Reply to:

Public Consultation to inform the development of the Offshore Renewable Energy Future Framework Policy Statement

Dear Minister Ryan & the Department of Transport Office Team,

As Assistant Professor of Dublin City University, I welcome the opportunity to feed information into this consultation to enable Government to set a clear direction for managing Ireland's resources, clarify objectives and priorities, and direct decision makers, users and stakeholders towards a more sustainable, environmentally and ecosystem focused, strategic, efficient and forward-thinking use of our marine & wind resources.

In my position in the School of Mechanical & Manufacturing Engineering at Dublin City University, I am actively involved with energy-related education, research and development. The main aim of my research is to develop a better understanding of the technologies, strategies and economic models required to achieve Paris aligned national & global ambitions to mitigate the major effects of Global Climate Change. Focusing on clean, low-cost, sustainable energy for households, industry and for transport, interacting with renewable energy, hydrogen and storage technologies, I have ongoing research projects with Irish & EU academic & industry partners and government bodies such as Science Foundation Ireland & Sustainable Energy Authority of Ireland (SEAI).

I am a FEL alumina of the World Energy Council & am an advisor to the World Energy Council Hydrogen taskforce.

I am a hydrogen expert to the United Nations Economic Commission for Europe taskforce on the role of hydrogen in attaining carbon neutrality in the UNECE region.

I am a task force advisor to the IEA on Energy Storage.

I am co-founder and outgoing chair of Hydrogen-Ireland. Hydrogen-Ireland is a not-for-profit association formed in 2019, on the back of a growing interest from industry, in Hydrogen, the technology, and its potential application in the energy, transport and industry sectors to assist with the transition towards a zero carbon economy.

Myself & my research team in SFI funded projects HyLIGHT & NexSys have developed the following section for your information and review. We hope it assists our country's energy, transport and industry sectors energy transition and national emissions reduction ambition/achievement.

I am available to be contacted to clarify any topic or answer any questions you may have.

Kind Regards,

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Executive Summary:

The following reply is a reply mainly to Questions 1(a) and 1(b)

- **Bigger may well be better in MW capacity terms but only when the technology is proven and deemed to have reached an agreed level of maturity.** The criteria would be drawn with the industry. The turbine size has a knock-on effect on all the components of the ORE system. There is an acceptance of the need to look to the maturity of technology to see if the approach of **plan-led** may also be applied equally here. **Look at approving only mature step level changes in MW rating of turbines,** with the industry and in particular the turbine companies, **installation-based proof can be given on reliability, robust supply line and availability/capacity.** This will assist in adding certainty to the rollout plan of Irelands ORE, and while it might seem to contradict the 'maximisation of more competitive technologies', it does not, as a technology is only competitive if it is proven to be reliable and obtainable.

- Technology used in the building of the floating platforms in the FLOW scenarios is noted as being steel. **The advocation of concrete (low carbon indigenous concrete) as a mainly locally sourced solution within the island of Ireland should also be considered and run in all modelling, as in Workstream 4.** It could be more beneficial to Ireland and its economy making the supply chain more self-sufficient in this aspect of ORE development. All this is dependent on the finalisation of the design of a suitable solution, which is believed to be possible. Equally, concrete has a role in gravity-based foundations but there is insufficient information available, to the authors, to comment on the need for this type of base within the ORESS 1 developments. If there is a need it would be an excellent lead in to concrete being used in the ORE rollout. The use of concrete will feed directly into **question 4(a).** as a **required skilled workforce** will be required in the related processes attached to using concrete and will develop on skill sets already available with the construction industry in Ireland. Steel fabrication required for the steel solution would not have a similar skill set to build upon.

- As pointed out in the draft policy document **ports are required to progress ORE** and ''distinct infrastructures are required depending on the technology, particularly in the case of fixed bottom compared to floating wind.'' In the attached the points being made are that –
  - Concrete sets different requirements on the port infrastructure, but also creates opportunities for the ports.
  - Belfast can not be assumed to be available as it could be consumed by the UK planned rollouts.
  - Developments of Irish port infrastructure does not seem to be recognised in the WS documents as progress seems to be progressing and possibly availability might be earlier. The policy should look to develop Irelands own ports to support the schedule.

- **End of life planning should be factored in even at this stage** as it will have a direct effect on port infrastructure, supply line and logistics. While it is appreciated that the expected life cycle can be in the region of 20-25 years, the ramp up will commence in the 2040's and should be in the policy document.

In relation to question 1(f). the industry needs to be the partner of the government in assessing technology maturity with the government in effect becoming the gatekeeper in the maturity of technology step changes. Maturity of technology is discussed in the attached, and with a mature product, suppliers who see a commitment to a product type for a set period in time, will be able to present a robust commercial proposition and they can match with schedule visibility.

Also, if the cement/concrete route is chosen, the cement industry needs to partner with Government to deliver a low carbon product for the benefit of bringing down the countries carbon emissions level.

Main Questions Addressed in this reply:

1(a) Has this section adequately identified the general key priorities for ORE delivery in Ireland? Are there additional priorities that should be integrated into the holistic, plan-led approach?

1(b) Has each key priority been adequately described and considered all relevant components? For each key priority please provide any additional concerns, aspects or commentary for inclusion.

1(f) What additional capacities and responsibilities should be held by industry in the context of the plan-led approach?

4(a) What structures, measures, and interventions can the State and State agencies implement to assist in the development of a long-term, sustainable skills and workforce pipeline? Provide any recommendations on what the State can do to promote careers in ORE across a range of educational backgrounds and movement from other relevant sectors.

Introduction:

The components of an ORE system are well laid out and address the main processes in section 1 of the draft policy statement.

Much of the focus of this submission is based on the methodology and assumptions made within 'Workstream 4: Export viability, policy considerations, trade and investment opportunities.' [1], which is the part of the package associated with this consultation and was prepared by BVG Associates on behalf of DECC. The workstream looks at the economic impact of offshore renewable energy deployment and presents its outputs in terms:

- Local gross value added (GVA)
- Direct and indirect employment (FTE), and
- Tax take.

In presenting these outputs in these terms the question arises as to whether the assumptions actually deliver the best potential GVA, employment potential and tax take to where it could possibly reach, even taking a conservative approach. As an input document to this Offshore Energy Renewable Energy Future Framework Policy Statement, there are questions to be asked.

This consultation input document does not necessarily fit nicely into the questions raised but this will be addressed in the Executive Summary and will show linkage to the questions raised. There is no doubt that this policy document overlaps and co-exists with the output of the Public Consultation for Review of National Ports Policy which closed in January 2024 [2]; the publication in March 2024, of the National Industrial Strategy Roadmap by the Department of Enterprise, Trade and Employment (DETE) [3]; and also of interest will be the Q2 publication by the SEAI Technology Road in in Q1 2024. All these documents have to maximise the return to Ireland as we embark on the next phase of the Offshore Renewable Energy (ORE) journey.

This document will focus the following points –

1. Mature Technology approach – Plan Lead
2. Strategy of the construction of the Flow Offshore Wind (FLOW) – Steel v Concrete
3. Opportunities for our Ports
4. End of Life Planning

Discussion:

1. **Mature Technology approach – Plan Lead**

Consideration to be given to a plan-led, iterative approach to step changes in the turbine MW range. A maturity step would be based on a MW rating, with a proven installation track record, and the attaining of agreed reliability, before the use of the unit is allowed in the Irish ORE rollout. The purpose of this is to give assurance to the supply line chain for a period of time, and volume to the manufacturers to allow for certainty on investment into manufacturing capabilities.

In creating this Future Framework document there is an opportunity to look back at the **Plan-Led** approach and apply it to technology in these early days of the FLOW in particular. The draft document does use the terminology of plan-led and mature technology. The industry cannot chase the race on the size of the next turbine and assume bigger is better. In an industry which has been experience financial challenges within the manufacturing sector, in particular with turbines, a line of certainty will assist in the ability to work suppliers on capacity and the ability of the manufacturers to develop manufacturing around a knowledge base of what is going to used, within a time period. This stepped time period is one within which a turbine is considered, through performance and reliability metrics, to have reached a level of maturity.

A 2023 article 'Scale Up Smarter, Not Harder – Why Offshore Wind Ambitions Can Be Met More Efficiently if Turbine Growth Is Paused'. It says that the offshore industry has reached a level of maturity through early governmental support that allows the sector to be competitive against conventional power plants. This causes a race for bigger turbines so developers, understandably, can be more competitive in tenders. ''However, this has spurred a development race among turbine OEMs that has proven to be highly unsustainable for the entire supply chain and infrastructure.'' [4] The article opines that ''it is imperative that attention is shifted from cost to the value, speed, security, and resilience of the supply chain.'' Having a plan-led step change approach, over time, will increase the certainty and contribute to a successful project rollout.

The technology life cycle is a model that describes the different stages that a technology goes through from its initial development to its eventual decline. This model can help businesses, and in this case the Irish Government, and innovators understand the stages of technology development, anticipate future trends, and make strategic decisions about investment and development. [5] This can be defined in 4 stages–

a. Innovation stage – initial development and introduction – untried
b. Growth Stage – The technology is now refined, and new competitors enter the market – it becomes the new norm. Competition will be centred here, and products will develop and be able to show real performance metrics in the environments that in Ireland case, can equate to the environment in the Atlantic for example.
c. Maturity Stage - At this stage, the technology becomes more standardized and widely adopted, and growth begins to slow down. The market becomes more saturated, and competition becomes more intense. Companies focus on reducing costs and increasing efficiency, rather than investing in new innovations.
d. Decline Stage - this when the newer technologies start overlapping as they will have completed stages and are now hitting the maturity stage, so time to move up a level.

There are many models with three, four and five stages and the one chosen is just an example. Another model talks about the stages in Innovation, Syndication, Diffusion and Substitution, but the diffusion and maturity stage equate to one another. [6] This article gives an excellent example where the decision was made by a developer to stay at a lower MW turbine as the ability to supply offshore foundations would have been slowed with the bigger turbine and when netted out the developer would have supplied a higher MW from the offshore field in the same timeframe with the smaller turbine. Bigger is not always better!

Logic says that the goals of the FLOW project will be achieved faster and more efficiently if the unstainable turbine race is not slowed down and the market can look at a mature supply line, in which suppliers can have some certainty, load the manufacturing process for a planned period of time, and deliver a mature and reliable product.

A 2023 report from Wind Europe and Rystad Energy notes under turbines in its key findings that 'Offshore wind serves as the key challenge, with a large gap between current manufacturing capacity and projected demand for the largest models.' See the graphic below.

RystadEnergy

Future supply chain risks

Key findings

Table 1: Key findings summary, selected parts of the supply chain unique to the wind industry

Segment	Industry	Sub-segment	2022-2030 demand growth*	Time to action*	Urgency assessment	Comment
Turbines	Onshore & Offshore wind	Total market	**~3X** *Capacity (MW)*	**2024-2025**		• *High inflation, low margins and an R&D race to supply the largest turbines on the market has put pressure on western OEM's ability to expand manufacturing capacities or repurpose facilities to accommodate a changing demand.* • *While onshore wind turbine size demand is relatively more stable, expansion of manufacturing is needed to match growth in activity levels in the 2030 Targets Scenario.* • *Offshore wind serves as the key challenge, with a large gap between current manufacturing capacity and projected demand for the largest models.* • *Rotor blade manufacturing represents the current bottleneck for European turbine supply, but both need a rapid expansion to meet demand in this scenario.*
	Offshore wind	>12 MW turbines	**0-29 GW**	**2024**		
Towers	Onshore & Offshore wind	All	**~2.5X** *Metric tons*	**2025**		• *Centralized tower supply for a larger range of turbines has enabled the supply chain to expand with growing activity.* • *Tower demand will be driven by a relatively high number of onshore wind turbines (compared to offshore wind) and increasing offshore wind activity and sizes.* • *Growth is expected to accelerate in the second half of the decade, creating an additional need for expansion.*
Foundations	Offshore wind	Monopiles	**~12X** *Metric tons*	**2024-2025**		• *Monopiles will remain the most popular concept in Europe, and with rapid growth in activity and turbine sizes in offshore wind, manufacturing must be scaled up quickly within the largest monopile segments.* • *Jacket manufacturing capacity less constrained thanks to O&G industry.* • *Floating foundation manufacturing must be industrialized. Today, it is characterized by pilots, demos and pre-commercial projects with one-off manufacturing and few units. From this small basis, manufacturing capacity must grow substantially towards the end of the decade.*
		Other grounded	**~7X** *Metric tons*	**None**		
		Floating	**~23X** *Metric tons*	**2024**		
WTIVs	Offshore wind	Total market	**~7.5X** *Vessel years*	**2024-2025**		• *Strong fleet additions in recent years have put supply in a strong position to cover demand in the next two to three years. Increased demand in the second half of the decade, primarily in the largest turbine size ranges will put pressure on supply.* • *A global fleet and increasing demand outside Europe will likely pull supply out of Europe, worsening the supply-demand balance, with new units forecast to be needed.* • *An increasing share of demand in the 15-20 MW range towards 2030 will also drive a need for new units, as the fleet of vessels capable of installing these units is currently limited.*
		>12 MW turbines	**0-25 vessel years**			

*Estimated European demand based on *2030 Targets Scenario*. Time to action refers to the estimated year when supply expansions need to be initiated to avoid a potential bottleneck.
Source: Rystad Energy research and analysis

[1]

A 2023 report from DNV – Offshore Wind 2023 – New Ambitions, New Challenges, says the following 'With the new targets of several European countries (but also global ambitions of many regions) the demand for offshore wind related developments and the demand for equipment increased. Larger markets with increased and accelerated targets obviously require the supply chain to grow at the same rate to capture the market and to allow a healthy supply demand mechanism. However, the turbine supply for many years has been working on a much lower level and –as said above- a very volatile project driven level, which now requires a fast ramp up.

Specifically, the turbine supply chain has suffered under the cost reduction ambition in the past. The combination of a cost reduction target and the related demand for new larger technology (turbine capacity and size) led to very limited or to no scale effects on certain product lines.' [7]

[1] https://www.review-energy.com/fileuploads/user/FINAL%20Rystad%20Energy%20-%20Wind%20Supply%20Chain%20Report-WEB.%5B1%5D.pdf

In a recent strategy document from Vestas, one the leading suppliers of wind turbines, it says that the ''speed of introduction of bigger wind turbines to the market will slow'. It suggests that offshore requires a vision of 2-3 years beyond given the current lead times. Their strategy seems to be tending towards meeting a customer requirement to turbines that are workable in today's environment, rather than banking on future technology developments. [8] This strategy would seem to align itself very much with what is been said here in this submission.

There is a lot of considered opinions that we must focus on deploying the proven or mature technology we have already and enabling the development of a sustainable and scalable supply chain and on expanding the infrastructure to execute and operate our projects. 'The ongoing race to develop larger turbines poses a significant threat to supply chain investments, as manufacturers cannot be certain that their multi-million-euro capacity investments will remain future-proof and may be depreciated too quickly. This dynamic may result in investment decisions being delayed or not taken at all throughout the supply chain.' [4]

Nielsen at Vestas recently emphasised the need for responsible development. "The only way that can actually attend to the market demand is to slow down the growth of turbines," he said, adding: "This industry needs to mature, and everyone has to make money in the supply chain to make it last." [9]

Currently a 10 or 11MW turbine (depending on the supplier) is perceived to be relatively mature, but the expectation for Ireland would be that a 15MW turbine will be in that stage before floating commences its rollout and from a plan-led perspective a plan around that size turbine should be developed. Dogger Bank in the UK, one of the biggest offshore sites, using fixed bottom turbines, is using the GE Haliade-X 13MW turbine, while it also announced a 14 MW turbine in that range. [10] Vestas V236 is a 15 MW just having developed, while Siemens Gamesa SG 14-236 DD is also in that range at 15 MW.

In China there are bigger turbines out there in various stages of development and trials. Goldwinds GWH252 is rated at 16MW and the Mingyang MySE is also 16MW but have unveiled an 18 MW unit. GE have also said they are working on a 17MW and 18 MW unit. There are others on the way. But there would be concerns of the logistics surrounding the installation of turbines with a such a long supply line, distance wise, and the ongoing maintenance and support aspects on.

But again, we should not follow the chase for bigger machines until maturity to proven. Capacity needs to be built and stability offers that opportunity. 'Industry observers say it could be difficult to reach that level of investment if goal posts keep moving. Others are concerned about the reliability of rapidly evolving turbines, as they are still untested in the real world.' [11]

In summary, there are two inputs that should be considered -

a) Continued the Plan-Led approach to technology and set a parameter around the size of the turbine to be used based on maturity of technology, ensuring that the rollout has a higher reliability threshold and better chances of success. Work with the industry to develop that step criteria to move up in size. This window to be two to three years potentially.
b) Ports should be future proofed as part of their development plans and prepare for the bigger 17 to 20MW units in their design, though they will initially contend with say a

15MW turbine. This is the approach taken in RenewableUK document previously referenced, and is a sensible approach. [12]

2. Strategy of the construction of the Flow Offshore Wind (FLOW) – Steel v Concrete

Consideration of the potential use of concrete as an alternative to steel in the manufacture of the floating platforms should have been considered in parallel to steel. It would be expected that the value to the metrics used such as FTE, GVA and tax take would be higher for the Irish economy and the industry would be more sustainable and self-reliant. It is assumed that a viable design will be in place in time to support the rollout.

Like all processes there is an interconnection between the various assumptions made and these can and will affect the output. Whether it was due to the DECC briefing to the consultants or was assumptions made by them, it is suggested here that the assumptions used in particular to local content was not broad enough and does not give the reader a view of the potential that is possibly understated.

This section will focus mainly on the assumption made in WS 4 that steel will be used in the construction of the floating semi-submersible platform for Floating Offshore Wind (FLOW), versus the use of 'locally' sourced concrete for the construction of the same unit. A discussion could also be extended into the use of Gravity Based Foundations in the installation of the fixed based estate currently being rolled out. Concrete based foundations are used, and for example 71 of this type of unit are being used in the construction at the Fécamp offshore wind farm site in Normandy, France. [13] This is a current project. An opportunity to delve into the plans of the 4-winning tenderers in ORESS 1 has not be possible but the logic and approach to the use of concrete in supplying these base units is the same.

WS4 states the following – 'In all scenarios, it is assumed that modular foundation components are manufactured elsewhere, before final assembly in Ireland. Ireland has little of the type of heavy manufacturing industries which would carry out this work, and there is no strong logic for local supply as components are designed to be transportable. We assume Ireland will not be an investment location of choice for new facilities of this kind due to its existing capability coupled with relatively high wages, which mean investment will more likely flow to other markets.'[1] This assumptions has a knock affect job creation, port set up and the ultimate return to the exchequer.

Based on this assumption the main component parts for the construction will be steel and while the assumption is correct when it comes to this material, consideration should also be given to the use of concrete in parallel and the models run to see what benefits are outputted and how they compare. Ireland does not have a steel industrial infrastructure of this size and is potential not the route that should be followed. While in particular on FLOW, there are many designs being worked upon with no clear direction being taken yet, designs will evolve in the coming years and there is a good chance there will be a viable concrete one when that a consensus is arrived upon.

What is the case for considering concrete?

Norwegian company called NorSea Impact AS commissioned consultants DNV, a leading consulting firm and certification body, to carry out a comparative study of concrete and steel substructures for Floating Ocean Wind Turbines, for a project they we relooking at. It looked at both a spar and semi-submersible constructions and the study indicated the concrete floaters have a lower carbon footprint and costs then their steel counterparts. [14] They assumed that the only location that could supply the volume of steel required at a competitive price was China and that still seems to be the case. A point to note is that the current war in Ukraine escalated (February 2022) around the time of the report being launched and since then the price of steel has again increased. This would certainly have influenced this report if the war had been factored in.

The report found that there would be a skills deficit in Europe to meet the volumes required for the project being assessed which was 67 units per year, similar or slightly more to a potential volume in Ireland. It concluded that Asia and in particular China offered the only potential for supply.

The report also concluded that the ability to manufacture these units existed in Norway, where the report was commissioned. It said that ‘it is found that the local labour and supply chains within Norway can meet the majority of the demand generated during full production of concrete spar or semi-submersible units…. The labour and skills market has capacity to cover all positions and expertise locally.’ But not the supply of the steel.

The supply line from China is also a considerable factor to note and the DNV report found that the carbon content of steel some 2.5 to 3 times higher for steel over concrete. The report delves into various hybrid solutions and examines the life cycle aspects and the inclusions of recycled materials, but still concludes that the carbon footprint is lower in concrete based units.
Just like concrete, there are many issues affecting the role of steel construction in FLOW. Depending on when the reports are published - one report has costs in offshore wind projects up some 57% (August 2023). [15] Fortune Magazine says that soaring materials costs, particularly for steel, forced turbine makers to raise prices. [16] But it also important to note that cement has also gone up in price, but the difference for us here in Ireland is that it can be sourced on the island of Ireland along with most of the other materials required in the manufacture of a concrete semi-submersibles. With China there is also large transport costs and possibly delays in delivery which you do not have with local sourced products.

It is also worth noting that with the introduction of EU Carbon Border Adjustment Mechanism (CBAM) will affect the import of steel and steel components from outside the EU. [17] CBAM, or the Carbon Border Adjustment Mechanism, is designed to prevent 'carbon leakage' by imposing a carbon levy on specific product imports from non-EU and non-EFTA countries. The levy is linked to the carbon price payable under the EU Emissions Trading System (ETS) for the same goods produced within the EU. As of now, **it does apply to steel**. It is an attempt to control the import of carbon emissions from outside the EU without additional cost and mitigation steps been taken. This was not a factor taken into consideration in the DNV report, and the implementation of CBAM started on a transitional phase on the 1st of October 2023. CBAM has initially been applied to iron, steel, aluminium, cement, electricity, fertilisers and hydrogen. All good reasons to look for solutions from within the EU. Reporting only started on this date, but the financial side comes into play in 2026. [18]

The UK ORE market is one of the leading global markets in the world at this time. It has one of the most extensive portfolios of installations, mainly fixed bottom at this point. But it has ambitious plans to rollout FLOW into its UK wates in the coming years. It too, is looking at issues around concrete as an alternative to steel platforms. RenewableUK’s Floating Offshore Wind Taskforce in its Industry Roadmap 2040 report, in March 2023, looked at building the UK Port Infrastructure required to support the rollout of FLOW. It ran both the steel and concrete as potential scenario’s and was agnostic to the solution that would actually use.[12] While it looks at both solutions with merit it does not recommend one solution over the other, but recognise concrete as a viable solution.

The report recommends that more work is required as set out below and considering the history of the UK in heavy steel fabrication against Irelands history there is skills deficit here, at this time.

''The feasibility and attractiveness of concrete substructure should be further investigated.
Further investigation in the feasibility, attractiveness and UK benefits of developing concrete substructures as a viable solution for FLOW. To get more clarity on the concrete manufacturing port feasibility and infrastructure requirements, the UK's potential for concrete construction needs to be better understood.

At first glance, it is expected that lower investment will be required due to the UK's existing industrial base for concrete solutions in other sectors. Additionally, it will also unburden steel supply and associated skill requirements as there will be healthier balance between the use of steel and concrete in the UK market. The question remains if concrete is going to be a widely used as the accepted solution to condone further development of infrastructure and skills.

Investigate the feasibility of modular and standard based steel substructure fabrication in the UK.
UK steel substructure fabrication facilities are required to service and secure UK deployment ambitions but can only be developed on the back of highly modular and based on standard components. Standardisation of steel structural components (e.g., tubes) by designers across the industry would greatly assist the industrialisation of the fabrication industry in UK.

Multiple steel fabrication locations will be required in the UK to supply FLOW steel assembly ports; these can feed in to one or more assembly location. Considering the increase in demand from FLOW, the UK would need to bridge the gap with existing European assembly capacity.
British ports and fabricators are unlikely to be able to compete with suppliers in the Far or Middle East in terms of infrastructure scale and labour cost, but with the high cost of transport there might be a case for securing supply, speciality fabrication and the value added via indigenous strengths in areas such as modern high-end automated welding must be prioritised.''

In theory the same consideration could equally apply to Ireland, but in the Irish case from a skills perspective the deficit is higher. In Workstream 4 of this consultation it would have been important to see what the value in terms of GVA and FTE would be if the concrete solution was run in parallel to steel.

Concrete manufacturing emits a high level of carbon dioxide each year. Portland clinker – cement's key binding ingredient – accounts for over 90% of those emissions. But there are alternative binders that are safe, scalable, cost-effective, and – above all – climate-friendly. [19] There has been difficulties in the EU's Emission Trading System to cater for these alternative materials, but it is hoped it will be sorted for 2026-2030. The cement industry is also a source for green hydrogen to be used in the kilns to again further enhance cements green credentials.

There is no concrete design fully approved and ready to go as of yet, but work is ongoing and potentially a hybrid of solution is ultimately decided upon as a workable solution. But there are a number of UK reports published as there is much activity on this topic of the use of concrete as a solution for offshore platforms. There are barge designs and semi-submersibles, as well as the spar design, the latter probably not suitable as it needs deeper waters to be built in, then our potential ports have available. RWE funded Catapult to look at Manufacturing Concrete Floating Wind Foundations in Scotland in 2021. [20] It is fair to say that the floating wind substructure designs are typically based on concepts used in the offshore oil and gas industry. There is a lot of firsthand experience of these structures in Scotland. 'In the context of the rapid growth of the floating wind market in Scotland, this study seeks to understand the potential for the Scottish supply chain to manufacture concrete floating offshore wind substructures.' It concluded that Scottish supply chain had sufficient capacity in most areas, including the supply of ''lower carbon concrete''.

The following summary very much could be equated to what the capabilities in Ireland would be. Ireland has 4 companies that manufacture cement currently and Low Carbon Cement (LCC) will be available in quantities in the coming years, in line with EU requirements to get to net zero. There are aggregates available in Ireland and there is some rebar manufactured. What capacity of rebar that would be available is unknown but could be addressed. Formwork skills are available, and the post-tensioning skill availability is unknown at this time to the author. In comparison to steel fabrication, the skillsets required are different and probably more readily available or could be more easily provided for through training. This is an industry, based on the current Irish plans that has a life of some 20 plus years and beyond assuming that the repowering of the offshore windfarms continues into the future, beyond 2050.

	Could be fully sourced in Scotland (in baseline scenario)		Comments
	Now	2030	
Aggregates	Yes	Yes	• The baseline scenario is estimated to use ~30% of Scottish crushed rock aggregate supply. • There is significant logistical benefit to local sourcing.
Cement	Yes	Yes	• Carbon allocations influence cement production volumes. • Some lower carbon cement constituents are currently imported but are likely to be available in the UK by 2030. • A number of Scottish companies are already committed to net zero cement by 2050 and there is progress locally and globally on innovation to achieve this.
Rebar	Partially	Likely	• Only one rebar producer with sufficient capacity is available in the UK (Cardiff). The baseline scenario would use 10% of Cardiff producer's capacity. • The baseline scenario would exceed the current Scottish rebar supply capacity by 100%. • On-site facility for rebar cutting and forming would need to be set up at port.
Formwork	Likely	Yes	• Scottish-based suppliers would be able to supply for precast options. Slip forming (where required) would need specialist skills and rigs that are not currently manufactured in the UK.
Post-tensioning	No	Likely	• Currently no domestic supply in Scotland but inward investment likely with sufficient demand.

[20]

Another Catapult report completed for the Welsh government demonstrated that in a comparison between both steel and concrete, concrete created more employment of the magnitude of 10% plus based on installing 1GW per annum. The table below is extracted from the report. [21] It also talked about supply line issues with the steel fabrication, the high skill that was required and that the security of supply offered by construction of concrete units.

All these reports come with the point that the design for a concrete floater has not been totally validated as of yet but should have been considered as part of the workstream.

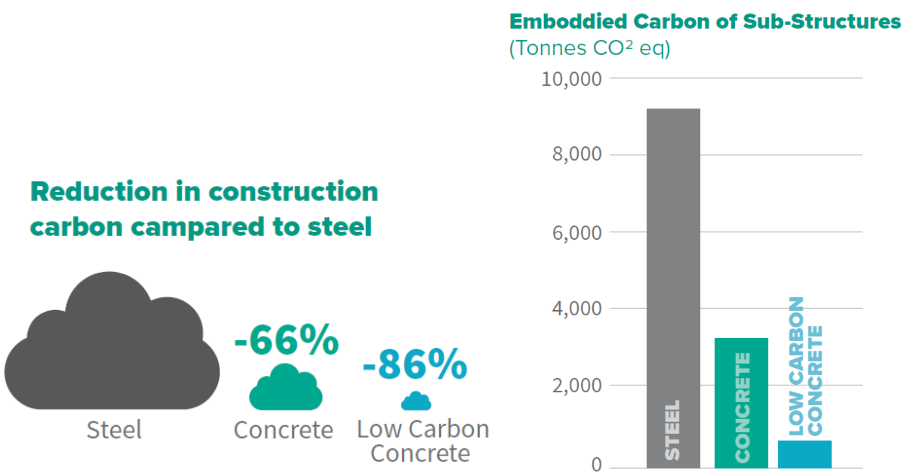
Direct FTE	Units	300MW South Wales	1,000MW South Wales	300MW North Wales	1,000MW North Wales
Steel Semi-Sub Substructure Assembly	FTE	305	684	305	684
Concrete Semi-Sub Substructure Assembly	FTE	362	747	362	747

[21]

Note the number of jobs will increase as the volume of installations will possibly be of the order of 2GW's and these semi-submersible units will be made in more than one construction port – possibly two or three.

It would be insightful to see the comparison of this locally sourced solution to the platform translate into the GVA and FTE figures as the supply more or less in totally on the island of Ireland, modelled as part of Work Stream 4. There is no reason or explanation given in the documentation that has been found.

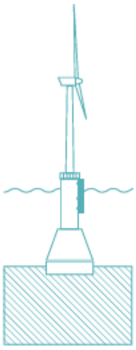
A final UK reference report that will be mentioned is a report issued in 2023 on behalf of the Cornwall FLOW Accelerator – Concrete for Celtic Sea Flow, and it outlines a regional concrete plan for the south east of England. It says that with sub-structures being the single highest value component, they present a realistic route to capturing desired levels of local content and maximizing socio economic gain for the region. The focus on carbon emissions is a useful insight as demonstrated in the following diagrams which are self-explanatory. [22]



[22]

There is work been carried out in other countries such as France, Norway, Italy and Spain, without exploring China and the Far East, on the use of concrete as a solution. An example would be Norwegian company Plav Olsen's 00-Star Wind Floater concept. [23] There are also many technical studies being carried out as there is much research ongoing.

This submission has not discussed the use of concrete in the fixed wind turbines in the initial phases of the Irish rollout following the ORESS 1 auction. There is a gravity-based foundation made from concrete that is a possibility, but without knowledge of the installation sites and the plans of the developers, there is no comment to be made at this point. The use of gravity-base foundations for installation of offshore wind turbines offers a potentially low-impact alternative to traditional construction methods for wind turbines such as pile-driven monopile and/or jacket foundation installations. [24] These are normally made from concrete and would be built portside in a construction port. Gravity Base Structures are the oldest and simplest foundation type, relying on the weight of the ballasted concrete base to provide stability. The volume of materials needed for depths beyond 35m makes them very expensive for deep-water sites. The fabrication and installation requirements are totally different to other fixed bottom foundations.


Suitable for depths of 15m to 40m[2]

There are many references discussing the benefits gravity foundations such as a recent one from Newcastle that found that they are potentially a marine-friendly future for wind turbines. [25]

The recent French installation at Fécamp Offshore Wind Farm used 71 concrete gravity-based foundations in depths of 25 to 30 meters and weight 5,000 tonnes each. [26]

Wind Energy Ireland in their 2020 report Harnessing our Potential said that concrete structures (e.g., gravity-based structures) are more amenable to local production, due to the challenges of lifting and transporting them between different locations. Concrete fabrication facilities require comprehensive facilities that may require considerable up-front investment. A large pipeline of projects is usually required to justify such investments; this is not likely to occur as the use of concrete structures is decreasing. [3]

Has consideration been given to the use of concrete gravity-based units in the rollout of ORESS 1 sites or considered in the work stream deliberations? It is another opportunity to bring jobs into Ireland rather than export them overseas. If there is potential for gravity-based foundations not data could be found at this time.

[2] https://www.empireengineering.co.uk/wp-content/uploads/2021/08/The_Empire_Engineering_Guide_to_Offshore_Wind_Foundations_eBook-1.pdf
[3] Https://windenergyireland.com/images/files/final-harnessing-our-potential-report-may-2020.pdf

3. **Opportunities for our Ports**

The use of concrete has an effect on port planning and construction. The units are much heavier and the load bearing characteristics of quays are much greater. Ports need some certainty when they finalise their design work and now is the time to future proof the requirements.

If the premiss of accepting the potential use of concrete as a possible alternative to steel in the rollout of FLOW, the impact on ports has to be factored in, as well as the flow of the assembly of process the FLOW turbines onto the platforms.

There has been a recent Ports Policy consultation so this input to the current consultation will not be dwelt upon, but a few points will be made.

If concrete is considered for the FLOW installations, there are considerations that have to factored into port planning and will only be mentioned here briefly:

- Workstream 4 mentions Belfast as the only port available on the island of Ireland to support the early phases of the ORE rollout. This is correct, but Belfast is also considered as a resource for the UK rollout of ORE. Has the assumption of the unavailability of Belfast been examines and what the effects on the plan will be. Consideration of the work ongoing progress in Rosslare [27] and the potential of Bremore [28] should be noted and while it does say that Irish ports can pick up the balance not catered by Belfast, consideration needs to be given an unavailability scenario, and expediting of the above-mentioned ports.
- Belfast is only a solution for fixed bottom installations. The document also suggests that investments in ports has not been triggered yet, but this does not seem to be the case. Rosslare is very proactive while other ports are actively engaged in their development.
- In the previously mentioned report by RenewableUK, Building UK Port Infrastructure to Unlock the Floating Wind Opportunity, [12] , they consider three port types in their considerations as per the diagram below. There is much detail in the report but just as mentioned in the BVG report there will be a number of manufacturing and installation ports required, depending on the rollout volume. The manufacturing ports will be an all year-round operation and can manufacture 12 months of the year. Both type of ports (concrete and steel) will manufacture a similar quantity per year and do not need to be co-located with the installation ports.

  There is no preference indicated in the report, one over the other, but the concrete will require a longer quay length. This is a limiting factor but as ports are being developed it is a consideration. The importance of this is for example, looking at Foynes Development from the outside, and with the location of the cement plant near the Shannon estuary, allows for the opportunity to manufacture potentially close by. If there is a manufacturing in the estuary and the opportunity now to develop this aspect accordingly there should be the ability to assemble the floating unit with turbine and all, within an installation port in the estuary and doing it portside rather the suggested jack up vessels in the harbour. The aim has to be to do it portside and should be part of the Future Framework policy, linking into the new Port Policy. Waiting till 2038 for this facility to be available seems very long and should it not be earlier?

The use of the imported jack up vessels and their foreign crews is an understandable solutions outlined in WS4, but the focus should be by early 2030's to at least to have one port in place to support this approach. It would be hoped that Cork could also be on line as well as Foynes, for floating as well, and any other suitable port. Rosslare and Bremore would be fixed based units only it would seem.

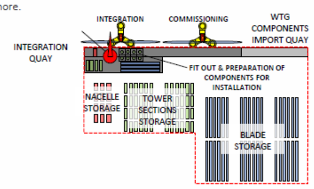
- From a port perspective there are challenges with Concrete over Steel when it comes to your ports structure, but all can be overcome with a clear and PLAN LED policy, indicating the direction of travel. The RenewableUK, which reflects similar thinking to other previous mentioned reports when it comes to ports - Manufacturing concrete floating wind foundations in Scotland [20], Floating offshore wind sector report: non-technical summary | GOV.WALES [21], and Concrete Position Paper 2023', Celtic Sea Power [22]

Critical port types

The key port requirements give an indication of the long-term dimensions to service large scale FLOW deployment. These dimensions can be the result of ports evolving over time to assure they grow with market scale and are future-proofed. **Existing ports with known parameters and sufficient supporting capacity (tug, cranage, launch facilities) could work with lower channel widths and reduced depth requirements, as circumstances and actual requirements are very site specific.**

Integration port

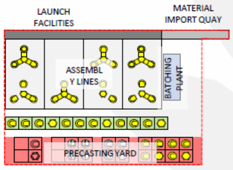
An Integration Port is a facility in the vicinity of the wind farm used to install the wind turbine on the substructure prior to deployment offshore.



KEY REQUIREMENT[1]	17MW	20MW
Distance from Wind Farm (km)	265	265
Entrance Width (m)	120	130
Air Draft (m)	Unrestricted	Unrestricted
Access Channel Width (m) [1]	230	260
Access Channel Water Depth (m below MLWS)	15.0	16.5
Landside Area (ha)	20	25
Integration Quay Length (m)	400	440
Integration Berth Water Depth (m below CD)	15.0	16.5

Concrete manufacturing port

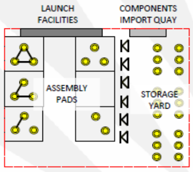
A concrete manufacturing port, which can be further away from project sites, is a facility where concrete substructures are manufactured and assembled.



KEY REQUIREMENT[1]	17MW	20MW
Entrance Width (m)	120	130
Air Draft (m)	50	50
Access Channel Width (m) [1]	230	260
Access Channel Water Depth (m below MLWS)	13.0	14.5
Landside Area (ha)	30	40
Launch Quay Length (m) [2]	520	560
Launch Berth Water Depth (m below CD)	8.5	8.5
Manufacturing Duration for Substructure (wks)	13	13
Number of Assembly Lines (No.) [3]	4	4

Steel assembly port

A steel substructure assembly port, which can be further away from project sites, is an intermediate facility used to construct steel substructures before being transported to an integration site.



KEY REQUIREMENT[1]	17MW	20MW
Entrance Width (m)	120	130
Air Draft (m)	50	50
Access Channel Width (m) [1]	230	260
Access Channel Water Depth (m below MLWS)	13.0	14.5
Landside Area (ha)	30	40
Launch Quay Length (m) [2]	275	275
Launch Berth Water Depth (m below CD)	8.5	8.5
Assembly Duration for Substructure (wks)	6	6
Number of Assembly Pads Required (No.) [3]	6	6

	Concrete manufacturing port	Steel assembly port
Port infrastructure	▪ Similar entrance, landside requirements ▪ **Higher bearing capacity requirements due to heavier substructures (circa 20,000t)** ▪ **More onerous landside transportation requirements** (i.e. skid transfer rails) due to higher loads	▪ Similar entrance, landside requirements ▪ Lower bearing capacity requirements due to lighter substructures (circa 4,000t) ▪ Components and substructures can be transported utilising SPMTs ▪ Noted that quay facilities are dependent on geometry of site and supply chain logistic and therefore are not considered a significant differentiator
Launch & depth	▪ Similar access channel and launch berth water depth ▪ **Careful consideration of how substructures are moved to quayside** is required to prevent bottle-necking of production lines	▪ Similar access channel and launch berth water depth. ▪ Noted that steel substructures are lighter than concrete structures and therefore **lesser water depths for steel substructures may be acceptable** provided that they have adequate stability at these draughts.
Supply chain needs	▪ Lower skills threshold with **more opportunity for workforce to move from existing buildings and civils construction industry** ▪ **Benefits from local supply** of raw materials for concrete production ▪ **Production is likely to take longer** but can utilise production lines for efficiency	▪ **Higher skills threshold for welding and steel assembly operations** ▪ Components imported from fabrication facilities either nationally or internationally

[12]

These concrete units are up to 20,000 tonnes so the load bearing ability of the port is a key consideration. Again, this is a key element if this policy is adopted and should overlap with the upcoming Port Policy

In summary, this input to this Future Framework Consultation, is advocating the re-running of the WS: 4 to investigate whether the process surrounding the use of concrete has a significant benefit to the returns to Ireland in doing this FLOW project. It also has implications for the fixed installations, if Gravity-based structures are required. It has a direct knock on the skills required in Ireland; the planning required around indigenous ports and their direction of travel and the necessary PLAN-LED development assistance to be given.

4. End of Life Planning

Provision for end-of life needs to be part of considerations as it will start coming into play in 2040's. The request is that is acknowledged in the policy statement and that provisions are made for space at ports, a review of what the best strategy will be to be done in time, and provision for ongoing headcount to be allowed for this activity.

Though addressed somewhat on the webinar number 2 by BVG (Leo Bartels), and with planning running out to 2060 in some of the slides, it is believed that by 2040's this matter will become a factor. End-of-life planning for offshore wind installations will be a reality for the infrastructure, ports and supply line. It would be hoped that this sector will contribute to the economy for a significant period of time.

Catapult outline the various scenarios that could be considered and possibly this out of scope, but it worth noting in the Future Framework document as a key step. The scenarios looked at were as follows:

• Full removal • Partial removal • Full repowering • Partial repowering, and • Life extension [4]

They talk about an end of life of 25 years, but other reference talk about blades having a life of 20 years, for example.

The purpose here is not delve any further into this at the point but this needs to be factored into all planning scenarios. Which of these scenarios might relevant is not for comment here, but some scenario will apply. In the harsh conditions of the Atlantic a stated life for a turbine at 25 years may be a challenge.

[4] https://ore.catapult.org.uk/wp-content/uploads/2021/04/End-of-Life-decision-planning-in-offshore-wind_FINAL_AS-1.pdf

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