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Investigating the potential for an offshore wind supply chain in Northern Ireland

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Disclaimer

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Executive Summary

The recently published Climate Change Act (Northern Ireland Assembly, 2022) committed Northern Ireland to ensure that at least 80% of electricity consumption is from renewable sources by 2030. In addition to the environmental benefits, the Pathway to Net Zero (Northern Ireland Executive, 2021) was also published which indicated that the move towards net zero should also bring economic benefits – with a target to "double the size of our low carbon and renewable energy economy to a turnover of more than £2 billion by 2030". Due to the large resource, offshore wind was identified as a key technology for this net zero transition and the Department's draft Offshore Renewable Energy Action Plan (DfE, 2023a) sets out a roadmap to deliver 1 GW of installed capacity of Offshore Wind from 2030. The purpose of this report is to analyse the current structure of the economy in Northern Ireland, determining any synergies with the offshore wind supply chain, then modelling potential economy-wide impacts of investment in these industries.

We take three approaches in the analysis of the current economic structure in Northern Ireland. First is a simple investigation of sectoral employment numbers, which is then compared with the employment in the nations of Great Britain. The second approach estimates, and compares, sectoral employment location quotients and the third approach estimates the backward linkages in the published Northern Ireland Industry by Industry Input-Output Table (IxI IOT). This analysis revealed four important areas of the offshore wind supply chain, which may bring investment to Northern Ireland; namely, manufacturing of foundations; electrical component manufacturing; onshore construction activities and ports.

Using published information on costs of UK based offshore wind farms and the Computable General Equilibrium (CGE) model for Northern Ireland, we estimate the potential economy-wide benefits of investment in these four areas for 1GW of installed offshore wind capacity (the expected increase in capacity from 2030)[1]. The area with, by far, the largest potential for growth (and by extension economy-wide benefits) in the construction stage is the 'Metal manufacturing' industry, linked to the fabrication of the foundations for offshore wind farms. We estimate an increase in Gross Value Added (GVA) of £211 million supporting ~4,300 Full Time Equivalent (FTE)[2] employees from the fabrication of structures linked to an increase of 1GW offshore wind in the next seven years. Ports are key for the Operations and Maintenance (O&M) of offshore wind farms and bring longer term benefits compared with construction as the wind farms have lifetimes of around 25 years. We estimate that investment in O&M could bring in excess of £1.65 billion GVA and ~30,800 FTE's to the Northern Ireland economy over a 25-year lifetime.

1 The assumption here is that the offshore wind capacity until 2030 is new generation. This is not replacing any current generation capacity. Over time this may change but this is out the scope of this project, the aim of this project is a simple chain analysis not full economic appraisal of offshore wind energy in Northern Ireland.

2 1 FTE is equal to the employment of 1 worker full time over the period of a year.

Key findings

Analysis of the current structure of the economy determined four key areas for the development of offshore wind in Northern Ireland.

- Fabrication of foundations
- Electrical manufacturing
- Construction
- Ports.

We then modelled potential economy-wide impacts of investment in these industries for the development of 1GW of offshore wind by 2030. Three different local content scenarios for each area were modelled with fixed/floating foundations modelled separately. The findings are presented below:

Table 1 – Summary GVA and employment results for offshore wind supply chain modelling[3]

	Local content		
	Low	Medium	High
Employment (FTE)			
Fixed foundations*	3,435	3,864	4,293
Floating foundations*	10,794	13,579	17,872
Electrical manufacturing *	127	157	186
Construction *	446	501	557
Ports #	20,803	25,841	30,878
GVA (£m)			
Fixed foundations*	168.8	189.9	211.1
Floating foundations*	530.5	667.3	878.2
Electrical manufacturing *	9.1	11.2	13.4
Construction*	21.8	24.5	27.2
Ports #	718.2	892.1	1,066.1

* - seven-year period; # - 25 year period

Source: Author's calculation

Fabrication of foundations has the largest impact related to the construction of wind farms. There is a significant difference between fixed and floating but floating estimates are based on current costs. Overtime these costs are likely to decline and in turn reduce the economy-wide benefits linked to their fabrication.

Foundations is also a key area where expertise in Northern Ireland could be exported to offshore windfarms worldwide, bringing extra economic benefits over an extended period of time.

Investment in ports linked to the O&M of the offshore wind farms has a large economic impact lasting over extended period of time. Further research is needed on the current capacity of Northern Ireland ports and potential for expansion to meet offshore wind demand.

3 The employment numbers is the creation of new jobs from the development of offshore wind in Northern Ireland, we assume no displacement of employment in other electricity generation technologies.

1. Energy Strategy for Northern Ireland & Offshore wind

The Climate Change Act (Northern Ireland Assembly, 2022), superseded the 2021 Energy Strategy for Northern Ireland (DfE, 2021), in terms of the proportion of electricity consumption from renewable sources by 2030.The legislation stipulates this is to be at least 80% and Northern Ireland is well on its way to meeting this target with the renewables producing 51.0% of electricity consumption by the end of 2022. (DfE, 2023b). To date much of the green electricity transition has been driven by onshore wind, accounting for 85.3% of all renewable generation in 2022, but for the 80% target to be realised the system must be diversified. Northern Ireland, along with the rest of the British Isles, has a large potential for offshore wind and as such this is a technology which has been identified as a key element in the path to net zero. The Department's draft Offshore Renewable Action Plan (OREAP) sets out a roadmap to deliver 1 GW of offshore wind from 2030.

Growing the Low Carbon Renewable Energy Economy (LCREE) is also identified as a key objective along Northern Ireland's pathway to net zero, with the aim of growing turnover in this sector to £2 billion annually by 2030. Achieving this goal is in line with the idea of 'inclusive green growth' but would require significant investment in green technologies.

While it is clear that offshore wind will play a significant part in achieving the goal of producing green electricity for Northern Ireland, the role the technology has in growing the LCREE is less certain. Offshore wind does require significant investment at all stages of development from pre-development to construction and there is usually a high level of expertise needed at many of these stages. Due to the high level of expertise and specialised equipment, much of the associated investment needs to be outsourced and the level of local content (i.e goods and services bought in the domestic economy) for offshore wind developments is low in many places across the globe. This is true even for larger economies such as the UK, which has offshore wind local content target of 60%, much lower than would be expected for an investment project in an economy of its size (HM Government, 2019). The smaller the local content, the lower the expected economic benefits of the projects.

For Northern Ireland, which has an economy 2.24% the size of the UK (ONS, 2023), this issue becomes even more profound. It is highly unlikely that there is the expertise in Northern Ireland to manufacture a large proportion of the components in the offshore wind turbine supply chain (such as blades, towers, nacelles, etc). However, there may be other stages of development of wind farms which could be supplied by expertise in Northern Ireland. In work commissioned by Renewable Northern Ireland, BVG Associates (BVGA, 2022) carried out a supply chain analysis of a potential offshore wind sector in Northern Ireland, finding possible synergies with current industries. Some key results from this are detailed in Section 2.4.

In this report we analyse the current available economic statistics on the Northern Ireland economy to determine if there are any synergies between the regional economies and the offshore wind supply chain. We then estimate the economy-wide impacts of offshore wind investment in key areas/sectors using a Computable General Equilibrium (CGE) model for Northern Ireland. The next section (2) outlines our approaches to analyse the current expertise in the economy of Northern Ireland, followed by the synergies with the offshore wind supply chain. The CGE modelling is detailed in

Section 3 then with results in Section 4 and sensitivity analysis around floating offshore wind in Section 5, finishing with conclusions.

2. Analysis of current NI economic structure

Before any CGE modelling is carried out, we analyse the current structure of the NI economy to determine the industries with links to the offshore wind supply chain. For this analysis we take three approaches, revealing different details of the economy. The first approach is a simple investigation in the sector employment in Northern Ireland compared with the three counties of Great Britain. In the second approach, we estimate the sectoral employment location quotients, which again are compared with the Great Britain countries. In the third and final approach, we estimate the backward linkages in the published Northern Ireland IxI IOT to reveal the industries most connected through supply chains to other local industries (since investment focused in these industries is likely to have a higher economic impact).

2.1 Simple Employment Analysis

The Business Register and Employment Survey (BRES) data can be used to identify industries of the economy with relatively high concentrations of employment. This is calculated as the industry full time equivalent (FTE) employment in Northern Ireland as a percentage of the total Northern Ireland employment at a 4-digit Standard Industrial Classification (SIC) level. The employment percentages in Northern Ireland were compared to the same indicators for the other three countries of Great Britain, to identify industries where Northern Ireland has higher employment rates, and potential areas of specialisation.

This simple employment analysis focussed on the following industry subgroups most applicable to offshore wind activities: 'manufacturing'; 'electricity, gas, steam and air conditioning supply'; 'construction'; 'wholesale and retail trade', 'repair of motor vehicles and motorcycles'; 'transport and storage'; 'professional', 'scientific and technical activities'. Decisions surrounding the importance of industries to offshore wind activities were based on the analysis conducted by BVG Associates (BVGA, 2022).

Table 2. Results of simple employment analysis of NI BRES data.

Industries[4] linked to the offshore wind activities where NI has higher concentration of employment than GB countries.	Industries linked to the offshore wind activities where NI has significantly lower concentration of employment than GB countries.
Manufacture of metal structures and parts of structures	Manufacture of other electronic and electric wires and cables
Engineering activities and related technical consultancy	Repair of machinery
Freight transport by road; Construction of other civil engineering projects; NEC	Repair of electrical equipment
Other research and experimental development on natural sciences and engineering	Manufacture of bearings, gears, gearing and driving elements
Wholesale of mining, construction and civil engineering machinery	Sea and coastal freight water transport
	Specialised design activities
	Other construction installation
	Technical testing and analysis
	Development of building projects
	Other specialised construction activities Not elsewhere classified
	Other professional, scientific and technical activities Not elsewhere classified

Source: Author's calculation

2.2 Location Quotient Analysis

The BRES employment data can also be used to estimate the sectoral employment location quotients for Northern Ireland and the other three countries of Great Britain. Location quotients are one of the most common methods found in the literature to describe the industrial specialisation of a region (Pereira-Lopez et al, 2021). For this report we use Simple Location Quotients (SLQ's) as:

$$SLQ_i^R = \frac{FTE\ employment\ of\ industry\ i\ in\ region\ R\ /\ FTE\ employment\ in\ region\ R}{FTE\ employment\ of\ industry\ i\ in\ national\ economy / FTE\ employment\ output\ in\ national\ economy}$$

In this case R is either Northern Ireland or an individual country within Great Britain. The numerator of the SLQ is sector i's proportion of employment in region R, while the denominator is sector i's proportion of national UK employment. The interpretation of the SLQs' values is relatively straightforward: an SLQ greater than one may be said to indicate that region R is more specialised in industry i than the nation as whole, whereas an SLQ less than one indicates that region R is less specialised in that industry.

The SLQ analysis was conducted at 3-digit SIC level for Northern Ireland and each country in Great Britain. Table 3 shows the headline results of this analysis. Northern Ireland has specialisations relative to the countries of Great Britain, indicated by SLQ›1, in a number of industries related to offshore wind activity, particularly in the 'manufacture of structural metal products' and 'manufacture

4 In this section we analysed the employment data at the lowest classification available which was 4 – Digit Standard Industrial Classification (SIC).

of other special-purpose machinery'. However, Northern Ireland lacks specialisation in other industries that will play an important role in offshore wind activities, notably in the 'manufacture of wiring and wiring devices' and 'technical testing and analysis'.

Table 3. Location Quotients for SIC sectors related to the offshore wind industry

Industries in NI linked to offshore wind activities with high specification (SLQ >1)	NI SLQ	Industries in NI linked to offshore wind activities with little specification (SLQ <1)	NI SLQ
Manufacture of structural metal products	25.0	Manufacture of wiring and wiring devices	0.0
Manufacture of other special-purpose machinery	22.3	Technical testing and analysis	0.1
Construction of other civil engineering projects	15.5	Sea and coastal freight water transport	0.6
Manufacture of other general-purpose machinery	8.7	Architectural and engineering activities and related technical consultancy	0.7
Treatment and coating of metals; machining	8.1	Specialised design activities	0.9
Manufacture of other electrical equipment	6.6		
Freight transport by road and removal services	6.2		
Other professional, scientific and technical activities Not elsewhere classified	6.1		
Development of building projects	4.7		
Wholesale of other machinery, equipment and supplies	4.2		
Manufacture of other fabricated metal products	3.1		
Electric power generation, transmission and distribution	2.8		
Other specialised construction activities Not elsewhere classified	1.7		

Source: Author's calculation

2.3 Backward linkage Analysis

In the third and final approach we carry out a key sector analysis of the latest Northern Ireland IxI IOT with a particular focus on backward linkage estimates. Backward linkages are the 'supply-chain' linkages of a sector. They reflect the purchases a sector makes from the output of other sectors within the economy as an input into their own production process. In this report we focus on the normalised backward linkages (BPLi), calculated as:

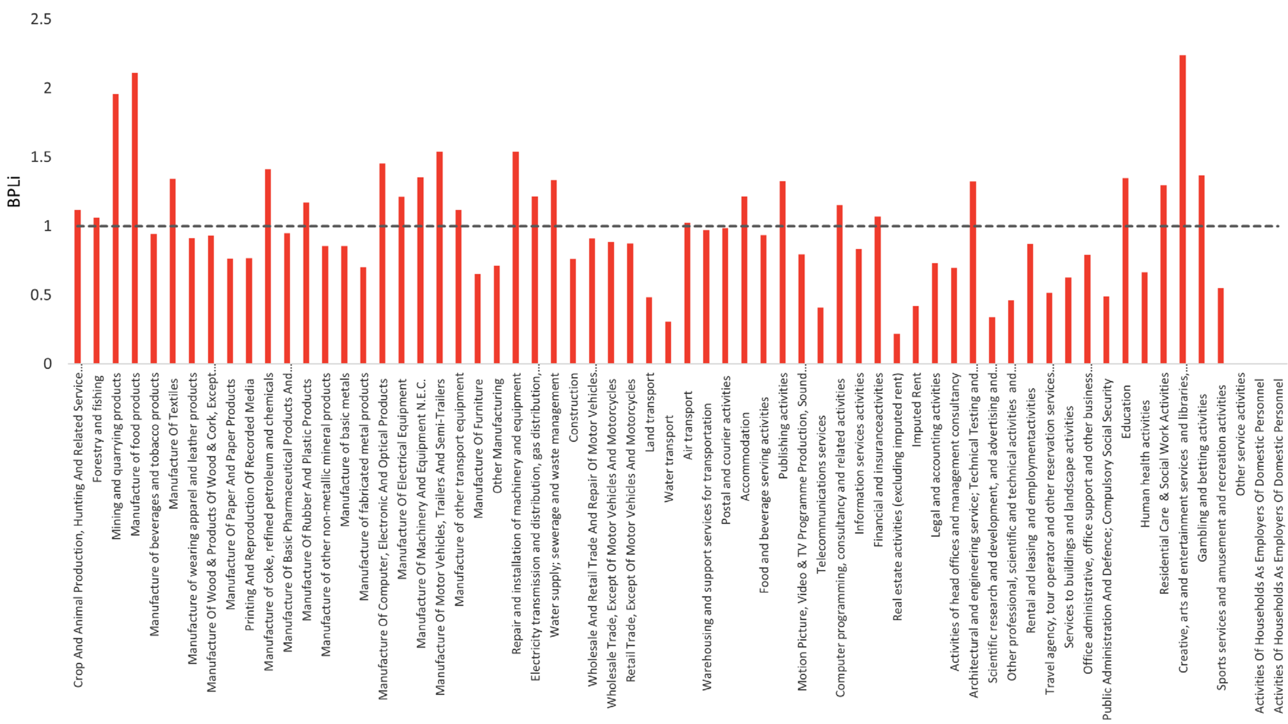
$$BPLi_j = \left[\frac{\frac{1}{n} \sum_{i=1}^{n} L_{ij}}{\frac{1}{n^2} \sum_{i,j=1}^{n} L_{ij}} \right]$$

Where n is the number of sectors, and $L_{I,J}$ are the values found within the Leontief inverse matrix, calculated from the Northern Ireland IOT.

With this approach we developed a backward linkage index for all 63 industrial sectors in the published table [5]. In this index, a sector with a BPLi greater than one has an above average backwards linkage strength, whereas a value below 1 indicates a lower-than-average backward linkage. The index also allows for rankings of the sectors in the economy based on their linkages to the other industries.

Another way of thinking of this measurement is that sectors which have a high BPLi value have higher than average supply chain purchases from other sectors in the region's economy, thus you would expect investment in these sectors to induce higher total economy activity than investment in sectors with low BPLi values (which may rely on imports). In Figure 1 and Table 4 below we outline some of the key results from the backward analysis of the 2018 Northern Ireland IxI IOT.

Figure 1. BPLi ranking for the 63 sectors in the NI IxI IOT (ranked by SIC code)



Source: Author's calculation

Figure 1 shows the BPLi ranking for each of the 63 sectors in the latest Northern Ireland IxI IOT. While it would be unnecessary to go through each of these values in detail, we can come to some general conclusion from the information found in the Figure 1. Firstly, we find that the Northern Ireland agriculture industry purchases (left part of Figure 1) many of the intermediates used in production locally as both the 'manufacturing of food products' and 'crop and animal production and hunting and related services' industries have large BPLi estimates of 2.11 and 1.96 respectively. The BPLi estimates for manufacturing industries (to the right of agriculture in Figure 1) vary significantly dependant on the products, for example the 'manufacturing of other transport equipment' index is 1.54 compared with 0.65 for the 'other manufacturing activities'. In general, services (right side of Figure 1) sectors have a lower-than-average BPLi with a notable exception being 'Gambling' and 'residential and care'. Table 4 contains the top 10 sectors by BPLi ranking[6].

5 These 63 industrial sectors are based on the 4-Digit Standard Industrial Classification (SIC) which classifies companies based on their business activity.

6 This is a for the analysis on all sectors in the Northern Ireland IxI Input-Output Table. Offshore wind specific sectors are detailed in Section 2.4.

Table 4 – Top 10 sectors by BPLi value

Sector	BPLi ranking	BPLI Value
Gambling and betting activities	1	2.238
Manufacture of beverages and tobacco products	2	2.112
Crop And Animal Production, Hunting And Related Service Activities	3	1.957
Manufacture of food products	4	1.542
Manufacture of other transport equipment	5	1.541
Electricity transmission and distribution, gas distribution, steam and air conditioning distribution and supply	6	1.454
Manufacture Of Electrical Equipment	7	1.412
Manufacture Of Basic Pharmaceutical Products and Pharmaceutical Preparations	8	1.370
Sports services and amusement and recreation activities	9	1.355
Manufacture Of Motor Vehicles, Trailers and Semi-Trailers	10	1.348

Source: Author's calculation

2.4 Offshore wind specific sectors

The 2022 paper published by BVG Associates (BVGA, 2022) reports on the potential of an offshore wind supply chain in Northern Ireland. While BVGA take a more bottom-up survey approach we can compare their key results with our findings to determine if there are noticeable conclusions from both methodologies.

A key takeaway from the BVGA report was that Northern Ireland has significant experience in the fabrication of offshore foundation structures with Harland and Wolff (H&W) being identified as a key business in this area. The report notes that H&W has already fabricated offshore wind foundations for non-Northern Irish projects and is expected to be the main fabricator of foundations for planned capacity in Northern Ireland. This result closely matches with the analysis of Northern Ireland's economic data in Section 2.1. Investigating the employment data, highlighted that Northern Ireland has a higher proportion of workers in the 'Manufacture of structural metal product's SIC (0.39% against 0.18% for the UK).

Also, the 'Manufacturing of structural metal', which includes offshore manufacturing, has a relatively high SLQ of 1.82 indicating that this is an area of specialisation in Northern Ireland when compared with the Great Britain countries. Interesting though is that the backward linkage coefficient for the 'Manufacturing of metal products' is lower than the average at 0.84, ranking the sector 38 out of 63 sectors. So, while the sector is important in terms of speciality and employment, they are not as connected to the rest of Northern Ireland's economy as some other sectors. However, the cost of manufacturing offshore wind foundations amounts to a large proportion of total offshore wind Capital Expenditure (CAPEX) and thus might bring significant economic benefit.

'Electrical manufacturing' was another sector which was identified by BVGA (2022) as potentially important for any Northern Ireland offshore wind supply chain, in particular the onshore electrical components of the developments (such as onshore substations). Our analysis also supports the notion that electrical manufacturing could be key to maximising economic benefits from Northern Ireland's offshore wind supply chain. On average, 'Manufacturing of electrical system equipment' in the UK accounts for 0.07% of employment but for Northern Ireland the value is near three times greater at 0.19%. Both Standard Industrial Classification (SIC) sectors ('Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus') and

(‘Manufacture of other electrical equipment’) have a high SLQ coefficient. This again suggests that the expertise is there in Northern Ireland for these sectors to become important in the supply chain of offshore wind developments. Unlike the metal fabrication sectors, electrical manufacturing is highly interconnected to the other sectors with a BPLi backwards linkage of 1.43.

Offshore wind is a large-scale infrastructure project requiring installation both off- and on-shore. While the offshore installation is highly specialised, much of the onshore construction is less specialised, such as cable cabling. ‘Construction’ is a core sector of most economies worldwide and in Northern Ireland this amounts to 35,063 FTE’s. The sector also has a high backwards linkage score of 1.33, ranking 13th out of the 63 sectors.

Ports play a pivotal part in the operation of offshore wind farms, in particular as an Operation and Maintenance (O&M) base and for logistics. Belfast port is a major international hub for freight and leisure which, along with smaller satellite ports is expected to be the main base for many Northern Ireland offshore wind operations. However, investigating the BRES data it is difficult to estimate the proportion of employment and associated SLQ’s of the ports in Northern Ireland. Many of the associated jobs in the port are registered to other industries due to their registered companies not part of the sea transport SIC. As a result of this, we cannot comment on the data analysis, but this will still be an important sector for Northern Ireland offshore wind thus we include it in the modelling.

3. Modelling

The previous section outlined sectors linked to the offshore wind sector which have the potential to bring the greatest economic return to Northern Ireland. To analyse the possible size of the economic impact of offshore wind in Northern Ireland we use the CGE model for Northern Ireland, built by the Fraser of Allander Institute (FAI).

The CGE for Northern Ireland is based on the A Model Of Scotland (AMOS) family of models first developed for Scotland in the early 1990s. These models have been extensively used in both the academic and policy literature to analyse the macroeconomic impacts of projects, policies, or shocks, with a particular focus on energy and environmental applications (see FAI, 2022 for a full literature review). The particular strength of CGE modelling is that is goes beyond the standard IO/ multiplier economic impact assessments by modelling the supply side along with demand side. This is important for large scale investment projects, which are likely to impact supply chain prices, as would be expected with offshore wind.

3.1 Model for Northern Ireland (AMONI)

This AMOS framework has been used in a number of applications (FAI, 2022) and allows for a degree of flexibility in choice of model parameters.

Fundamentally, the model assumes that producers minimise cost using a nested multilevel production function. Output is produced from a combination of intermediates (which can be sourced from NI, Rest of the UK, and Rest of the world), labour and capital. These inputs combine in a constant elasticity of substitution (CES) function to produce output, allowing for substitution in response to relative price changes. There are four components of final demand in the model: household consumption, investment, government expenditure and exports. Household consumption is a linear function of real disposable income. Investment is based on the difference between current capital stock and the desired level of capital stock. Government expenditure in the model is constant, while exports are determined endogenously by relative prices.

All simulations are run in a multi-period setting, with the periods interpreted as years as both the Social Accounting Matrix and behavioural relationships are benchmarked using annual data. The model is initially assumed to be in steady-state equilibrium, implying that with no exogenous disturbances, the model simply replicates the initial value over all subsequent time periods.

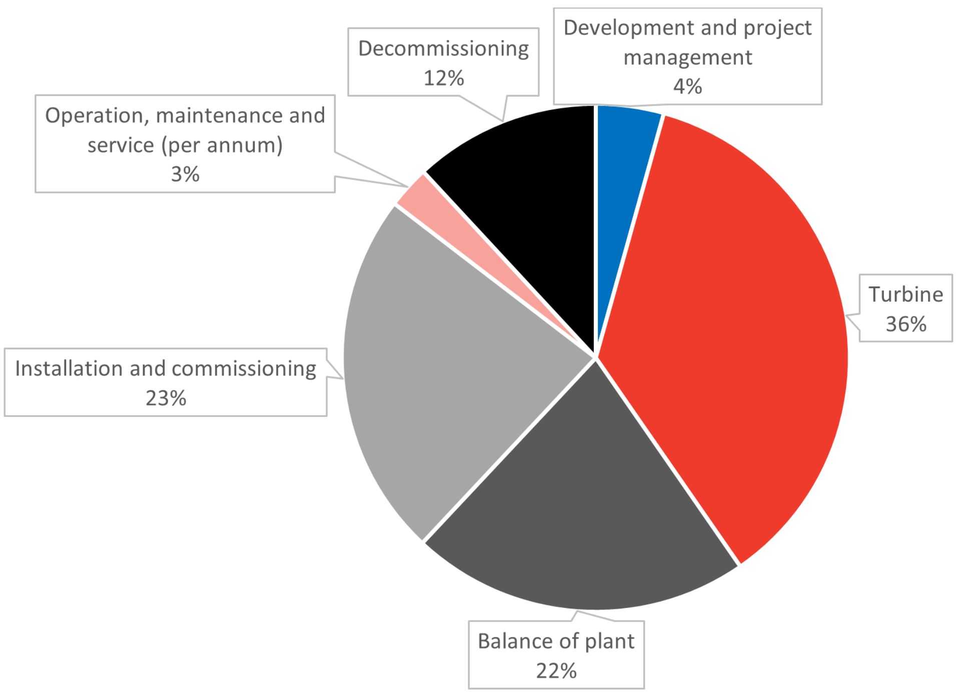
The supply-side of the economy determines the use of capital and labour in the model. Capital is fixed in the first period but in subsequent periods each sector's capital stock is updated through investment.

A single labour market with perfect sector mobility is imposed on the model whereby workers are free to move between different sectors.

3.2 Simulations

To analyse the economy-wide impacts we must produce estimates for the potential investment in the key Northern Ireland offshore wind supply chain industries identified in Section 2. These investments are introduced into the CGE model as a demand shock. The first stage in developing the demand shock is to estimate the cost per Megawatt (MW) of offshore wind capacity. Of course, this varies depending on a number of factors such as: location, turbine type, developer etc, but for this paper we use the latest Offshore Wind Catapult (2023) estimate a CAPEX £2.7 million per MW of capacity and £75,000 per year in O&M. Costs are then spread across the different stages of development, shown in Figure 2, based on the wind farm cost data again published by the Offshore Wind Catapult (2023). These costs are based on a UK based fixed offshore wind farm, however with recent technological advancements floating offshore may be an option for deployment in Northern Ireland. Sensitivity analysis linked to floating offshore is outlined in Section 5.

Figure 2. Breakdown of offshore wind farm expenditures[7]



Source (Offshore Wind Catapult, 2023)

As is to be expected the construction of the actual wind turbine account for a large proportion of total expenditure, with the nacelle; rotor; tower and other turbine stages nearly a third of the total.

For the purposes of this report, the stages (components) we are interested in are the turbine foundations, cables element manufacturing, installation of onshore components and port operations. Turbine foundations, on average, account for significant proportion of offshore wind investments. The Offshore Wind Catapult (2023) estimates that turbine foundations cost around £280,000 per MW, which amounts to a total of £280 million if the 1GW of offshore wind capacity by

7 The costs have been aggregated to the six main stages of wind farm development for illustration purposes.

2030 was to be realised. As there are already Northern Ireland based companies producing offshore wind foundations, we could realistically assume that all Northern Ireland offshore wind foundation manufacturing could be carried out locally. One of the key strengths of macroeconomic modelling techniques is they allow for sensitivity analysis, which we take advantage of in this report. We carry out three simulations for wind foundation manufacturing with local content[8] of 80%, 90% and 100%, respectively. This was based on our best estimate using the public information available from BVGA (2022) and information on other UK based offshore wind supply chains made available to the FAI. Realistically, with a major player in offshore wind foundations already operating in Northern Ireland the maximum (100%) amount possible of local content can be achieved, which we have reflected in our simulations.

In Section 2, 'Electrical manufacturing' was identified as another sector in Northern Ireland which, on the surface, has links to a potential local offshore wind supply chain. This is not just because of the current size of the sector, but also because of its links with other industries. Many of the cables needed for use in offshore windfarms are high voltage, which requires specialised equipment and expertise to manufacture. Based on the analysis from BGVA, the industry in Northern Ireland does not have. As a result of this, the 'local content' for electrical manufacturing is expected to be somewhat minimal.

There may be two areas of offshore wind farm developments which the 'Electrical manufacturing' sector in Northern Ireland can contribute to – cable protection and part of the onshore substation. Northern Ireland based companies are already involved with the manufacture of cable protection systems and similar to foundations, with regional expertise available (BVGA, 2022), we can reasonably assume that between 80-100% of these components could be produced locally. Cable protection, however, is only a small percentage [0.07%] of overall offshore wind CAPEX costs, with the total for 1GW of planned capacity amounting to £2 million. Again, based on the information from BVGA (2022), for the onshore substation there are certain components which cannot be manufactured in Northern Ireland. Therefore, for these components we assume that local companies may reasonably be involved in 40-60% of manufacturing on substation costs. Taking this information into account we estimate that between £10.4 and £15.2 million of investment could be made in the 'Electrical manufacturing' industry related to offshore wind development. Again, similar to the foundations, we carry out three separate simulations.

'Construction' was also identified as another local important industry which may benefit from the investment in 1GW of offshore wind capacity in Northern Ireland. Wind developments require both offshore and onshore installation of components. Offshore install of wind farm components relies heavily on a limited number of specialised ships and as such, it is unlikely that any of this process could be carried out by companies based in Northern Ireland. The onshore components, however, are not specialised as there are many companies which could carry out this process. Thus, we assume that between 80-100% of the onshore install can be carried out locally. The reasoning behind this is that the construction related activities to these components is non-specialised and there are many companies locally which could carry out this process. These construction companies are more than likely cheaper than bringing in external labour thus developers are expected to use local companies for non-specialised construction, increasing local content at the same time as minimising cost. There are two main elements to onshore infrastructure related to this – the onshore substation and the land part of the electrical export cable. Overall, for 1 GW of offshore wind, this investment amounts to between £24-30 million.

8 Local content is proportion of project contracts given to local (i.e Northern Ireland based) companies.

The fourth and final industry we consider could play an integral part in the Northern Ireland local offshore wind supply chain is in ports. Belfast is the largest port in Northern Ireland. Ports are key for offshore wind farms as they serve as bases for the O&M crews, which accounts for a non-trivial amount of total offshore wind cost. Unlike the other stages of development, the operation of offshore wind is a longer-term project and is likely to bring continuous benefits to the local area for the lifetime of the projects. Estimated to be around 25 years.

In our cost modelling, using information from the BVGA (2022) supply chain report and data based on previous UK based offshore wind farms, we assumed that the majority, if not all, of the logistics could be carried out in ports based in Northern Ireland. For the other O&M areas (such as balance of plant and turbine manufacturing) an estimation of 40-60% was made. A key advantage for Northern Ireland is that there is already a large international port operating, which could serve the 1GW of offshore wind capacity. Currently ports could be the base for planned maintenance by specialised crews, however any unplanned maintenance may require specialised equipment would need to be carried out by non-local industries. An important issue here is capacity for ports, there may need to be investment made in local ports to bring to the level necessary for offshore wind. In this paper we have assumed a costless increase in port capacity to enable the operation of offshore wind capacity. This might not be the case but the costing the upgrade to the port is out of scope for this project. It would require higher levels of detail of the current port operations, costs and capacities. Overall, in our modelling, the increase in offshore wind capacity and local content estimates equates to between £31.2 and £46.2 million annually being spent in Northern Ireland based ports for the operation of 1GW of offshore wind.

For this report it must be noted that the focus of the macroeconomic impact of the investment is only in the key sectors individually. For example, we compared the impacts in investment in the electrical manufacturing sector versus that of the foundation construction. This is not an analysis of the total economic benefit from offshore wind developments to 2030 and beyond, as this would require much more detail than currently available for this report.

4. Results and Discussion

The modelling finds that the economy-wide impacts related to investment in the Northern Ireland offshore wind supply chain is highly sector specific, dependant on the size of potential investment and on the sector's links to the rest of the local economy. By far the biggest opportunity for local economic development in the construction stage is in the manufacturing of the offshore wind foundations, with the results for the three simulations outlined in Table 5.

Table 5. Summary results for potential economy wide impacts producing of 1GW offshore wind fixed foundations in seven-year period until 2030.

	Low content-80%	Medium Content-90%	High content-100%
Gross Value Added (£m)	168.8	189.9	211.1
Employment (FTE)	3,435	3,864	4,293
Direct (FTE)[9]	1,744	1,962	2,179
In-Direct (FTE)	1,691	1,902	2,114
Investment (£m)	224	252	280

Source: Author's calculation

As detailed in Section 3, there are already companies based in Northern Ireland, in particular Harland & Wolfe (H&W), which operate in the offshore wind foundation space. Therefore, we expect the vast majority of these structures for the 1GW to be produced in Northern Ireland. Table 5 shows the results for simulations if 80%, 90% and 100% of offshore foundations were manufactured locally. The total investment locally would be between £224 (low content) and £280 (high content) million. The investment related to the foundations, in the high content scenario, could lead to an increase overall in Northern Ireland GVA of £211 million and increase in employment of ~4,300 FTE over the seven year period until 2030. This employment is split nearly equally between direct and indirect employment with 2,179 (50.8%) FTE in the metal manufacturing sector linked to the construction of offshore wind foundations and the remaining 2,114 FTE (49.2%) in other sectors of the economy. If we focus on only the 100% local content (High content from Table 5) we can explore how investment impacts on a range of economic variables in the long run, shown in Table 6.

9 Direct employment is employment in the sectors directly related to the production of foundations (e.g fabrication of metal' whereas in-direct employment is employment is in other sectors either through the supply-chain or increase in household spending attributed to increase in employment.

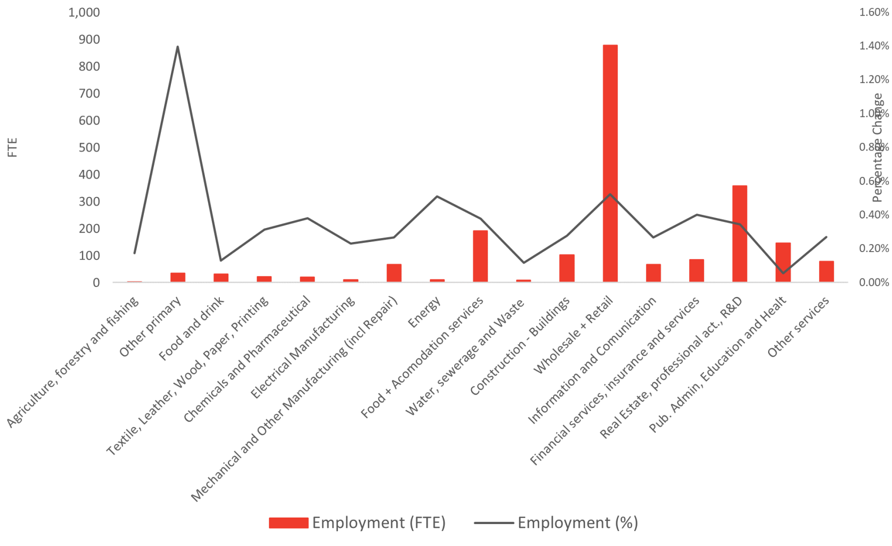
Table 6. Economy wide results if 100% offshore wind foundation is manufactured in Northern Ireland over the seven year period until 2030.

	Change from base economy[10]
GVA	0.55%
Household Consumption[11]	0.39%
Capital Stock[12]	0.49%
Indirect taxes[13]	0.69%
Total Household Tax[14]	0.60%
Unemployment Rate	-0.58%
Employment	0.60%
Government Revenues[15]	0.27%

Source: Author's calculation

In the period until 2030 we find an overall increase in national GVA of 0.55% combined with a decrease in the unemployment rate of 0.58%. Increased investment leads to an accumulation of capital stock over time and the increase in employment also leads to an increase in tax revenue, which the Government can then redistribute across the economy. Figure 3 illustrates the indirect employment change by sector.

Figure 3: Indirect employment change by sector related to 100% local offshore wind foundation supply



Source: Author's calculation

10 Baseline economy refers to the economy with no changes (i.e no investment in offshore wind).
11 Change in consumption of goods and services by households.
12 Change in assets which help in the production of goods and services e.g. machinery.
13 Change in taxes from increase in spending e.g. VAT.
14 Change in government income from household employment tax (income tax + Employee national insurance).
15 Change in total tax income.

Already noted was the increase in the manufacturing sector, Figure 3 focuses on the indirectly impacted sectors from investment in offshore wind foundation (100% local content). Focusing on the percentage changes, the analysis indicates that the 'other primary' (1.40%), 'energy' (0.51%) and 'wholesale & retail' (0.52%) sectors are the most indirectly impacted sectors. Manufacturing of metals is a resource and energy intensive industry so you would expect that the increase foundation manufacturing will lead to an increase in energy and materials (bought from both the primary and retails sectors). However, as both the 'Primary' and 'Energy' sectors are not labour intensive, we find that the 1.4% and 0.51% increase in employment in these sectors only leads to an absolute change in employment of 35 and 10 FTE's respectively. 'Wholesale & Retail', with a high labour intensity, does have a large increase in employment of 878 FTEs. Other large absolute increases in employment are 'Real Estate, professional act., R&D (358 FTEs) and' Pub. Admin, Education and Health' (146 FTEs).

Investment in the other sectors follows the same pattern with the increases in capital stock and GVA leading to an increase in employment and household consumption, albeit at a much-reduced scale. Table 7 outlines the summary economy-wide results for 'Electrical manufacturing' and 'Construction' sectors offshore wind developments.

Table 7. Summary results for electrical manufacturing and construction sectors over the period until 2030.

Electrical Manufacturing	Low Content – 80% cable protection; 40% onshore substation	Medium Content – 90% cable protection; 50% onshore substation	High Content – 100% cable protection; 60% onshore substation
GVA (£m)	9.1	11.2	13.4
Employment (FTE)	127	157	186
Investment (£m)	10.4	12.8	15.2

Construction	Low Content – 80% onshore components	Medium Content – 90% onshore components	High Content – 100% onshore components
GVA (£m)	21.8	24.5	27.2
Employment (FTE)	446	501	557
Investment (£m)	24.0	27.0	30.0

Source: Author's calculation

Section 2.4 notes the speciality needed in the development of offshore wind farms. The results in Table 7 reinforce this and the difficulty in producing large economic benefits for Northern Ireland. The opportunities for investment in the electrical manufacturing and construction sectors are significantly reduced when compared to the metal manufacturing, which already is involved in external offshore wind supply chains.

Over the period until 2030 the maximum estimated investment for electrical manufacturing of £15.2 million and £30 million for construction (high content values from Table 7). These will still bring economy-wide benefits in terms of increased employment (up to 186 FTE in electrical manufacturing and 557 for construction) and GVA (£13.4 & 27.2 respectively).

The direct and indirect employment benefits with investment in each of these sectors is also determined. For electrical manufacturing, we find that the direct employment accounts for 36.3% of the total FTEs created, with the remaining 63.7% indirectly created in other sectors. In the construction sector, the share of in-direct employment (54.0%) is also larger than that of direct (46.0%). While the investment in these two sectors is expected to be low, given the impacts are likely to be distributed across the wider economy. Table 8 contains the results for the economy wide impacts of port related expenditure.

Table 8. Economy-wide impacts of expenditure on port services[16]

	Low Content – 40% O&M; 80% logistics	Medium Content – 50% O&M; 90% logistics	High Content – 60% O&M; 100% logistics
GVA (Yearly average) (£m)	28.7	35.7	42.6
Employment (Yearly average) (FTE)	832	1,034	1,235
Investment (yearly average) (£m)	31.2	38.7	46.3
GVA (Cumulative)(£m)	718.2	892.1	1,066.1
Employment (Cumulative) (FTE years)	20,803	25,841	30,878

Source: Author's calculation

Table 8 above reports both the yearly and cumulative economy-wide benefits of the operation of 1 GW offshore wind with lifetime of 25 years. On average, the yearly expenditure on the ports system is estimated to be between £31.2 and £46.3 million. This potentially increases Northern Ireland GVA by £42.6 million and adding 1,235 FTE annually. Cumulatively the operation of offshore wind in Northern Ireland could bring in excess of £1.07 billion GVA and 30,800 FTE years to the Northern Ireland economy over a 25-year lifetime.

16 Cumulative is 25 years which is the expected lifetime of offshore wind farms.

5. Sensitivity around floating offshore wind

To this point, due to the available data, the focus has been on the fixed foundation offshore wind turbines, however floating offshore is also expected to play a pivotal part in the future energy system. Fundamentally most of the components (and costs) of a floating offshore wind farm are the same as fixed with the major difference being in the foundations used. As such some sensitivity analysis is carried out around the manufacturing of foundations.

There is no public floating offshore wind information currently available for Northern Ireland thus we estimate potential floating costs using Scottish information, as winds farms in both areas will experience similar conditions. The recent Scotwind leasing round granted planning permission to almost 28GW of offshore wind capacity, with more than 60% being floating (Crown Estate Scotland, 2023). As part of the tendering process developers were required to submit a detailed supply chain plan outlining expected value of location of investment for different stages of developments[17]. We use information gathered from these supply chain reports to estimate the CAPEX increase for floating offshore wind and the potential for local manufacturing of the foundations. From the publicly available information we find that on average the CAPEX for floating offshore wind is around £3.3 million, i.e. £0.6 million larger than fixed foundation farms. As the other components are mainly the same we assume that this £0.6 million increase is attributed to the fabrication of floating offshore wind structures.

There are several different designs of floating offshore wind structures with some more complicated than others. However, from the Scotwind data, there seems to be no impact on local fabrication from fixed offshore to floating as many of the materials and fabrication processes are similar. It is only the cost increases. As such, we assume in our modelling that the local content for the fabrication of floating offshore wind foundations in Northern Ireland will be the same as fixed foundation. Table 9 below outlines the key macroeconomic indicators if investment in 1GW of floating offshore wind foundations were to be fabricated in Northern Ireland.

Table 9. Summary results for potential economy wide impacts of investment of 1GW local offshore wind floating foundations v fixed foundations over the seven-year period until 2030.

	Low content	Medium Content	High content
Floating foundations			
Gross Value Added (£m)	530.5	667.3	878.2
Employment (FTE)	10,794	13,579	17,872
Investment (£m)	704	886	1,166
Fixed foundations			
Gross Value Added (£m)	168.8	189.9	211.1
Employment (FTE)	3,435	3,864	4,293
Investment (£m)	224	252	280

Source: Author's calculation

17 Our estimates for offshore wind are based on information published within the 17 Scotwind supply chain reports available from https://www.crownestatescotland.com/news/scotwind-developers-set-out-multi-billion-pound-supply-chain-commitments.

Comparing the GVA and employment impacts of floating foundation (rows 1-4 Table 9) with fixed (rows 5-8 Table 9) we find that the fabrication of floating offshore wind foundations could bring much larger economy-wide benefits than fixed foundation fabrications. For example, in the high content case, fixed foundation fabrication could increase GVA by £211 million and employment of 4,293 FTEs compared with £878 million and 17,872 FTEs for the fabrication of floating platforms. These results are driven by the additional £0.6 million investment needed for floating platform, which we estimate to be nearly four times that of fixed foundations.

While our modelling suggests that floating offshore wind fabrication has the potential for larger economy-wide effects there are few caveats to this. First, the modelling is based on current information available for the cost of floating offshore wind, which may over-estimate costs due to the Scotwind projects being some of the first commercially viable offshore wind farms to date[18]. As more floating capacity is installed and learning rates increase, it is inevitable that CAPEX per MW will reduce overtimes, as has been seen with fixed wind farms. The second caveat is that we have used the same local content estimates for floating and fixed. There are a range of different foundation platforms, with some being more complex than others, and use will depend on the location at turbines. As this information is not available for any planned Northern Ireland floating offshore wind farms, we assume that the local expertise in steel manufacturing would be instrumental into the floating platform fabrication.

18 Much of current floating offshore wind capacity is demonstration projects.

6. Conclusion

The recent Climate Change Act (Northern Ireland Assembly, 2022) set statutory obligation of at least 80% of electricity consumption is from renewable sources by 2030 and also a net zero position in terms of greenhouse emission gases by 2050. This will require significant investment and diversification of the electricity sector, with offshore wind expected to play a key role in the future energy system. Up to 1GW of offshore wind capacity is expected to come online in Northern Ireland from 2030.

As well as reducing emissions an additional goal of the Energy Strategy is to grow the LCREE linked to the development of new technologies. Offshore wind is a large scale infrastructure project with the total capital investment needed for 1GW of capacity expected to be between £2.7 billion-£3.3 billion (depending on foundations used), with a further £1.9 billion in O&M costs over an expected 25 year lifetime. However, while this is a large investment, the local economic benefit to Northern Ireland is uncertain due to the specialisation needed for the manufacturing and installation of many offshore wind components.

The purpose of this report is to investigate the potential areas which may be a focus of Northern Ireland's local offshore wind supply chain. We first analyse the current structure of the economy in Northern Ireland then determine if there are any synergies with the offshore wind development process. Using CGE modelling, we estimate the potential growth in these sectors and the economy-wide impacts of the investment.

In our analysis of the current economic structure, we identify four core sectors which have growth potential linked to offshore wind supply in Northern Ireland. The sector with by far the largest potential for growth (and by extension economy-wide benefits) in the construction stage is the 'Metal manufacturing' industry linked to the fabrication of the foundations for offshore wind farms. Companies, such as H&W, are already operating in the offshore wind and we expect these to be major players in the local Northern Ireland offshore wind supply chain. Due to their current penetration in the market, it would not be unreasonable to assume that all tier one offshore wind foundation contracts will be won locally. From our modelling, we estimate that these contracts could be worth between £224 million and £280 million. Through the linkages with the rest of the economy we estimate a total £280 million investment in the fabrication of fixed foundation for 1GW of offshore wind capacity could lead to an increase in economy-wide GVA of £211 million supporting ~4,300 FTEs.

The two other growth industries linked to the construction stage – 'Electrical manufacturing' and 'Construction' - do not have nearly the same potential for economy-wide benefits as the manufacturing of metals. While these sectors are important to the local economy, it will be difficult to penetrate the offshore wind supply chain due to specialised labour and equipment needed. This is most evident for the electrical manufacturing sector. From Table 3, this is a sector which has a high location quotient of 6.6 and a BPLi rank of 7. An indication that electrical manufacturing is more specialised in Northern Ireland as a whole compared with the three countries of Great Britain and has significant linkages with other local industries. However, when looking at the industry in more detail in relation to offshore wind it is noted that there is little synergy between the offshore wind sector and the electrical manufacturing businesses in Northern Ireland. Much of the electrical equipment needed for offshore windfarms is high voltage cabling, which the electrical manufacturing industry in Northern Ireland has no specialisation. Even much of the onshore electrical components for offshore wind substations, needs to be imported due to specialised components. As a result, the estimated maximum economy-wide benefits for Northern Ireland electrical manufacturing contracts with 1GW of offshore wind is only an increase in GDP of £13.4 million and an increase in employment of 186 FTEs.

For the 'Construction' industry the economy wide benefit potential is only slightly better at increased GVA and employment of £27.23 million 557 FTEs, respectively. This is driven by only a small proportion of the installation process taking place onshore, most is offshore, which requires specialised labour and equipment that is not available in Northern Ireland.

Local ports are expected to play a pivotal part in the operation of Northern Ireland's offshore wind capacity with the economy-wide benefits expected to be much larger than the three sectors previously identified. On average annually, there is an expected to be an additional £42.64 million of GVA and 1,235 FTEs linked to the running of the 1 GW of offshore wind capacity. Over the 25-year lifetime, this amounts to a total GVA impacts of more than £1 billion and 30,000 FTEs – significantly larger than any of the other sectors analysed in this report. While we have assumed the ports of Northern Ireland have the capacity from offshore wind operation, more analysis is needed into port capacity and investment requirements for offshore wind.

Our sensitivity analysis shows that due to the increased cost of construction, the fabrication of floating offshore wind platforms may bring greater economic benefits to Northern Ireland. However, this analysis was based on current floating offshore wind costs, which are in their infancy and these costs are expected to decrease significantly as deployment increases.

In conclusion, we have noted that while there will likely be large investment in offshore wind in Northern Ireland, there is only really one current industry (metal manufacturing) in position to be a significant player in the construction supply chain of offshore wind. This is not an indictment of Northern Ireland's economy, but rather shows the difficulties for smaller economies to achieve green goals that are economically beneficial. Northern Ireland, like many other smaller economies, does not have the capacity to manufacture or install many of the specialised components needed for offshore wind. While Northern Ireland may develop these industries over time there may not be an incentive for companies to move into the space as it would cost money, there is only limited scope for growth in local offshore wind and it is usually only short term projects. However, to offset this, there may be opportunity for Northern Ireland to focus on the foundations as an area of excellence which could open the potential to export a large number of these to offshore structures worldwide, delivering more longer term benefits.

While it may be difficult to gain a local foothold in the construction and installation of offshore wind, there is great potential in the operation of the farms, particularly as this period lasts for at least 25 years. From a policy perspective the focus of the Energy Strategy maybe on areas of the green transition that are on the smaller scale but last for an extended period, bringing constant benefits which cumulate overtime. An example other than the operation of offshore wind is the construction sector bringing housing stock to the required energy efficiency level.

This project has only focused on potential from individual areas of the offshore wind supply chain, future projects could 1) Investigate the overall expected economic benefits from increasing offshore wind capacity in Northern Ireland 2) Explore the export potential for expertise in the metal manufacturing sector and how this would benefit Northern Ireland.

References

BVG Associates. (2022). ‘Building Northern Ireland’s offshore wind industry’. Available from: https://renewableni.com/wp-content/uploads/2022/09/The-Clean-Revolution-%E2%80%93-Building-Northern-Irelands-Offshore-Wind-Industry.pdf [Last accessed 08/06/23]

Crown Estate Scotland. 2023. ScotWind leasing round. Available from: https://www.crownestatescotland.com/scotlands-property/offshore-wind/scotwind-leasing-round [Last accessed 08/06/23]

Department for the Economy (DfE). (2021). ‘Energy Strategy - Path to Net Zero Energy’. Available from: https://www.economy-ni.gov.uk/publications/energy-strategy-path-net-zero-energy [Last accessed 08/06/23]

Department for the Economy (DfE). (2023a). ‘Draft Offshore Renewable Energy Action Plan’. Available from: https://www.economy-ni.gov.uk/consultations/draft-offshore-renewable-energy-action-plan [Last accessed 08/06/23]

Department for the Economy (DfE). (2023b). ‘Electricity Consumption and Energy Generation in Northern Ireland: Year ending December 2022’. https://www.economy-ni.gov.uk/publications/issue-26-electricity-consumption-and-renewable-generation-northern-ireland-january-2022-december [Last accessed 08/06/23]

Fraser of Allander Institute (FAI). (2022). Scoping the Potential Use of Macroeconomic Models to Energy Policies Questions in Northern Ireland. https://pureportal.strath.ac.uk/en/publications/scoping-the-potential-use-of-macroeconomic-models-to-energy-polic-2. [Last accessed 08/06/23]

HM Government. 2019. Offshore wind: Sector deal. Available from: https://www.gov.uk/government/publications/offshore-wind-sector-deal [Last accessed 08/06/23]

NI Assembly (2022). Climate Change Act (Northern Ireland). Available from: https://www.legislation.gov.uk/nia/2022/31/contents/enacted [Last accessed 08/06/23]

Office of National Statistics (ONS). (2023). ‘Regional gross value added (balanced) by industry: all ITL regions’. Available from: https://www.ons.gov.uk/economy/grossvalueaddedgva/datasets/nominalandrealregionalgrossvalueaddedbalancedbyindustry [Last accessed 08/06/23]

Pereira-Lopez, X., Sanchez-Choez, N,. & Fernandez-Fernadez, M. 2021. Performance of bidimensional location quotients for constructing input–output tables. Journal of Economic Structures, 10, 7. https://doi.org/10.1186/s40008-021-00237-5

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