THE CLEAN REVOLUTION

Building Northern Ireland's Offshore Wind Industry

BVGAssociates

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EXECUTIVE SUMMARY

Offshore wind can help Northern Ireland (NI) achieve its decarbonisation goals while realising economic benefits through the involvement of its supply chain. The emergence of floating offshore wind technology provides a unique opportunity for NI businesses.

This analysis of the NI offshore wind supply chain explores the economic and environmental benefits of an NI market of 1.5 GW installed by 2032 along with the wider export opportunities. It proposes actions to support the development of the NI supply chain and maximise the economic benefits that NI can realise from offshore wind.

PRIMARY CONTRIBUTIONS OF THE NORTHERN IRELAND SUPPLY CHAIN

DEVELOPMENT

Development work that requires interaction with local stakeholders and the regulatory environment.

Site investigations and above water surveys.

Engineering design and consultancy.

Legal and financing expertise.

MANUFACTURING

Supply of foundations and offshore substation structures from Harland and Wolff.

Several companies capable of supplying secondary steel for these components.

Construction of operation bases can be almost entirely undertaken by local suppliers.

INSTALLATION

Installation of onshore civils and electrical assets can be entirely covered by NI suppliers.

NI suppliers heavily involved in port side activities of turbine and foundation installation.

Some involvement in offshore cable installation such as onshore connection and cable protection.

OPERATIONS, MAINTENANCE AND SERVICE

NI suppliers can cover a large portion of the onshore logistics as there is significant crossover with onshore wind.

Offshore logistics a mixture of local and imported supply.

General maintenance of turbines and balance of plant will use local technicians.

An enterprise hub could attract new companies to NI.

BENEFITS OF OFFSHORE WIND FOR NORTHERN IRELAND INCLUDE:

Offsets 49 million tons of CO_2e

1.5 GW of NI projects by 2032

Up to £1.9 billion spent with NI suppliers over projects' lifetime

Equivalent of 1.2 million cars taken off the road

Enough to power 2.5 million electric cars

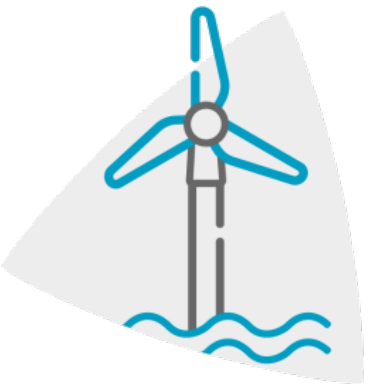
Up to £2.4 billion gross value added

Equivalent of 145 thousand flights from London to New York offset

Enough to power 1.6 million homes

Up to 32,400 FTE years added for NI suppliers

ACTIONS THAT THE NORTHERN IRELAND GOVERNMENT AND INDUSTRY CAN TAKE TO ACHIEVE THESE BENEFITS INCLUDE:

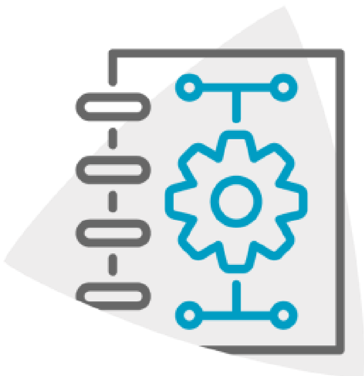


Provide a visible route to market for Northern Ireland projects:

- Develop a long-term pipeline of projects to instil confidence in developers and other suppliers

Support collaboration between the Government and industry:

- Agree a local supply chain charter
- Second Government employees into developers
- Encourage collaboration between developers



Support collaboration in the Northern Ireland supply chain:

- Encourage collaboration between Belfast Harbour and Harland & Wolff
- Provide capital investment grants

Establish a local enterprise hub:

- Identify a suitable location and tenants
- Put together attractive package to bring these tenants in

Train the workforce of Northern Ireland:

- Apprenticeship programs to shift risk from suppliers
- Support synergies between sectors
- Promote awareness for jobs in offshore wind

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1. INTRODUCTION

Offshore wind creates business opportunities for companies and offers the prospect of economic development where it's needed most. The floating offshore wind market creates an additional opportunity because supply chains and technology are less mature and there are fewer incumbents.

Northern Ireland (NI) has a track record of supporting offshore wind projects, dating back to UK Round 1 projects in the Irish Sea. The development of its supply chain has been hampered by the lack of NI projects, but this could change with Department for the Economy (DfE) committing to its Energy Strategy Action Plan, which involves introducing a Renewable Electricity Support Scheme for NI by 2023.

A factor in sustaining political support will be a clear understanding of the potential supply from NI and the economic impacts that this can have. Also crucial will be a clear understanding of how this potential can be maximised.

RenewableNI has commissioned this analysis to demonstrate the opportunities for NI companies, establish the economic benefits from the industry and identify actions to grasp the opportunity fully.

2. **METHODOLOGY**

The work was undertaken in six stages:

- **Market assessment**
- **NI supply chain and infrastructure mapping**
- **NI supply chain scenarios**
- **Economic impact analysis**
- **Environmental impacts, and**
- **Actions to support the NI supply chain.**

2.1 MARKET ANALYSIS

The extent of NI's supply chain opportunity ultimately depends on the size of the markets within geographic reach. NI's domestic market will be a source of valuable business opportunities but rapid growth elsewhere provides opportunities for NI companies to invest sustainably for the long term.

Considering this, we forecasted the following markets to 2032:

- **NI domestic,**
- **Great Britain west coast (GB west),**
- **Republic of Ireland east coast (RoI east), and**
- **Rest of Europe (including the rest of the UK and Ireland).**

In general, there are advantages to being local to the project. NI projects are more likely to use NI suppliers where there are additional costs and risks from importing components. GB west and RoI east projects are accessible for NI suppliers, but political pressures are distinct and they have therefore been considered separately. While being the largest market, the rest of Europe is less accessible to NI suppliers but still significant.

For each geographical area, we used forecasts developed by BVGA and agreed by RenewableNI. These forecasts were built using project pipelines, the offshore wind goals of each country, and the likelihood that they reach these goals.

2.2
SUPPLY CHAIN AND INFRASTRUCTURE MAPPING

We established NI's supply chain's capability to supply to offshore wind projects by researching potential suppliers on RenewableNI's member database and Invest NI's supply chain list. We:

- **Interviewed the suppliers most likely to be major employers in the sector**
- **Issued short questionnaires to all potential suppliers, and**
- **Researched information from publicly available sources.**

This list was categorised into level 2 supply chain categories as defined in Appendix A.

Each category was assessed with the following criteria:

- **NI supply track record.**
  How much NI companies have supplied to the offshore renewable industry to date.
- **Supply chain and technology maturity.**
  How well-developed the global supply chain is. (This is most relevant for floating, where the immaturity of parts of the supply chain creates new opportunities.)
- **Relevance to other NI supply chains.**
  How strong NI's core expertise is and the synergy with the parallel sectors where NI has strengths.
- **Logic of NI supply.**
  How strong the logic is for NI supply. Includes intrinsic strengths deriving from the location, such as the size of potential workforces available and the distance to the projects in question.
- **NI investment risk.**
  The risks to investment in NI. They may either be generic (applying also to investments made in other countries) or specific to NI. They consider the size of investment and the lead time for the first returns on that investment

These criteria give an understanding of those supply chain categories where the NI supply chain is going to be most successful.

2.3
SUPPLY CHAIN SCENARIOS

Following the supply chain mapping exercise, we built two scenarios quantifying the extent to which the NI supply chain can supply the four markets defined in the market analysis:

- A business as usual scenario, representing the state of the NI supply chain with incremental growth and development.
- An ambitious scenario, representing what the NI supply chain could achieve with significant growth and development, through investment or otherwise.

Economic impacts for the business as usual scenario were informed by:

- Discussions with suppliers about their expected involvement in offshore wind,
- An expectation that a local workforce will be established in areas that require a local presence (such as development and turbine technicians) and
- An expectation that local suppliers will be used in areas that have sufficient crossover with NI's onshore wind supply chain (such as turbine asset management, onshore civils, onshore electricals, and legal).

The ambitious scenario built on these assumptions by assuming:

- A general increase in local content through the growth of existing suppliers and emergence of new suppliers.
- NI projects will use NI suppliers wherever possible.
- Suppliers we spoke to will achieve their growth plans for offshore wind.
- A regional offshore wind cluster will be established, comprising of 10-15 global companies, each with 10-15 local full-time employees. These are stable long-term jobs, as the global nature of these companies means that workers can be relocated if local demand drops.

2.4 ECONOMIC IMPACT ANALYSIS

Following the supply chain analysis, the economic modelling was carried out. For each of the scenarios, we calculated for each state the following economic benefit metrics:

- Net expenditure (£)
- Local content (%)
- Direct, indirect and induced employment (full-time equivalent years, or FTE years), and
- Direct, indirect and induced gross-value added (GVA).

GVA is the value generated by any unit engaged in the production of goods and services. One FTE year means one full-time job for one year and is derived using GVA and salary data. Salaries and employment costs were researched from public sources and from data collected by BVGA during previous analysis.

The methodology used was developed specifically for the offshore wind sector by BVGA. Our approach is further described in Appendix B.

All values are in 2022 prices.

2.5 ENVIRONMENTAL IMPACTS

We quantified this benefit by calculating the net carbon savings over time for the NI projects in our market forecast.

- Gross carbon savings: the equivalent CO_2 produced using fossil fuel generation (of the NI fossil fuel mix) for equal offshore wind electricity production.
- Embodied carbon: the carbon produced by the construction, operation, and decommissioning of offshore wind.
- Net carbon savings: gross carbon savings minus embodied carbon.

For offshore wind, most embodied carbon comes from the capital investment phase, mainly the extraction of raw materials, the manufacturing of components and fuel use during installation. A figure of 11 kg CO_2^e/MWh was used to estimate lifetime carbon expenditure of the offshore wind farms[i].

Annual carbon equivalent savings were calculated by taking the annual energy production of the NI wind farms and calculating the equivalent emissions if the same quantity of energy was produced using NI's current fossil fuel mix.

According to BEIS, in 2019, 73.7% of NI's non-renewable electricity mix came from natural gas, with 24.7% coming from coal and 1.6% from oil. With carbon equivalent outputs of 227 kg CO_2^e/MWh, 414 kg CO_2^e/MWh, and 314 kg CO_2^e/MWh respectively, the weighted average fossil fuel emissions is 274 kg CO_2^e/MWh.

2.6 ACTIONS TO SUPPORT NI SUPPLY CHAIN

For the ambitious scenario to be achieved, certain conditions need to be met. In this phase of the work, we identified:

- What those conditions are
- What actions could be taken
- Where they should be focused to maximise local content
- The optimal scale of investment needed to deliver them effectively
- How they could be delivered
- The risks for delivery, and
- The potential involvement of coastal communities.

These actions could be undertaken by:

- Industry (collectively by RenewableNI or wider UK groupings), and
- Government (the Department for the Economy or at UK level if needed).

[i] This figure has been used by the Offshore Renewable Energy Catapult

https://ore.catapult.org.uk/blog/race-reduce-carbon-footprint-wind-energy/

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3. **RESULTS**

3.1 **MARKET ANALYSIS**

According to NI Executive's 2021 report, Energy Strategy for Northern Ireland, NI aims to have 70% of its electricity from renewable sources by 2030, with offshore wind being necessary to do so. [ii] The Climate Change Act of 2022 upped this target to 80%, increasing the need for offshore wind. [iii] While NI projects are not eligible for UK CfDs, the option of setting up an alternative Renewable Electricity Support Scheme is being pursued. We assumed 1.5 GW will be built by 2032, most of which will be after 2030, and modelled a period of 2027-2032 to demonstrate the economic impacts of a domestic offshore wind market.

Great Britain and the Republic of Ireland have more established project pipelines. We expect Great Britain to install over 33 GW by 2032 and the Republic of Ireland to install 4.5 GW. For each, we took any capacity expected to be installed in the Irish Sea or off Scotland's west coast to quantify the GB west and RoI east markets. Projects in the Celtic Sea, off the west coast of Ireland, and off the north coast of Scotland were considered to be part of the Rest of Europe market.

The annual installation forecast for the four markets analysed is shown in Figure 1. We expect 85 GW of installed capacity in the rest of Europe between 2027- 2032. As seen in the chart, the Rest of Europe market accounts for most of the installed capacity. Figure 2 shows the NI, UK west, and Ireland east markets split by foundation type. These markets combine for a little over 7.3 GW of installed capacity from 2027-2032.

[ii] *https://www.economy-ni.gov.uk/publications/energy-strategy-path-net-zero-energy*

[iii] *https://www.legislation.gov.uk/nia/2022/31/enacted*

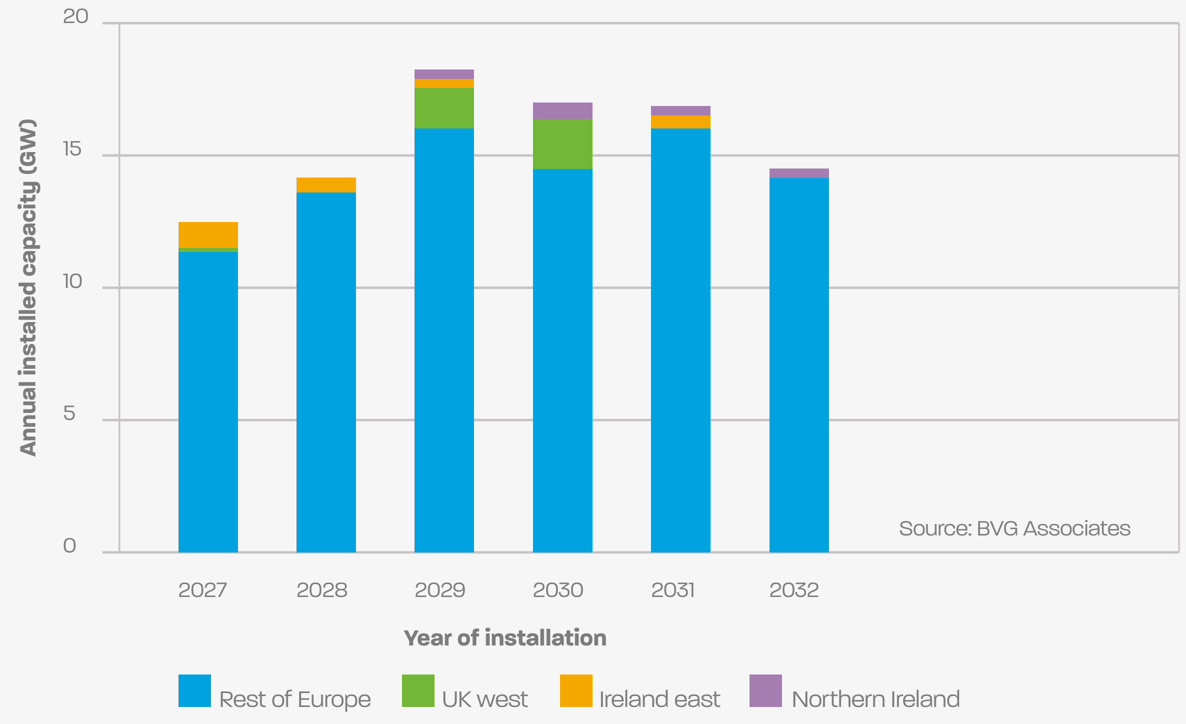

Figure 1 Annual installation forecast

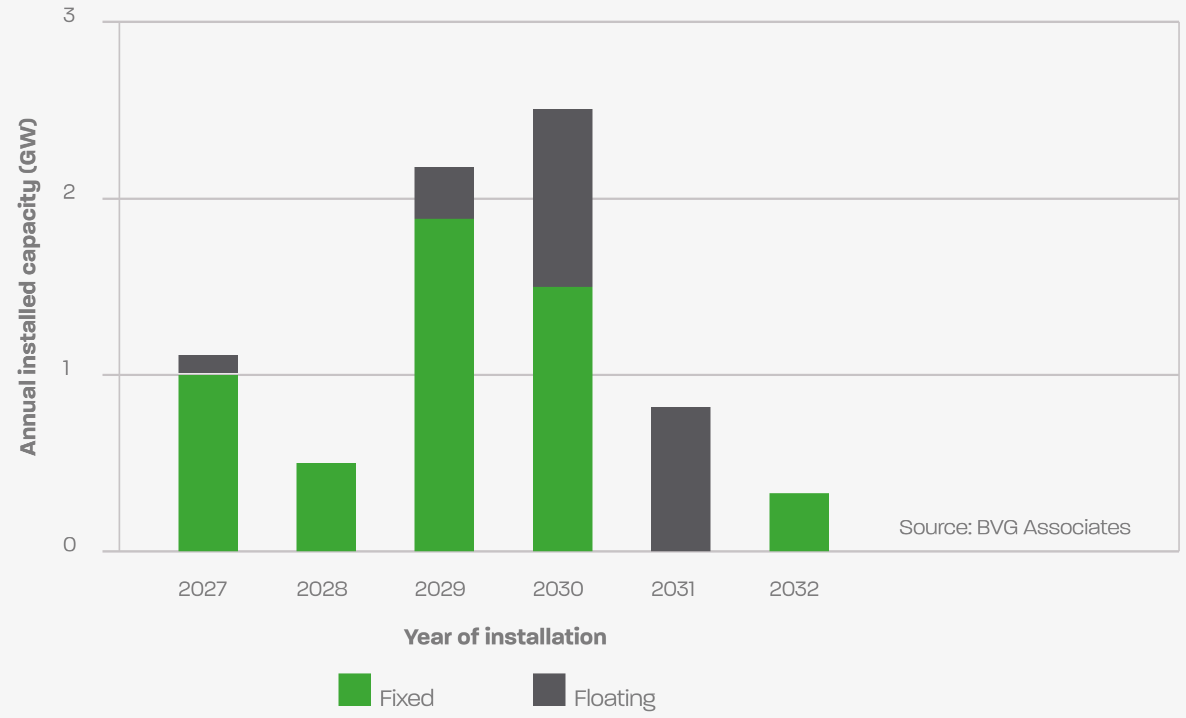

Figure 2 Annual installation forecast for NI, Great Britain west, and Republic of Ireland east markets by foundation type.

3.2 SUPPLY CHAIN AND INFRASTRUCTURE MAPPING

3.2.1 DEVELOPMENT AND PROJECT MANAGEMENT

Development and project management is a mature element of the supply chain. New market entrants may find it difficult to compete with established companies with experience. However, a large portion of development involves interacting with local stakeholders and the local regulatory environment. For NI, this area will be new to non-NI companies and could be an advantageous angle for NI suppliers.

RES's NI office was involved in the early stages of developing the First Flight with Ørsted, but the project was cancelled with no route to market available. Some developers have a NI presence, such as SSE, but have not developed any offshore wind projects locally.

NI could draw experience from its large onshore wind market and associated developers (such as RES, ScottishPower and SSE). There are also global engineering and consultancy companies (such as AECOM, Byrne Looby, GDG and RPS) that could contribute to development and project management from their NI offices. There is a legal presence in NI, particularly Belfast, that could contribute to projects with their knowledge of local policies and regulations.

As offshore wind projects cannot be developed entirely remotely, a local presence is required. Developers of NI projects are likely to set up or grow offices in NI.

3.2.2 SURVEYS

NI suppliers have experience in offshore wind surveys. Seasource has provided marine traffic surveys for the Hornsea and Dogger Bank projects. It has also conducted marine mammal surveys. Suppliers such as GDG, RES and RPS provide site assessment surveys, meteorological monitoring, and survey management services, although not necessarily from their NI offices.

Surveying for offshore wind is a well-established practice but there is room for innovation. More advanced sea bed mapping technologies and the use of AI and digitalisation to monitor birds and other wildlife are some of the more recent innovations. Potential for innovation provides an opportunity for NI suppliers to enter the market.

NI has some suppliers in other supply chains that could transition into offshore wind. Meteorological monitoring and site assessment can likely be done by existing suppliers with offices in NI. For subsea surveys, Causeway Geotech have marine ground investigation experience relevant to offshore wind.

The logic of NI supply is dependent on the nature of the surveys being carried out. Sea bed investigation requires specialist vessels from European fleets and meteorological monitoring can be done remotely. Other surveys which require a sustained local presence such as marine mammal monitoring make sense for local supply.

There is not much risk in NI investment in surveys outside of investing in specialist vessels. Most of the services are not CAPEX intensive and for many, suppliers could continue to work in the rest of the UK and Irish markets if domestic demand drops.

3.2.3 ENGINEERING AND MANAGEMENT

NI has several global engineering firms with a local presence. Companies such as AECOM, Byrne Looby and RES are all capable of engineering design and construction management in offshore wind. This includes design of foundations, offshore platforms, towers, mooring lines, anchors and transmission systems.

It is not guaranteed that they would resource from their NI offices because they will seek to maximise the use of their technical expertise regardless of where it is based. A domestic offshore wind market and a local enterprise hub could encourage these companies to establish or grow local teams in offshore wind in NI. This raises the prospect of NI teams used to support projects across Europe.

3.2.4 OMS BASE

An OMS base comprises a small building with offices and warehousing at a port close to the associated project. Construction can be carried out by any civil engineering contractor. NI has plenty of suppliers capable of carrying out the works and has smaller ports that would make suitable locations for a base.

3.2.5 FOUNDATION AND OFFSHORE SUBSTATION SUPPLY

Foundation (fixed and floating) and offshore substation supply have overlapping supply chains. Harland & Wolff (H&W) is the key supplier in NI. It has a track record of fabricating substations, substation foundations and suction buckets for meteorological masts, and assembled jackets from its Belfast facility. It has also experience manufacturing and repairing tidal turbines. With its two drydocks and heavy steel fabricating capabilities, H&W is equipped to manufacture floating foundation platforms. H&W also has a painting and blasting workshop in Belfast.

H&W has three other locations around the UK, potentially allowing NI to access further economic benefits by H&W resourcing from its Belfast workforce.

Lagan Engineering explored the option to supply secondary steel for a project, but this never materialised. Suppliers such as CASC and Lagan have the engineering workshops with the potential to supply secondary steel for foundations and offshore substations. NI engineering design firms can be involved in the design of mooring lines and anchors.

There is logic to NI supply of foundations and offshore substations. H&W is at an ideal location to supply to NI, Irish Sea, Celtic Sea and ScotWind projects. H&W is also close to Belfast Harbour's D1 Terminal, providing an opportunity to manufacture floating foundations at H&W and integrate the turbines onto them at the D1 Terminal.

3.2.6 TURBINE AND FOUNDATION INSTALLATION (FIXED)

Belfast Harbour's D1 Terminal is the premier installation port in the area. Some NI suppliers have developed roles in the onshore side of installation works. Doyle Shipping has worked across Europe providing port logistics planning services. CASC fabricates working platforms and structures for onshore tower erection and provides site mobilisation and demobilisation globally.

As the offshore installation works are mostly specific to offshore wind, there is little overlap to other NI supply chains such as onshore wind.

There is logic in NI continuing to provide or expanding on the onshore portion of installation activities, such as the full turbine preassembly package.

3.2.7 TURBINE AND FOUNDATION INSTALLATION (FLOATING)

NI suppliers' involvement in the installation of floating foundations and turbines is expected to be much the same as for fixed-bottom, covering most of the onshore activities and some of the offshore. This would mean port logistics, supply of working platforms, site mobilisation and demobilisation, and potentially turbine preassembly. There is the possibility of using a local workforce to integrate the turbines onto the floating foundations at Belfast Harbour, but the primary installation contractor may draw on framework contracts it has with other European suppliers.

There is a strong logic for using NI workers for all the onshore installation activities. With H&W one of the only ports suitable for the manufacture of floating foundations and a large floating market in the surrounding areas, H&W and Belfast Harbour should see sustained work in the floating market.

3.2.8 OFFSHORE CABLE INSTALLATION

NI suppliers can contribute in two areas of offshore cable installation – onshore connection and cable protection.

NI suppliers already have experience in these areas in offshore wind projects.

Ridgeway Rockbags has experience in cable protection via rock-filled bags.

Ridgeway has worked on offshore wind projects across Europe. For NI projects, local quarries can provide the rock.

Omexom provides the onshore connection of offshore assets across the UK and rest of Europe and would use a local team for local projects.

Offshore cable installation is a highly specialist process but NI suppliers have an opportunity to provide services to support offshore logistics.

3.2.9 ONSHORE SUBSTATION AND CABLE INSTALLATION

Onshore substation and cable installation is not an offshore wind specific activity. NI has a strong track record with suppliers such as Omexom and M&M Contractors providing turnkey onshore electrical installation works across a range of energy sectors. These suppliers can take on the full scope of any onshore installation works.

There is a strong logic for using NI suppliers for local onshore electrical installation. The current suppliers have the experience and workforce to provide the full scope of work. NI suppliers must be globally competitive to supply these services to external markets as most will already have their own suppliers capable of providing the work.

3.2.10
PORTS

Belfast Harbour's D1 Terminal is a world-class installation port for fixed offshore wind. The port is capable of marshalling both foundations and turbines. H&W in Belfast is suitable for a supporting role. For example for moorings storage and staging. Belfast Harbour does not have a large tidal range, allowing for 24 hour access of jack-ups and other construction vessels.

Belfast Harbour already has experience as a construction port in offshore wind. It has been used for the staging and pre-assembly of turbines for projects for Ørsted and ScottishPower Renewables.

A port owner typically acts solely as a landlord, leasing the space to developers or their main suppliers but not necessarily employing many people directly. It does provide an advantage for local suppliers to get involved in port-side activities.

Availability of ports is a potential bottleneck for the offshore wind market, meaning Belfast Harbour expects to get consistent work.

Belfast Harbour's D3 Terminal is also being developed for NI's cruise industry, but it could also be used for offshore wind work if D1 is at capacity. We understand that the D3 Terminal investment would not involve significant quayside strengthening and could not be used for heavy components.

Developers of NI projects may face strong competition for the use of the D1 terminal as larger projects, such as those in GB west, may be able to offer multiyear leases which smaller NI projects may not be able to offer.

3.2.11
OPERATIONS

NI suppliers have no direct track record in operations of offshore wind farms as a large portion of operations are typically done locally. However, NI suppliers can draw upon experience in other supply chains.

NI will be able to capture a large portion of the onshore logistics. Much of the asset management and remote site monitoring is the same as it is for onshore wind and can be done locally. The staff at the various O&M bases will be local, along with much of the secondary indirect services supplying the bases.

Additional onshore logistics such as warehousing and operational planning will also likely be local.

Offshore logistics is likely to be a mix of local and non-local supply. Crew transfer vessels and service operation vessels can be crewed with local workers, and NI suppliers also have a track record in vessel maintenance. Marine coordination and weather forecasting systems are typically managed by third party European suppliers.

Training may not be provided locally as personnel are typically sent to already established training centres for the necessary courses.

It is logical that much of offshore wind operations for NI projects is supplied locally as much of the work needs to be close to the project. This reasoning also means that NI will be unlikely to supply much in operations to wind farms in external markets.

3.2.12
MAINTENANCE OF TURBINES

Turbine maintenance provides one of the largest opportunities for local content on offshore wind farms. Many local technicians are required to maintain turbine availability. Planned maintenance of turbines is typically restricted to summer months.

General turbine maintenance is much the same as it is for onshore turbines. NI has a large onshore wind market. RES, Barton Industrial Services, and Everun are just some of the local suppliers that currently maintain the onshore fleet.

Such suppliers could diversify to work offshore, although the working patterns and offshore training required mean that distinct teams would be needed.

Major component replacement requires the use of a jack-up vessel and therefore will need to be carried out by European suppliers.

It is logical that turbine maintenance is supplied locally where possible. Maintenance costs are reduced by having technicians as close to the wind farm as possible.

3.2.13
MAINTENANCE OF BALANCE OF PLANT

NI suppliers have experience in the above water and onshore portion balance of plant maintenance.

Omexom and RES provide maintenance of offshore substation topsides and electrical systems in external markets. Local suppliers like Omexom and M&M Contractors are capable of maintaining onshore transmission assets. Local teams could be established to take on the ongoing maintenance of local NI wind farms.

Subsea cable and foundation maintenance are usually subcontracted as packages to established European contractors as they require specialist vessels and equipment such as side-scan sonar vessels, ROVs and cable repair equipment. Providers of these services could be attracted to an NI enterprise hub. There is potential for less specialist above water maintenance, such as statutory inspections, to be carried out by local workers.

It is logical that the maintenance of transmission assets is based locally, where unplanned faults need to be fixed quickly to minimise loss of revenue.

3.2.14
OTHER SUPPLY CHAIN ELEMENTS

The following supply chain categories are not considered in this section due to the NI supply chain having little to no involvement in the business as usual scenario:

- **Turbine supply** – Turbine suppliers source components from a global network of suppliers. The location of the project does not influence where components are sourced from. No NI supplier currently supplies turbine components, but the possibility of NI suppliers providing some minor turbine components is explored in the ambitious scenario.
- **Onshore substation supply** – The primary expense of onshore substation, the transformers and switchgear, need to be imported. NI suppliers can provide supplementary components such as the foundation, fencing, lighting, and security systems.
- **Onshore and subsea cable supply** – NI has no factories that manufacture medium or high voltage cables and there is no logical reason for a supplier to establish one. Cables can be easily transported long distances at relatively low expense meaning there is no issue with them being supplied from European factories.
- **Offshore substation installation** – Installing an offshore substation requires the use of a specialist heavy lift crane vessel.
- **Decommissioning** – Decommissioning will not become a significant market for another 20 to 30 years. It is difficult to evaluate what the supply chain might look like in that timeframe.

3.3
ECONOMIC IMPACT ANALYSIS

Employment impacts are expressed as FTE years, where one FTE year is the equivalent of one person working full time for a year. The unit is necessary because many workers will be employed for a short period or only work for a portion of their time on the wind farm. A further breakdown of the economic impacts can be found in Appendix C.

3.3.1
AMBITIOUS SCENARIO

NI FTE years from direct and indirect sources for the ambitious scenario are shown in Figure 3.

Total lifetime FTE years are about 24,400 with an annual peak of about 1,500 during the construction phase of projects and about 530 during OMS. Total FTE years are approximately twice that of the business as usual scenario.

FTE years are broken down by supply chain category in Figure 4. The primary reasons for the increase over the business as usual scenario are:

- **Development.** FTE years in this area double during the period modelled due to a combination of higher local content from new companies entering the market and growth in existing companies and the exportability of services within the cluster.

ECONOMIC IMPACT ANALYSIS OVERVIEW

Ambitious scenario

For the period modelled, a total of £1.9 billion is spent on NI suppliers. This results in total GVA of £2.4 billion and about 32,400 FTE years (24,400 of which are direct or indirect).

About 29% of FTE years are in the development and construction stage of projects, with the remaining 71% in operations and decommissioning.

About 66% of direct and indirect FTE years are from NI projects.

Business as usual scenario

For the period modelled, 2027-2032, a total of £0.9 billion is spent on NI suppliers. This results in total GVA of £1.1 billion and about 14,700 FTE years (11,300 of which are direct or indirect).

About 27% of FTE years are in the development and construction stage of projects, with the remaining 73% in operations and decommissioning.

About 85% of direct and indirect FTE years are from NI projects.

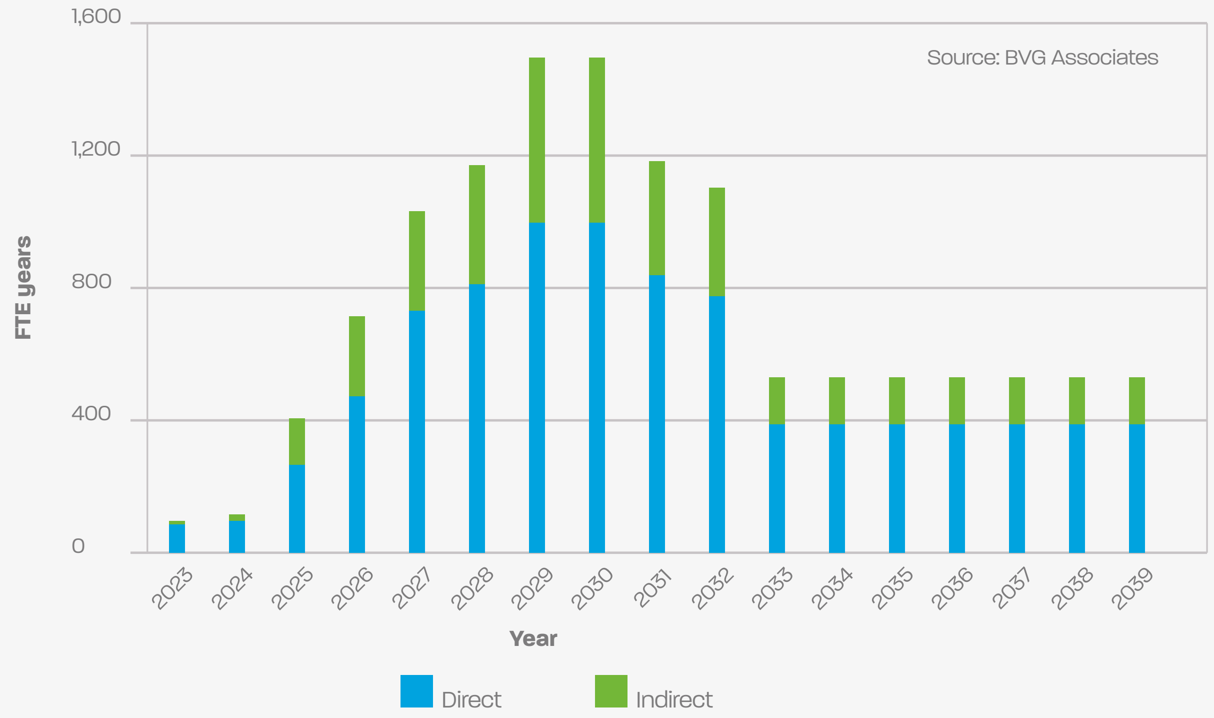

Figure 3 Direct and indirect FTE years for projects installed 2027-2032 in the ambitious scenario.

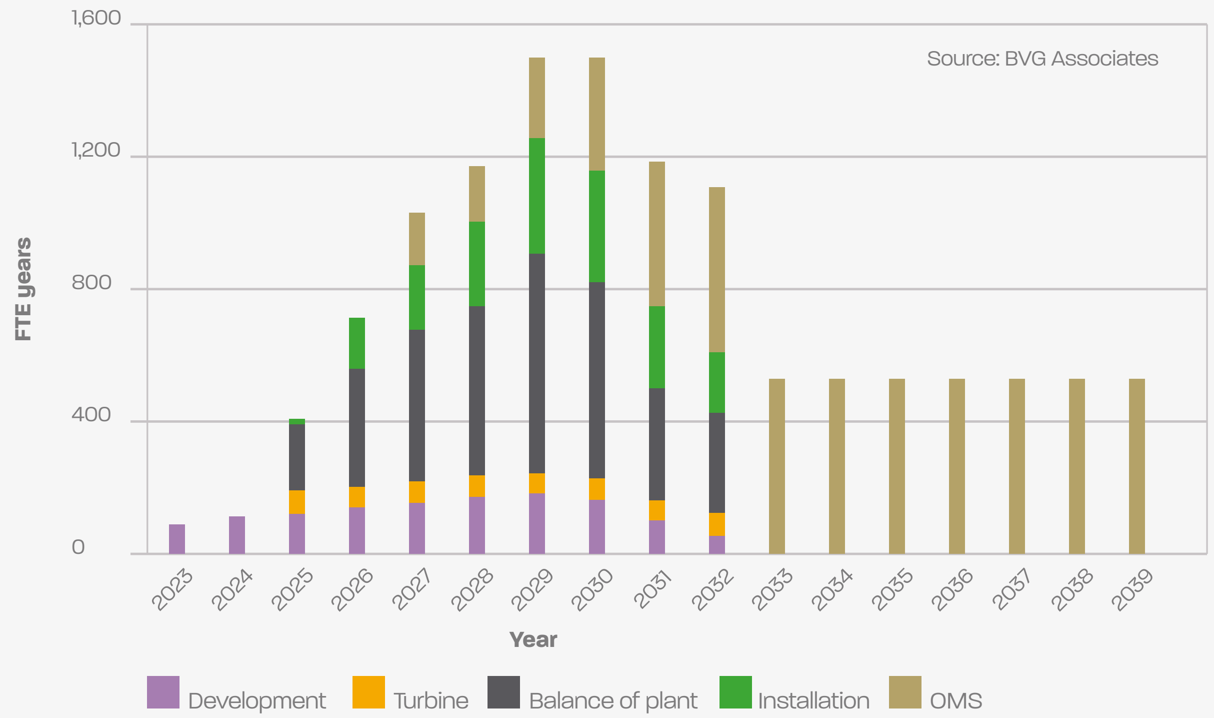

Figure 4 FTE years by supply chain category for projects installed 2027-2032 in the ambitious scenario.

- **Turbine.** There is the opportunity for NI to manufacture some turbine components (such as platforms and tower internals). This would provide stable, long-term FTE years as the jobs would not be dependent on a local offshore wind market to be sustained.

- **Balance of plant.** The increase in balance of plant supply FTE years (2.5 times the business as usual scenario) is largely determined by the growth of H&W, with plans to have as many as 600 workers at their Belfast facility.

- **Installation.** The increase in installation FTE years in the ambitious scenario (approximately double the business as usual scenario) comes from the potential growth in existing suppliers, such as CASC and Doyle Shipping Group, expanding their current teams to work on multiple projects in parallel, and expanding their role within port side installation activities to include the full preassembly of turbines.

- **OMS.** There are twice the FTE years in OMS in the ambitious scenario. This is partially due to an assumed increase in local content through the emergence of new suppliers and growth of existing suppliers, but mostly due to the local cluster and the exportability of the jobs. The cluster is assumed to be largely made up of suppliers in the OMS phase.

3.3.2 BUSINESS AS USUAL SCENARIO

NI FTE years from direct and indirect sources for the business as usual scenario are shown in Figure 5.

Total lifetime FTE years are about 11,300, with an annual peak of about 630.

FTE years are broken down by supply chain category in Figure 6. OMS accounts for the largest portion of lifetime FTE years at about 7,900 (70% of total FTE years) largely due to high local content and the long-term nature of the jobs. FTE years within balance of plant supply are the second largest portion at about 1,400 (12% of total FTE years) though the production of foundation and offshore substations from H&W's Belfast facility. Installation accounts for about 900 FTE years (8% of total FTE years) during the modelled period, mostly from port activities and onshore civil and electrical works. Development (6%) and decommissioning (4%) contribute the remaining FTE years.

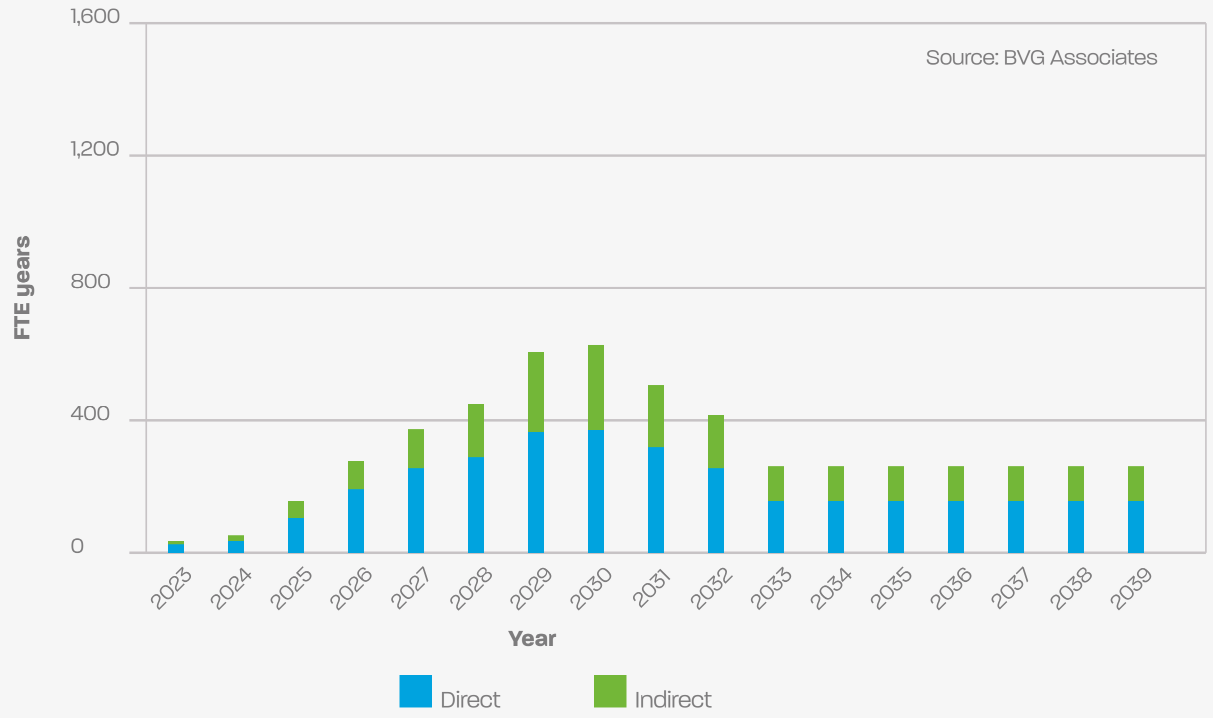

Figure 5 Direct and indirect FTE years for projects installed 2027-2032 in the business as usual scenario.

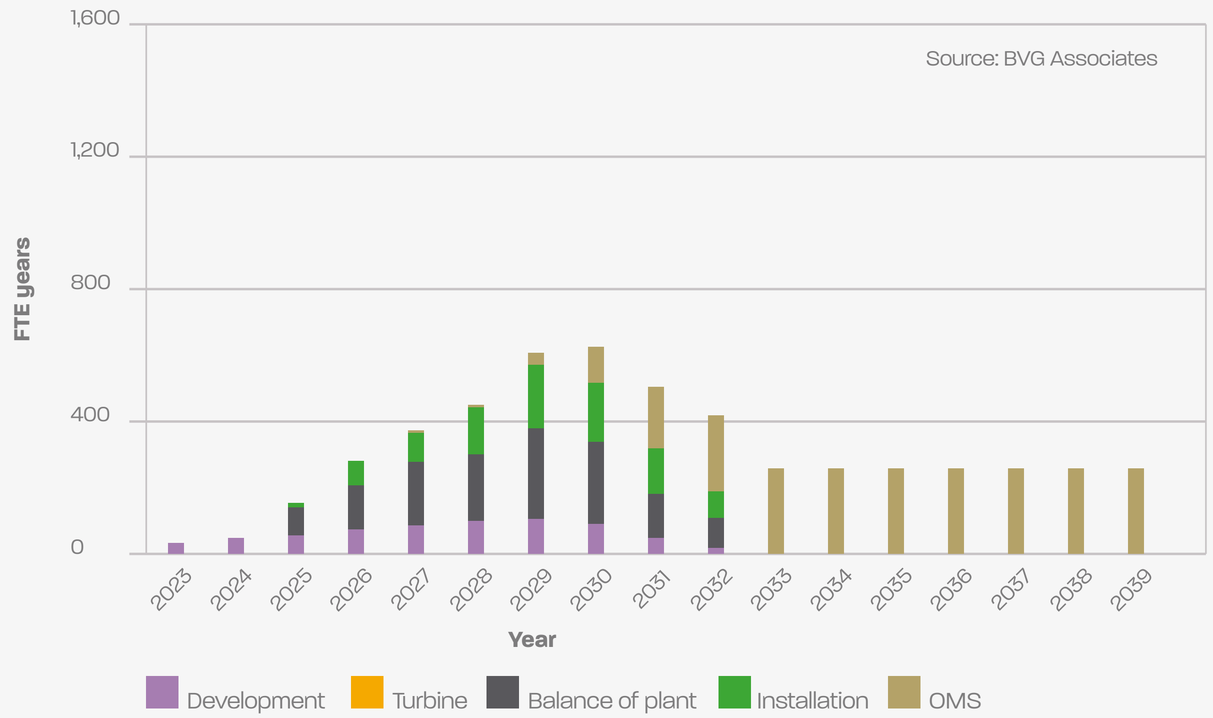

Figure 6 FTE years by supply chain category for projects installed 2027-2032 in the business as usual scenario.

3.4
ENVIRONMENTAL IMPACTS

For the 1.5 GW of NI projects installed by 2032, we calculated the CO_2e education, saved water, homes powered, electric vehicles powered, and cars taken off the road.

The 1.5 GW of NI projects will produce almost 6,000 GWh of clean electricity annually, enough to power:

- **1.6 million homes[iv], or**
- **2.5 million electric cars.[v]**

This will save over 49 million tonnes of CO_2e emissions over the lifetime of the windfarms, as seen in Figure 7. These savings are equivalent to:

- **Taking 1.2 million cars off the road[vi],**
- **Offsetting 145 thousand fully laden flights from London to New York[vii], or**
- **Planting 800 million trees.[viii]**

Additionally, around 6 billion litres of water will be saved annually by replacing fossil fuel generation with offshore wind.[ix]

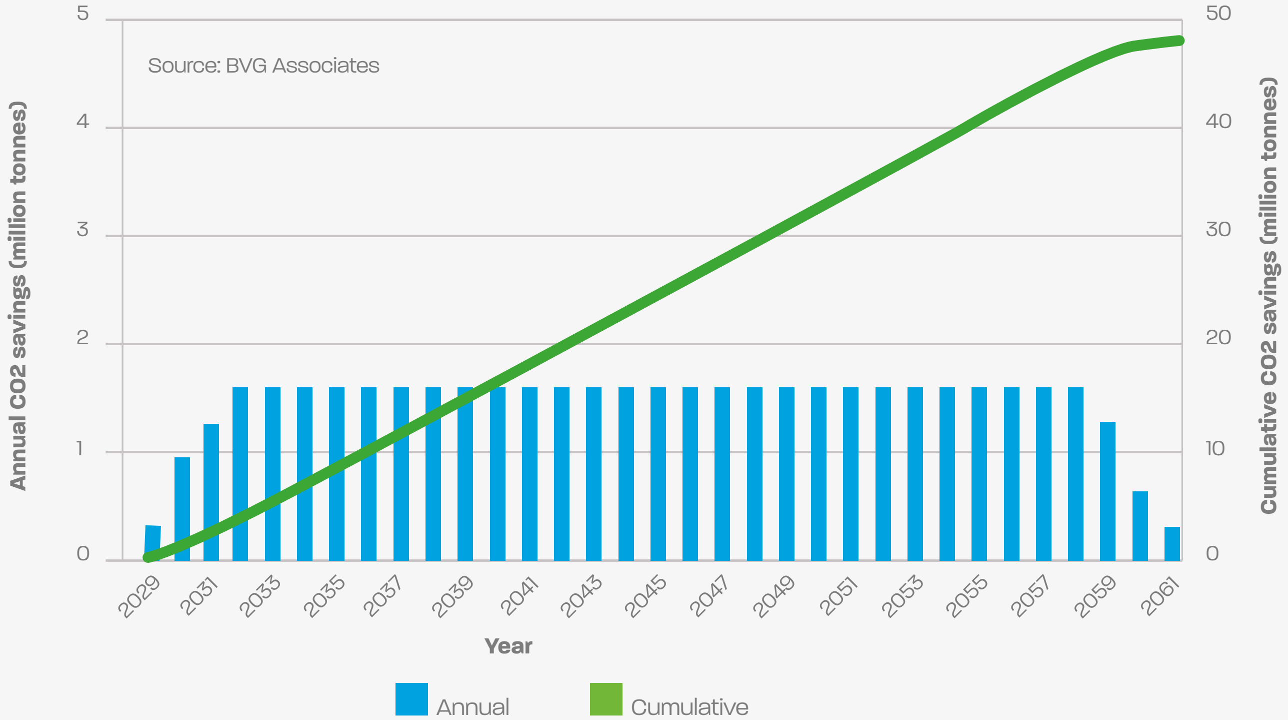

Figure 7 CO_2e savings over the lifetime of the NI windfarms

iv *Based on mean NI domestic consumption of 3,682 kWh/household/year*
https://www.gov.uk/government/statistics/sub-national-electricity-consumption-statistics-in- northern-ireland

v *Based on an average electric car consumption of 0.195 kWh/mile at 12,200 km/year*
https://ev-database.uk/cheatsheet/energy-consumption-electric-car

vi *Based on 0.109 kgCO2e/km at 12,200 km/year*
https://www.daerani.gov.uk/publications/northern-ireland-carbon-intensity-indicators-2021

vii *Based on 6 hour flight of 416 passengers, each with footprint of 134 kgCO2e/hour*
https://www.carbonindependent.org/22.html

viii *Based on 60 kgCO2 captured per tree planted*
https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculationsand-references

ix *Based on 1.04 litres/KWh of water used during electricity generation using NI fossil fuel mix, and 0.043 litres/KWh used for offshore wind*
https://www.sciencedirect.com/science/article/pii/S1364032119305994#bib113
https://www.sciencedirect.com/science/article/pii/S1364032119305994#bib113

4.
ACTIONS TO SUPPORT NI SUPPLY CHAIN

PROVIDE A VISIBLE ROUTE TO MARKET FOR NI PROJECTS

Most of the economic benefits realised by NI are from local NI projects. This is logical as there are certain aspects of the supply chain that need to be local to the project, and others that will likely be awarded to local suppliers where possible. It is critical that there is a visible route to market in place for NI offshore wind projects, to give suppliers and developers the confidence they need to invest within NI. The NI Government is in the process of providing a route to market for NI projects through the implementation of a Renewable Electricity Support Scheme. Further actions that the Government must take to facilitate domestic offshore wind include putting suitable regulations and legislation in place, efficiently planning onshore development and licensing, and the rapid development of sufficient grid connection capacity and connection policy.

TRAIN THE NI WORKFORCE FOR OFFSHORE WIND

Local workers can be trained to maintain turbines and balance of plant. This has been a challenge for the industry, with suppliers struggling to retain enough quality technicians with high demand across the industry. Supporting synergies between sectors such as solar could be a way around this, as technicians could work in offshore wind maintenance during the summer and solar maintenance during the winter, allowing them to remain in NI throughout the year.

Offshore technicians are also expensive to train. The combination of high employee turnover and high training costs creates risk for suppliers, potentially making new local entrants wary to get involved in the offshore maintenance market. Government-led schemes such as apprenticeship programmes could help shift some of this risk off the suppliers and create a dependable route for local workers to get into the offshore maintenance market. Conditions of the scheme could be that workers stay resident in NI for a fixed period. Establishing offshore wind training facilities could be an opportunity for NI to capture content in this area, as it would currently be expected to outsource to other parts of the UK.

There is also a general lack of awareness about the opportunity that offshore wind presents for stable and well-paid careers. Awareness campaigns could be valuable to attract new skilled workers and could be particularly effective for exmilitary personnel seeking employment in a new sector. This could be an effective way to get coastal communities involved, as much of the work will be centred around the smaller ports and harbours that will host OMS bases and storage facilities.

ESTABLISH AN ENTERPRISE HUB

Establishing a supply cluster or enterprise hub could also help to maximise economic benefits. The local offshore wind market may not have sufficient installed capacity to support suppliers in more specialist areas, for example, OMS vessel maintenance. A supply cluster could allow NI to capture local content in these more specialist areas by not relying on a large local offshore market, while providing a base for companies to service the wider Irish and Celtic Sea markets.

Setting up such a hub would need Government support. This would involve identifying an area for the cluster and helping to attract tenants. The most suitable tenants would be able to make use of the strengths of NI, such as the skill-base of the workforce, the proximity to the surrounding offshore wind markets, and the world-class facilities at Belfast Harbour and H&W. The NI Government could put together an attractive package for tenants to encourage them to set up in NI.

COLLABORATION IN THE NI SUPPLY CHAIN

NI can maximise its exportable content by promoting collaboration. Its main advantage is the combination of facilities at Belfast Harbour and H&W. With the emerging floating markets in the surrounding areas, NI has an opportunity to be an early mover in the floating market through the manufacture and installation of floating foundations. Many other ports in the surrounding areas are looking to become regional hubs of floating deployment but first require large investment in infrastructure upgrades and would need to mobilise a skilled workforce. NI already has these aspects in place giving it an early advantage. H&W has the necessary facilities to fabricate foundations but potentially lacks the space to deploy large scale projects. Belfast Harbour has plenty of space between its D1 and D3 Terminals. NI should look to support collaboration between the two suppliers to make the offering as attractive as possible to developers.

Capital investments grants could be a means to support this collaboration, and could also help to offset any perceived loss of facility or functionality due to offshore wind involvement at other ports around NI.

SUPPORT COLLABORATION BETWEEN INDUSTRY AND GOVERNMENT

An option is for Government and industry to agree a 'charter' with a set of commitments to support local supply chain development. Developers and leading suppliers could be asked to sign up to the charter.

NI could apply the concept of the Scottish Offshore Wind Energy Council. This could provide a focal point for discussion on how to maximise the opportunity for the NI supply chain.

The NI Government could second specialists into developers to work with the supply chain and skills development organisations.

APPENDIX A
SUPPLY CHAIN CLASSIFICATION

LEVEL 1	LEVEL 2	LEVEL 3
Development and project management	Development and project management	Development expenditure
		Financing costs
		Legal
		Internal advisor costs
		External advisor costs
	Surveys	Meteorological monitoring
		Environmental surveys
		Sea bed surveys
	Engineering & Management	FEED
		Construction management

LEVEL 1	LEVEL 2	LEVEL 3
Turbine	Turbine	Rotor components
		Rotor assembly
		Rotor transport
		Nacelle components
		Nacelle assembly
		Nacelle transport
		Electrical systems
		Auxiliary systems
		Tower main structure
		Tower flanges
		Tower internals
		Tower coatings
		Tower transport
		Tower base section assembly

LEVEL 1	LEVEL 2	LEVEL 3
Substations and foundations	Onshore substation	Rotor components
		Onshore substation electrical systems
		Onshore substation structure
		Onshore substation facilities
		Grid connection (TSO)
	O&M base	O&M base
	Foundations and offshore substation	Offshore substation electrical systems
		Offshore substation foundations
		Offshore substation topside structure
		Offshore substation engineering
		Offshore substation facilities
		Offshore substation helideck
		Offshore substation crane
		Foundation lattice
		Foundation platform/primary structure
		Foundation secondary steel
		Foundation pin piles
		Foundation coatings
		Foundation crane
		Foundation transport
		Floating foundation primary structure
		Floating foundation secondary structure

LEVEL 1	LEVEL 2	LEVEL 3
		Mooring lines
		Anchoring
		Foundation coatings
		Foundation crane
		Foundation transport
Cables	Onshore and subsea cables	Onshore cable core
		Onshore cable insulation and armouring
		Onshore cable fibre optics and communication
		Onshore cable accessories
		Onshore cable jointing and testing
		Onshore cable transport
		Subsea export cable core
		Subsea export cable insulation and armouring
		Subsea export cable fibre optics and communication
		Subsea export cable accessories
		Subsea export cable jointing and testing
		Subsea export cable transport
		Array cable core
		Array cable insulation and armouring
		Array cable fibre optics and communication
		Array cable accessories
		Array export cable jointing and testing
		Array cable transport

LEVEL 1	LEVEL 2	LEVEL 3
Turbine and foundation installation	Turbine and foundation installation (fixed)	Foundation installation vessel
		Foundation installation vessel fuel
		Foundation installation vessel mob and demob
		Foundation sea fastenings
		Foundation installation vessel crew
		Foundation installation equipment
		Foundation installation vessel maintenance and administration
		Turbine installation vessel
		Turbine installation vessel fuel
		Turbine installation mob and demob
		Turbine sea fastenings
		Turbine vessel crew
		Turbine OEM personnel
		Turbine installation equipment
		Turbine installation vessel maintenance and administration
	Turbine and foundation installation (floating)	Floating foundation installation vessels
		Floating foundation installation vessels fuel
		Floating foundation installation vessels mob and demob
		Floating foundation installation vessels vessel crew

LEVEL 1	LEVEL 2	LEVEL 3
		Floating foundation installation equipment
		Floating foundation installation vessels maintenance and administration
		Turbine installation vessel
		Turbine installation vessel fuel
		Turbine installation mob and demob
		Turbine sea fastenings
		Turbine vessel crew
		Turbine OEM personnel
		Turbine installation equipment
		Turbine installation vessel maintenance and administration
		Mooring installation vessel
		Mooring installation vessel fuel
		Mooring installation vessel mob and demob
		Mooring sea fastenings
		Mooring installation vessel crew
		Mooring installation equipment
		Mooring installation vessel maintenance and administration
Offshore cable installation	Offshore cables installation	Export cable vessels
		Export cable vessels fuel
		Export cable vessel mob and demob

LEVEL 1	LEVEL 2	LEVEL 3
		Export cable vessel crew
		Export cable vessel maintenance and administration
		Export cable ROVs
		Export cable route survey and clearance (UXO, PLGR)
		Export cable pull-in, termination and testing
		Export cable protection
		Array cable vessels
		Array cable vessels fuel
		Array cable vessel mob and demob
		Array cable vessel crew
		Array cable vessel maintenance and administration
		Array cable ROVs
		Array cable route survey and clearance (UXO, PLGR)
		Array cable pull-in, termination and testing
		Array cable protection
Installation other	Offshore substation installation (electrical and topside)	Offshore substation installation vessel
		Offshore substation installation vessel fuel
		Offshore substation installation vessel mob and demob
		Offshore substation sea fastenings

LEVEL 1	LEVEL 2	LEVEL 3
		Offshore substation installation vessel crew
		Offshore substation installation vessel maintenance and administration
		Offshore substation commissioning
	Onshore cable and substation installation	Onshore cable civil works
		Onshore cable electrical works
		Onshore cable horizontal directional drilling
		Onshore substation civil works
		Onshore substation electrical works
		Onshore substation commissioning
	Other	Marine warranty surveyor
		Marine coordination
		Ports
		Guard vessels, CTVs
		MetOcean forecast and measurements
		Compensation payments
		Navigation aids
		Insurance
OMS	Operations	Operational management
		O&M base maintenance
		O&M vessels
		Wind farm rent / sea bed rent

LEVEL 1	LEVEL 2	LEVEL 3
	Grid costs	TNUoS wide
		BSUoS
	Maintenance - BoP	Onshore substation maintenance
		Onshore cables maintenance
		Offshore export cable maintenance
		Offshore array cables maintenance
		Foundation above water maintenance
		Foundation below water maintenance
		Offshore substation maintenance
		Foundation maintenance
		Onshore substation maintenance
	Maintenance - WTG	Blades maintenance
		Pitch system maintenance
		Main gearbox maintenance
		Generator maintenance
		Electrical maintenance
		Control and auxiliary maintenance
		Support structure maintenance (incl. tower)
		Other WTG maintenance
	Other	Insurance
		Environmental studies
		Compensation payments

LEVEL 1	LEVEL 2	LEVEL 3
Decommissioning	Decommissioning	Preparation for disassembly
		Turbine and foundation removal
		Onshore and offshore substation decommissioning (OFTO)
		Rock dumping and inspection
		Port, transport and logistics
		Decommissioning engineering
		Decommissioning project management
		Decommissioning insurance

APPENDIX B
ECONOMIC IMPACT METHODOLOGY

Conventional modelling of economic impacts for most industrial sectors relies on government statistics, for example those based on European industrial activity classification (NACE) codes and use input-output tables and other production and employment ratios, for example those produced by the Central Statistics Office of Ireland. NACE code data can be appropriate for traditional industries at a national level. The development of new codes for a maturing sector, however, takes time. This means that conventional NACE analyses of offshore wind need to map existing NACE data onto offshore wind activities, which is not easy and a source of error. Analyses using NACE codes also rely on generalised data.

Offshore wind requires a more robust approach that considers current and future capability of local supply chains because:

Projects tend be large and have distinct procurement processes, and

Projects tend to use comparable technologies and share supply chains.

An offshore wind specific approach therefore enables a realistic analysis of the local and national content of projects, even if the data is incomplete.

In a conventional NACE-based analysis, successful contractors are categorized using NACE. Input-output tables created, for example, by the Central Statistics Office are then used to develop multipliers. These multipliers attempt to calculate how demand in each of the NACE sectors leads to direct, indirect and induced impacts. The multipliers used in conventional analysis ignore the specific offshore wind supply chain characteristics.

The BVGA method is based on the offshore wind UK content methodology. It uses understanding of the supply chain in the lower tiers to produce a figure that is equivalent to direct and indirect GVA. Calculating a local and national content figure, and understanding profit margins, costs of employment and salaries enables direct and indirect FTE years to be calculated. Induced impacts are calculated using conventional multipliers. The same methodology is followed for local content.

The remaining expenditure is analogous to the direct and indirect GVA created. GVA is the aggregate of labour costs and operational profits. We can therefore model FTE years from GVA, provided we understand some key variables. In our economic impact methodology, employment impacts are calculated using the following equation:

$$FTE_a = \frac{(GVA-M)}{Y_a + W_a}$$

Where:
FTE_a = Annual FTE employment
GVA = Gross value added (£)
M = Total operating margin (£)
Y_a = Average annual wage (£), and
W_a = Non-wage average annual cost of employment (£).

To make robust assessments, therefore, we considered each major component in the offshore wind supply chain and typical salary levels, costs of employment and profit margins, bringing together BVGA's specific sector knowledge and research into typical labour costs for the work undertaken in each part of the supply chain.

APPENDIX C
ECONOMIC IMPACTS

TABLE 1
GROSS VALUE ADDED FOR BUSINESS AS USUAL SCENARIO

GVA	PRE-COD	POST-COD	TOTAL
Direct	£142 million	£409 million	£551 million
Indirect	£82 million	£271 million	£352 million
Induced	£62 million	£170 million	£232 million
Total	£286 million	£849 million	£1,136 million

TABLE 2
GROSS VALUE ADDED FOR AMBITIOUS SCENARIO

GVA	PRE-COD	POST-COD	TOTAL
Direct	£294 million	£1,050 million	£1,343 million
Indirect	£174 million	£360 million	£534 million
Induced	£130 million	£377 million	£507 million
Total	£598 million	£1,787 million	£2,385 million

TABLE 3
FULL TIME EQUIVALENT YEARS FOR BUSINESS AS USUAL SCENARIO

GVA	PRE-COD	POST-COD	TOTAL
Direct	1,910	5,030	6,940
Indirect	1,080	3,270	4,360
Induced	970	2,400	3,370
Total	3,960	10,700	14,660

TABLE 4
FULL TIME EQUIVALENT YEARS FOR AMBITIOUS SCENARIO

GVA	PRE-COD	POST-COD	TOTAL
Direct	4,630	12,950	17,580
Indirect	2,460	4,310	6,770
Induced	2,330	5,680	8,010
Total	9,430	22,940	32,360

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.