Floating Offshore Wind - an Opportunity for Ireland

UCD Energy Institute

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Introduction

Floating offshore wind is an increasingly fast maturing technology that will enable Ireland to benefit from the substantial offshore wind resource both near-coast and, importantly, in deeper waters off the west coast. The trend in, and scale of, technology development supports the view that commercial scale floating wind at competitive costs/prices could be in place by 2030 and become increasingly competitive in the 2030-2050 period. There is a substantial opportunity for Ireland to develop, connect and use electricity at significant scale and to benefit by way of industrial development and energy export. The integration with the future production of Green Hydrogen provides additional potential benefits, in particular for transporting the energy and for the decarbonisation of energy demands that are difficult to electrify. The industrial development benefits associated with floating offshore wind are

- port development for assembly and O&M
- manufacture of floating wind platforms/substructures
- green hydrogen production
- connection of some wind to Ireland and a much greater amount to the EU using supergrid and superconductivity.

An understanding of the needs of our future energy system and the relevant interactions will be essential to understanding the opportunity. To deliver the benefits Ireland needs an agreed National Implementation Proposition. The UCD Energy Institute will work to develop a draft proposition for discussion.

Ireland's Floating Offshore Wind (FOW) Potential

Ireland has a substantial wind resource. Significant progress has been made in the development of onshore wind in recent years with more than 4,000 MW of electricity generation capacity currently installed in 2020[1]. Under the Climate Action Plan[2], onshore wind is set to increase to approximately 8,200 MW by 2030. The recent Programme for Government sets an ambition of 5 GW of fixed bottom offshore wind off the east coast by 2030, and there is potential for in the region of

[1] https://www.iwea.com/
[2] Ireland's Climate Action Plan

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10 GWs by 2040. A recent Government announcement has paved the way for 7 fixed bottom offshore wind projects to advance, designating them as Relevant Projects that are eligible to be processed to receive a valid grid connection offer.

The development of Floating Offshore Wind (FOW) could open up huge potential off the south and west coasts. While Ireland's floating wind potential has yet to be fully assessed, a potential of up to 70 GWs[3] off the west coast was suggested by John Fitzgerald to the Joint Oireachtas Committee on Climate Action and some EU estimates have included figures greater than that. There is already in the region of 3.3 GW of proposed FOW projects in Irish Waters off the south and west coasts in the absence of any policy framework.

Ireland's floating wind potential is a function of ongoing technology development and cost reduction. The Programme for Government mentions a conservative figure of 30 GW. Floating wind could replace fixed-bottom off the east and south coasts in the years beyond 2030 if technology development makes floating wind more effective in shallower waters in that timeframe. The integration with the production of Green Hydrogen can help address some of the wider challenges of decarbonisation of the wider energy sector.

Floating Offshore Wind Technology and Costs of Development

Floating Offshore Wind is an increasingly fast maturing technology. It has moved from an R&D phase to a high technology readiness level with many demonstration projects underway and a number of projects now at the initial commercial development stage. The EU Commission has given major support in R&D for FOW projects. Two projects are currently producing electricity: Hywind[4] by Equinor off Scotland, with reported capacity factors of over 50%, and Wind Float[5] by an EDP/Principal Power led consortium off Portugal. The COREWIND[6] project aims at achieving significant cost reductions and enhancing performance of floating wind technology through the research and the optimisation of mooring and anchoring systems and dynamic cables.

A number of countries including Scotland, France, Japan and the US have announced commercial tenders for FOW. Relatedly an increasing number of major developer companies have invested in demonstration projects and now in commercial scale FOW projects. Every week brings further floating wind announcements from major companies. Because of the potential in the EU, in Japan, in the USA and increasingly from China, floating technology will develop at a fast pace and the cost of the electricity produced will fall quickly, figures of the order of 60cent per KW/hour have been mentioned authoritatively. The "Flagship" initiative is a demonstration project spearheaded by Iberdrola and backed by an international consortium, that will be rolled out at the Met Centre in Norway to help reduce the levelised cost of energy (LCOE) to a range of 40-60 €/MWh by 2030, driven by economies of scale, competitive supply chains and a variety of technological innovations[7].

[3] https://www.kildarestreet.com/committees/?id=2019-12-04a.7
[4] https://www.equinor.com/en/what-we-do/floating-wind.html
[5] https://www.edp.com/en/innovation/windfloat
[6] http://corewind.eu/
[7] https://www.iberdrola.com/press-room/top-stories/flagship-project#main-content

Statoil and Masdar also aim to reduce the costs of energy from the Hywind floating wind farm to EUR 40-60 (USD 50-75) per MWh by 2030.

There are some ongoing projects of Irish interest. A demonstration project has received funding of over €30 million recently from EU Interreg involving the deployment of a full-scale floating wind turbine for testing off the west coast of Ireland at a Sustainable Energy Authority of Ireland (SEAI) test site near Belmullet, Co. Mayo, by 2022. The project is led by the European Marine Energy Centre (EMEC) working in partnership with SEAI, SAIPEM and other organisations in France, Germany, Ireland, the Netherlands, and the UK.

An Irish company Simply Blue Energy is developing a project off the Welsh coast with the major French company Total. The 96MW Erebus development is being looked to as the flagship of a more ambitious build-out in the Celtic Sea basin, which is calculated to be home to a potential of 50GW of capacity[8]. The project is expected to be brought into operation "in 2025/26" in 70 metres of water some 45km off Pembroke coast.

The EirWind[9] project, led by the MaREI Centre, is focused on the study of strategic areas for offshore wind, off Ireland's east, south and west coasts and tools to develop an advanced approach to planning for bottom fixed and floating offshore wind scenarios in Ireland.

Industrial Development Opportunities for Ireland from Floating Wind

Realising Ireland's floating wind potential will require significant work and, if achieved, could deliver substantial industrial development. A strategic and coordinated approach to FOW development will enable development of supply chain infrastructure and industrial development opportunities.

Ports

A number of ports will be required for the assembly and shipping of floating turbines and platforms and for the operation and maintenance of floating wind farms. According to Wind Europe in its Policy Blueprint for Europe[10], existing ports are not sufficient to handle FOW today and converting existing ports will require significant political support at national, regional and EU level. This is a core aspect of the economics of FOW.

Turbines

The likelihood is that turbines for floating wind farms will be manufactured outside Ireland but this should be examined in the light of the scale of potential generation that emerges.

Floating substructures manufacture

There is a significant opportunity for Ireland to produce the floating substructures/platforms required for floating wind. Work is ongoing in relation to the best designs, and involvement in

[8] https://www.rechargenews.com/wind/oil-giant-total-dives-into-offshore-wind-with-worlds-biggest-floating-array/2-1-776916
[9] https://www.marei.ie/project/eirwind/
[10] https://windeurope.org/wp-content/uploads/files/policy/position-papers/Floating-offshore-wind-energy-a-policy-blueprint-for-Europe.pdf

demonstration projects will be important in this regard. Ireland should be able to play an important part in technology demonstration based on technology developed by major companies. This can provide the basis for significant opportunities for industrial development in Ireland if we can establish a clear floating wind development strategy through a National Implementation Proposition with Government backing. Recent EU funded work in LIFES50+[11] has set out a substantial area of work necessary to realise industrial development potential of substructure design.

Green Hydrogen

There will be a major opportunity for green hydrogen production using the electricity generated from FOW. UCD Energy Institute has produced a related paper highlighting that a National Hydrogen Strategy is needed to identify and evaluate the options for hydrogen development in Ireland[12]. That strategy must link to the proposed National Implementation Proposition on Floating Wind Development as the electricity generated by floating wind will be a key element in enabling Green Hydrogen.

Grid Connection

There is potential for Ireland to play a key role in the grid connection developments for FOW, with companies such as Supernode (https://supernode.energy/) looking at developing superconducting technology to connect offshore wind projects to each other and to a wider interconnected grid. The scale of energy potential may make such an approach sensible over the longer term.

Cables, Anchors etc.

There will also be a need for the production of cables, anchors and other infrastructure which will be required to support FOW. As the scale of development emerges, further industrial opportunities will become apparent.

Legislative and Regulatory Framework for Floating Wind

Ireland already has a significant part of the legislative work underway that is required to enable floating wind development through the Marine Planning and Development Management Bill and the National Marine Planning Framework. The development process is likely to involve designating areas for floating wind farms and inviting bids for these areas. This approach is being used in a number of European countries (e.g. Scotland and France) and works well. A reframed Offshore Renewable Energy Development Plan (OREDP) could be the vehicle to undertake the work to identify and quantify the floating wind potential. The North Sea Wind Power Hub project (referred to below) could be a mechanism to be considered. A Regulatory framework that deals with various aspects, including environmental requirements, will have to follow from the legislative provision.

[11] https://lifes50plus.eu/
[12] https://energyinstitute.ucd.ie/wp-content/uploads/2020/06/UCD-Energy-Institute-The-need-for-a-Hydrogen-Strategy-for-Ireland.pdf

Programme for Government

The Programme for Government makes specific reference to "the massive potential of offshore energy on the Atlantic Coast" and commits to producing a plan that will set out how Ireland can become a major contributor to a pan-European renewable energy generation and transmission system. The Programme for Government refers to "at least 30 GW of offshore floating wind power in our deeper waters in the Atlantic". We believe as technology advances it will be possible to reach up to 70 GW as outlined above, or even greater when deeper waters can be accessed.

The Connection and Use of Floating Wind Generated Electricity

The connection and use of floating wind generated electricity given the scale (70 GW) of production in the Irish case as a small country off the Atlantic will give rise to significant issues common to floating wind projects and also a number of relatively unique issues. These include that only a very limited amount of the electricity can be used in Ireland and the distance to the EU mainland for exported energy.

Grid connection is a challenge for the entire offshore wind sector. Wind Europe points out that the distance to shore and the availability of networks at the point of connection are a bottleneck hampering both FOW and bottom fixed offshore wind. Initiatives such as the North Sea Wind Power Hub (https://northseawindpowerhub.eu/project/) or the Supernode (https://supernode.energy/) seek to address this challenge at large scale.

The North Sea Wind Power Hub (NSWPH) Programme aims to combine grid connections of offshore wind farms with interconnection between North Sea countries. The consortium involved has applied for funding from the Connecting Europe Facility for studies to develop the concept further and to bring a first hub and spoke project a step closer. It has also been included in the latest of European Projects of Common Interest.

It will also be important to connect FOW to the Irish grid to deliver energy to the local network. Moneypoint could be explored as a possible landing site due to the already existing grid infrastructure in that location. The Department of Climate Action, Communication Networks and Transport has published a Consultation to Inform a Grid Development Policy for Offshore Wind in Ireland[13]. This is based on Navigant Report on grid connection and will be key for the development of offshore wind (fixed bottom and floating) in Ireland.

Another option for transporting the energy produced is through the **production of green hydrogen** which could be transported via ships and/or pipelines to a range of demand centres and uses. Hydrogen has many uses and applications and can support the decarbonisation of the wider energy system when produced using renewable electricity. Challenges exist in transitioning from carbon based fuels to hydrogen which will have to be overcome to develop green hydrogen at large (GW) scale. The efficiency of electrolysers and the price of offshore wind, which has fallen substantially in recent European auctions, are key issues. Beyond the basic cost challenge, deployment of green

[13] https://www.dccae.gov.ie/en-ie/energy/consultations/Pages/Consultation-to-Inform-a-Grid-Development-Policy-for-Offshore-Wind-in-Ireland.aspx

hydrogen production alongside a source of renewable electricity will lead to a series of interactions that will have to be dealt with, in particular the location of the hydrogen production facility (onshore or offshore) and the arrangements for the storage and transport of the hydrogen produced. These issues will need to be analysed in the development of floating wind off Ireland's west coast.

Generation plants with a total capacity of up to 5 GW corresponds to a green hydrogen production of up to 14 TWh and a required renewable electricity quantity of up to 20 TWh. The German Federal Government sees a hydrogen demand of about 90 to 110 TWh until 2030, with an expectation that the demand for electricity-based fuels will increase to a range of between 110 TWh and 380 TWh by 2050[14]. This provides a significant opportunity for Ireland.

Research opportunities

A significant number of research opportunities arise when the development of offshore wind (both fixed bottom and floating) is considered. Building on a substantial base of research on the Island and in line with some of the industrial development opportunities there is now a window in which Ireland could become world leading in a number of important areas. These include the following:

Integrating large amounts of offshore renewable wind generation onto the electricity grid

Ireland is world leading in the grid integration of onshore wind and a similar opportunity now presents itself for FOW to ensure the operation of a secure and stable grid alongside the increasing decarbonisation of the grid. Significant Electrical Engineering challenges arise, several of which are already covered by initiatives such as DS3, but particular aspects relevant to offshore wind are critical: HVDC controls and management of energy storage systems; Ability of offshore wind to provide system services; Interaction with the onshore power system; Optimisation applied to offshore grid topologies, and Offshore wind farm topologies. These aspects will feed into determining the appropriate network design offshore and the best locations and scale for onshore connection, the technologies and grid code requirements that may need to be introduced, and the operational tools required by the system operators. As we move to large scale offshore grids, there will be a need for increased coordination with other connected system operators.

Beyond Ireland and in the context of connection of electricity to the EU the opportunity presented by the SuperGrid[15] may be required. An interesting aspect is how superconductivity and large scale power electronic interfaces (HVDC) can sit alongside technologies such as Green Hydrogen (Electrolysis). Effectively the use of electricity alongside 'molecules' as energy vectors points toward an interesting avenue for energy systems integration research.

Green Hydrogen

The use of large amounts of renewable electricity for the production of Green Hydrogen provides a significant opportunity for decarbonisation of our whole energy system, including electricity, heat

[14] https://www.cleanenergywire.org/factsheets/germanys-national-hydrogen-strategy#:~:text=According%20to%20the%20strategy%2C%20%22only,to%20establish%20corresponding%20value%20chains.

[15] http://www.energyireland.ie/developing-the-super-grid/

and transport. The role of Green Hydrogen needs to be assessed and teased out, i.e. what are the options for the generation of hydrogen associated with offshore wind coupled with associated energy transmission challenge? A follow on question is then what is the best end use of Hydrogen? How do we ensure that supply and demand are developed in a coordinated manner to enable development of an effective market?

An important aspect to consider is the relative merits of electrolysis on platforms or on land with the possibility that both may make sense depending on distance from the shore of the wind park.

Structural Engineering (Design, Dynamics, Monitoring, Control, Reliability), Sensors and analytics to make offshore wind safer and more efficient

The dynamic stability of the floating platform is one of the main challenges that needs to be addressed. Dynamic analysis of the floating structure plays a critical role in predicting its behaviour and assessing its performance and stability. Ongoing research is focused on a simplified model for the dynamic analysis of floating offshore wind turbines. Further modelling and assessment is required for the modelling of dynamic cabling for floating wind generated electricity. These cables are subject to greater levels of mechanical and electrical stress due to the platform's motion and sea conditions. A range of relevant research targeted at current offshore wind turbines and towers will also be relevant for FOW.

Atmospheric reanalysis models

Floating offshore wind may not be immune to the developing influence of climate change. There is a need to investigate and quantify the climatology and extremes in wind speed, direction and hub-height wind power at offshore locations coupled with consideration of how this may evolve over the coming decades. The change in wave dynamics can also be investigated which will impact the dynamics of the floating platform referred to above.

As well as research into the technical aspects of FOW, considerable work will be required to establish the appropriate **regulatory framework** required to integrate large amounts of offshore wind coupled with **techno-economic** scenario modelling, **social acceptance** of the required infrastructure and the required **market and finance** instruments. Energy Systems Integration research brings these different aspects together through the multidisciplinary research approach which is central to UCD Energy Institute.

Next Steps for the Energy Institute

As we have outlined in this document, there is a significant opportunity for Ireland to develop its offshore energy resources, in particular off the south and west coasts. A strategic approach is required for Ireland's future energy development to meet our decarbonisation objectives, bringing together the different aspects of the energy system. The Energy Systems Integration Partnership Programme (ESIPP - https://esipp.ie/) is the first step in examining energy systems in an integrated manner in Ireland. Arising from this research we see a number of emerging opportunities including the development of Hydrogen as a potential fuel of the future and the opportunity for Floating

Offshore Wind development. In order to develop this further we see the following steps as playing a key role:

- The development of future energy scenarios outlining the potential role of different technologies (including floating offshore wind and hydrogen) in our future energy mix.
- An assessment of the different scenarios and pathways from technical, social and economic perspectives (including grid connection, market frameworks, social acceptance, employment opportunities, cost benefit based financial appraisals etc.)
- Examine the industrial development opportunities in terms of ports, cabling, substructures/platforms, electrolysis (green hydrogen) and grid connectivity
- The development of testing facilities and demonstration sites to bring the research to higher Technology Readiness Levels (TRLs).

At UCD Energy Institute, and through our network of collaborators and industry partners, we are well placed to support these activities with rigorous research support. Our experience in the area of Energy Systems Integration through the ESIPP project ensures that this is examined within the context of the wider energy system. A coordinated approach to energy infrastructure development will ensure that this continues to be an important area of research focus, enabling increased capacity to be developed and maintained to support the decarbonisation of our energy future.

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