 (50% of total length). Our costs have been verified through industry engagement.

Transmission

Topside

For HVAC offshore substations the steel structure is 50% of the total mass, and for HVDC it is 40%.

The topside mass for HVAC is 240 tonnes fixed with an additional 4.2 tonnes per MW. For HVDC, the variable topside mass is 7 tonnes per MW.

Compensator

Compensator costs were calculated for cable lengths between 50 and 250 km, as well as for ratings between 71 and 355 MVA. Costs for compensators are limited to a cable length of 250 km as there is limited data above this point.

Switchgear

Costs are based on work done in *Power transmission systems for offshore wind farms: Technical-economic analysis,* regularly verified through industry engagement and adjusted according to the year of commissioning.[59]

Transformer

Transformer costs are for HVAC only. These costs are based on work done in *Power transmission systems for offshore wind farms: Technical-economic analysis,* regularly verified through industry engagement and adjusted according to the year of commissioning.

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59 https://upcommons.upc.edu/bitstream/handle/2117/77913/Bs_Thesis_Joaquin_Rebled_Lluch.pdf?sequence=1&isAllowed=y

Convertor

Convertor costs are for HVDC only. These costs are based on work done in *Power transmission systems for offshore wind farms: Technical-economic analysis*, regularly verified through industry engagement and adjusted according to the year of commissioning.

Export cables

HVAC offshore export cable costs consider three-core 220 kV cables with conductor cross sections between 300 and 2200 mm^2.

HVAC onshore export cable costs consider single core 220 kV cables with conductor cross sections between 185 and 2000 mm^2.

HVDC offshore export cable costs consider single core cables between 150 and 525 kV, with conductor cross sections between 1,000 and 3,000 mm^2.

HVDC onshore export cable costs also consider single core cables between 150 and 525 kV, with conductor cross sections between 1,000 and 3,000 mm^2.

It is assumed for HVAC that there will be three export cables, and for HVDC that there will be two.

Onshore substation

In all cases assumes connection to an existing transmission substation.

Covers only upgrade costs needed to facilitate new connection.

Assumes no further network reinforcement costs allocated to the developer.

HVAC

Uses indicative costs from the SPEN transmission charging statement 2021, Appendix 1.[60]

Each substation upgrade requires:

- One double busbar bay per transformer
- 100 m of transformer cable per transformer
- One 275/132 kV 240 MVA Transformer per 250 MVA of power being connected

HVDC

For HVDC

- Converters are rated to the connection power.
- The equivalent of one double busbar bay is required per 250 MVA of connection.

Installation

Installation costs are taken from day rates for installation vessels. Average weather downtime is taken into account. This is informed by feedback from contractors. Variation with depth is taken into account using a multiplier.

For monopile installation, we are assuming a medium self-propelled jack-up vessel. This vessel can handle 4 monopiles per voyage up to 20 MW turbine monopiles, which have a payload of 3 per voyage. Monopile installation day rates include the cost of the vessel and the hammer.

For jacket installation, assuming a self-propelled floating heavy-lift vessel. This vessel can handle 4 jackets per voyage.

For turbine installation, assuming a self-propelled large jack-up vessel. This vessel can handle 6 turbines per voyage for 8 MW turbines, 5 turbines per voyage for 10 and 12 MW turbines, and 4 turbine per voyage for 15 and 20 MW turbines.

[60] https://www.spenergynetworks.co.uk/userfiles/file/SPTransmission_2022-2023_Charging_Statement.pdf

For array cable installation, assuming a self-propelled cable-lay vessel. Array cable installation day rates include costs for support vessels for pull in.

For each turbine rating, installation costs are assumed to scale linearly with distance to construction port.

Operational expenditure

This is a primarily based on top-down modelling, with costs taken from a variety of sources. Some costs are known for older (operating) wind farms, but many costs are based on expectations for wind farms with COD 2023 and beyond.

Detailed costs are difficult to obtain due to the majority of sites being tied up in long-term service agreements (LTSAs) with turbine suppliers. Much of our assessment of the details related to turbine operation and maintenance (O&M) has been established through extensive industry engagement with developers, owner/operators, and the supply chain.

Cost savings due to future technical and supply chain growth and innovations, with the site-specific O&M philosophy (mix of vessels, in-house versus turbine supplier LTSA, etc.) are particularly sensitive input choices. The industry is generally optimistic about what level of cost reduction can be achieved over the coming decade, and we have sought to bring rigour and challenge to these claims while still reflecting the general trends of cheaper O&M, particularly with increasing turbine capacity.

The bottom-up modelling incorporated into the model includes assumptions on:

- Crew transfer vessel (CTV) costs
- SOV costs
- Jack-up vessel costs
- Port-side facilities (varies across land lease, office space, warehouse, laydown areas, parking, etc.)
- Average employment cost of offshore technicians
- Average offshore presence (technicians per GW)
- Average employment cost of onshore legal/engineering/accounting, and
- Average onshore presence (staff per GW).

Wider operational costs

The model includes assumptions on use of system and sea bed lease costs.

The model assumes values that are representative of the North Sea coast of the UK and includes:

- Transmission use of system costs
- Balancing market costs
- Sea bed lease costs, and
- Community fund contributions.

Other cost impacts

In addition to the basic building blocks described above, there are other inputs into the model which enable further refining of the costs.

Time based variation

Commodity prices

The model can evaluate the impact of the following seven commodity indices on each cost output, benchmarked against 2019 prices:

1. Consumer price index
2. Steel

3. Copper
4. Electricity
5. Fuel
6. Labour
7. Transport

The user can choose (or manually enter) the specific index for each commodity, using annual ratios from 2019 to 2035 and beyond.

Learning rates

Changes in future prices based on market volume-related learning rates are implemented. Learning rates are applied to each output cost individually, enabling reductions in cables to be modelled at a different rate to reductions in floating foundations, for example. Learning rates are based on our thorough understanding of technology and supply chain status in each area.

Geographies

The model defaults to northern European waters when estimating costs. It can adjust each cost output for a different geography, either pulling from a number of BVGA-created country lookup tables or using user-defined adjustments specified at runtime.

For this analysis, costs were aligned to those calculated for the economic benefits study BVGA produced for DECC[61]. This includes premiums in certain cost elements, such as development and tower costs, where the novelty of the Irish market will mean higher costs initially.

[61]Offshore renewable energy export potential for Ireland, BVGA, January 2024, available online at assets.gov.ie/281435/8d698eac-0112-4058-9524-e43d1668e979.pdf

About BVG Associates

BVG Associates is an independent renewable energy consultancy focussing on wind, wave and tidal, and energy systems. Our clients choose us when they want to do new things, think in new ways and solve tough problems. Our expertise covers the business, economics and technology of renewable energy generation systems. We're dedicated to helping our clients establish renewable energy generation as a major, responsible and cost-effective part of a sustainable global energy mix. Our knowledge, hands-on experience and industry understanding enables us to deliver you excellence in guiding your business and technologies to meet market needs.

- BVG Associates was formed in 2006 at the start of the offshore wind industry.
- We have a global client base, including customers of all sizes in Europe, North America, South America, Asia and Australia.
- Our highly experienced team has an average of over 10 years' experience in renewable energy.
- Most of our work is advising private clients investing in manufacturing, technology and renewable energy projects.
- We've also published many landmark reports on the future of the industry, cost of energy and supply chain.