Co-designing opportunities towards the development of Irish offshore wind

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Deliverable D4.10: Socioeconomic Study

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Executive Summary:

With over 12GW of offshore wind energy at various stages of planning, Ireland is on the cusp of a renewable energy boom. Given the size of offshore wind projects, there is great potential for the sector to deliver considerable environmental, social, and economic benefits to Irish society in the coming years. This study, part of the Eirwind project, explores the socioeconomic opportunity associated with the development of the offshore wind sector for Ireland. It focuses on three key areas - job creation, economic value, and regional development potential. The outputs can be used to inform policy and

strategies for sectoral development in order to maximise the socioeconomic benefits of offshore wind development and minimise or avoid potentially negative impacts on stakeholders.

The study uses qualitative and quantitative research methods to assess the value of offshore wind for Ireland. It builds on previous research to give a contemporary appraisal of the direct and indirect domestic job creation and gross value added (GVA) impact in the coming years. Projections are derived from an economic model that was developed as part of this study. Two scenarios were modelled, one assuming an installed capacity of 2.5GW by 2030 and one assuming 4.5GW by 2030, with 25% of installed capacity from floating wind from 2026. The approach to this modelling – a value chain analysis – was selected as it is more accessible and transparent than traditional methods, such as input-output (IO) modelling, and the model can be updated under changing market conditions. Many previous estimates of the employment impacts associated with offshore wind development are outdated or lack transparency in their methods and are difficult to compare with one another, and therefore verify, due to differences in underlying assumptions. This is the first study to quantify the GVA impact of offshore wind development for Ireland.

Key findings of this report suggest that in 2030, 2.5-4.5GW of domestic offshore wind development would support between 4,620 and 8,316 jobs in the domestic supply chain and generate between €325m and €585m in GVA. This equates to between 11,424 and 20,563 person years of employment and €763m and €1.4bn in gross value added for the period 2020-2029. This is a conservative estimate, as it does not take into account induced effects from personal expenditure of the labour force. **If the scenarios modelled in this study were to be realised and current trends for other ocean economy sectors were to remain constant, direct and indirect GVA from offshore wind development could exceed that of the marine advanced technology products and services sector, the marine manufacturing, construction and engineering sector, the sea fisheries sector and marine retail services sector by 2030.** This would contribute significantly to Ireland's Harnessing Our Ocean Wealth target of doubling the value of Ireland's ocean economy by 2030 (Inter-Departmental Marine Coordination Group, 2012). The potential economic impacts of the recent and ongoing COVID-19 pandemic, which are not yet well understood due to the fast changing nature of the situation, have not been factored into this research, but are recognised in this report. Offshore wind could play a key role in the post-COVID economic recovery by stimulating growth and creating jobs, and several EU state ministers have called for integrating the green transition in the European recovery plan.

In addition to the economic modelling, research was undertaken to explore ways in which Ireland can maximise the socioeconomic benefits of offshore wind development, including domestic job creation and the growth of indigenous goods and services, and minimise or avoid potentially negative impacts. A demographic assessment of the areas around ports with capabilities or potential capabilities in offshore wind reveals **offshore wind development, and the development of an offshore wind supply chain, could be an effective means for addressing Ireland's regional economic imbalance and associated issues, such as rural depopulation and the decline of coastal communities.** A qualitative review of the experiences in countries with experience in offshore wind highlights lessons that can be learned from elsewhere with regard to the impacts of offshore wind on local communities, tourism, fisheries, and other industries.

The report concludes with a number of recommendations, based on the research, for maximising the socioeconomic benefits of offshore wind development. Specifically, these address trends in social deprivation and the unequal distribution of economic opportunities across the island, particularly around ports on the south and west coasts. These recommendations include:

1. *Create an offshore wind supply chain stimulus package*
2. *Invest in port infrastructure to support*

    i. *manufacturing (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs),*
    ii. *staging (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs), and*
    iii. *O&M (e.g. at Shannon-Foynes, Waterford, Rosslare, Killybegs, New Ross, Rossaveal, and Fenit/Tralee)*
3. *Take a strategic approach to development of regional clusters around ports in preparation for the next wave of projects on the south and west coasts*
4. *Support R&D and the development of skills training programmes*

List of abbreviations

AMETS	Atlantic Marine Energy Test Site
AFLOWT	Accelerating market uptake of Floating Offshore Wind Technology
AWEA	American Wind Energy Association
BIWF	Block Island Wind Farm (USA)
BOP	Balance of plant
BOWL	Beatrice Offshore Windfarm Limited
CAPEX	Capital expenditure
CE	Crown Estate
CSO	Central Statistics Office
DECEX	Decommissioning expenditure
DEVEX	Development expenditure
DHPLG	Department of Housing, Planning and Local Government
ED	Electoral district
EIA	Environmental impact assessment
EPCI/EPIC	Engineering, Procurement, Construction and Installation
FEED	Front end engineering and design
FLOWW	Fishing Liaison with Offshore Wind and Wet Renewables Group (UK)
FTE	Full-time equivalent
GVA	Gross value added
GWO	Global Wind Organisation
IO	Input-output
IWEA	Irish Wind Energy Association
IRENA	International Renewable Energy Agency
MRIA	Marine Renewables Industry Association
NFFO	National Federation of Fisherman’s Organisations (UK)
O&M	Operations and maintenance
OPEX	Operating expenditure
ORE	Offshore renewable energy
OW	Offshore wind
OWF	Offshore wind farm
RESS	Renewable energy support scheme
VMS	Vessel monitoring system

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1 Introduction and Background

The Irish government has committed to meet 70% of its electricity needs from renewable sources by 2030 and to achieve net zero carbon emissions by 2050 (Government of Ireland, 2019). Separately, Ireland's integrated marine plan, Harnessing Our Ocean Wealth, sets a target to double the value of Ireland's ocean economy by 2030 (Inter-Departmental Marine Coordination Group, 2012). The deployment of significant offshore wind capacity will be an essential element to meeting these targets. Given the scale of development required to fulfil these objectives, there is the potential to make a significant contribution to the Irish economy and wider society, including remote coastal communities. This study, which is part of the governance work package of the Eirwind project, seeks to explore the socio-economic impacts of offshore wind development for Ireland through both qualitative and quantitative research. It focuses on three key areas - job creation, economic value, and regional development potential. This document sets out the findings, conclusions, and recommendations of this research. It is divided into six sections.

Section 1 provides the context for the study. It gives an overview of the state of the sector and reviews relevant work to date relating to the potential socioeconomic impacts of offshore wind development for Ireland.

Section 2 gives a demographic profile of the areas around Irish ports with capabilities, or potential capabilities, in serving the offshore wind sector. This helps to highlight the coastal communities that could see the maximum socioeconomic benefits of offshore wind development in their area.

Section 3 looks at the impacts of offshore wind development in countries with experience in the industry, including the UK, USA, Germany, China and Denmark. It focuses on observed impacts rather than potential impacts and highlights key stakeholder issues encountered in these areas.

Section 4 provides an overview of the domestic offshore wind supply chain. It is based on a detailed study by the Carbon Trust for the Irish Offshore Wind Energy Association (IWEA).

Projections for domestic job creation and gross value added (GVA) are presented in section 5. These are derived from an economic model that was developed as part of this study. The approach to model development, assumptions, and scenarios are also described in this section. This is the first study to estimate the GVA impact of offshore wind development for Ireland.

Finally, section 6 concludes by summarising the key findings and recommendations of this research.

1.1 Offshore Wind in Ireland

Ireland's offshore wind sector is currently underdeveloped relative to our Northern European neighbours. There presently exists only one operational offshore wind farm in the state, the 25.2 MW Arklow Bank Wind Park off the east coast (figure 1.1). In contrast, there are 37 operational offshore wind farms in the UK with a total capacity of 9,945 MW and 27 offshore wind farms in Germany, with a total capacity of 7,445 MW (Wind Europe, 2018).

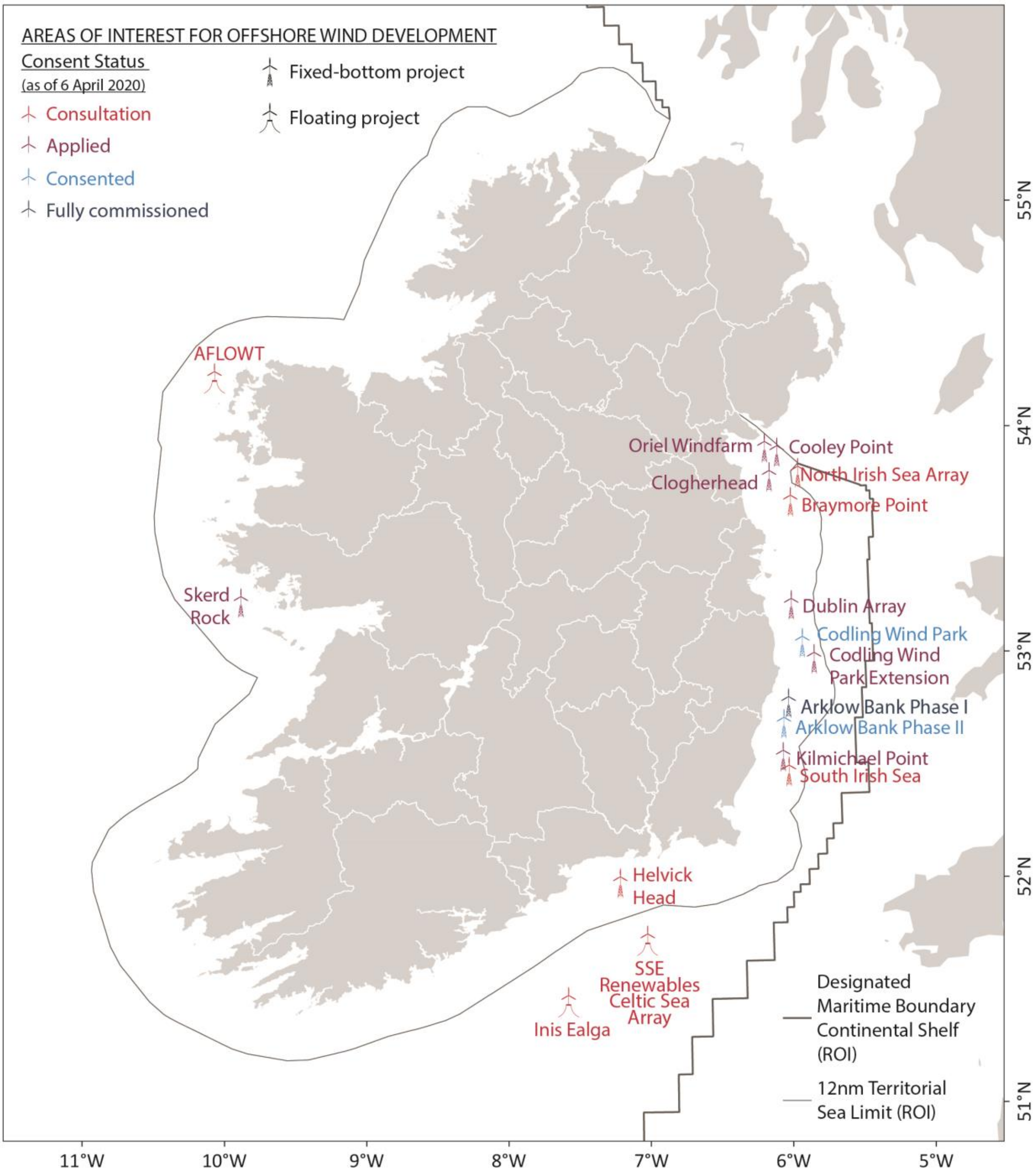

Figure 1.1 Current areas of interest for offshore wind development in Ireland and consent status as of April 2020. Another potential development includes the Clare Marine Energy Park Offshore Wind Farm (not shown), which would be located off the coast of County Clare, although a licence application has not yet been submitted for this project.

Eighteen new commercial developments totalling 12,300 MW are currently at various stages of planning (Leahy *et al.*, 2020; 4C Offshore, 2020). These include:

- 1.62GW consented
- 2.33GW in the current planning system (applications made for a foreshore lease to the Department of Housing, Planning and Local Government, DHPLG)
- 8.35 GW early stage developments

According to recent reports, it is expected that Ireland's installed offshore wind capacity will range anywhere from 250 MW to 4.5 GW by 2030 (DCENR, 2014; Eirgrid, 2017; Cornwall Insight Ireland *et al.*, 2018; KMPG, 2018).

1.2 Potential socio-economic benefits

KPMG (2018), on behalf of National Offshore Wind Ireland (NOW Ireland), recently highlighted four general economic and social opportunities associated with offshore wind (OW) development in Ireland:

- Job creation
- Regional development
- Export opportunities
- Security of energy supply

In terms of employment, there are no publicly available figures that quantify the employment opportunity specific to offshore wind for Ireland. Instead, figures for the wind sector as a whole, which have been quantified, show that onshore + offshore wind combined supported 4,800 direct and indirect jobs in Ireland in 2018[i]. Employment in the offshore renewable energy sector, which includes offshore wind energy production and services, wave energy production and services (pre-commercial) and tidal energy production and services (pre-commercial), increased from 454 full-time equivalents (FTEs) in 2016 to 461 FTEs in 2018 (Tsakiridis *et al.*, 2019). New employment projections for offshore wind energy are presented in section 5 of this report.

Large commercial offshore wind developments have the potential to stimulate regional development, especially in areas with low employment density. However, as Roche *et al.* (2016, p. 1337) has highlighted with regard to the development of Wales' wave and tidal resource, "whether benefits [felt at the national level] will filter down to the regional and local scale will depend on local and regional abilities to provide the goods and services developers require." As such, it's important to know what suppliers of goods and services to the offshore wind sector already exist in Ireland, where they are, and developer's willingness/ability to source locally. Some aspects of the supply chain have been mapped out for the offshore wind sector in Ireland by Cronin (2018), as part of WP4 of the Eirwind project, and for the RE sector as a whole by the IMDO (2019) and Enterprise Ireland (Liam Curran, *pers. comm*, 31 Mar. 2019). Recently, a comprehensive review of the domestic offshore wind supply chain was undertaken by Leahy *et al.* (2020). An overview of this study is provided in section 4 of this report, and maps showing the geographical distribution of Irish supply chain companies are provided in section 2.

In addition to creating employment, the development of the offshore wind energy supply chain will facilitate the export of goods, services and skills, which can thus stimulate the national economy. Given its significant wind resource, Ireland also has the opportunity to become a net exporter of energy, provided we can meet our domestic demand, deal with grid constraints, and we can meet the challenges associated with interconnection.

[i] EurObserv'ER, as reported by the International Renewable Energy Association (IRENA) (2018)

Finally, the development of offshore wind will increase Ireland's security of energy supply. This will protect Ireland against volatility in future international fossil fuel prices. Also, by increasing the diversity of our energy generation mix, we can reduce the risks associated with an overreliance on any single technology.

1.3 Future employment potential

Some studies have addressed future employment potential for offshore wind development in Ireland. According to the government's Offshore Renewable Energy Development Plan (DCENR, 2014), offshore wind will support 3 construction job years[ii] per MW of offshore wind deployed, with 0.6 in ongoing operations and maintenance jobs.

Specific studies that address employment in OW in Ireland include:

- *Estimating Potential Job Creation from ORE Developments* in IPORES 2018 A Review of Irish Ports Offshore Renewable Energy Services (IMDO, 2019)
- The Value of Wind Energy for Ireland (Pöyry, 2014)
- An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland (Siemens, 2014)
- Wind Energy Roadmap - 2011-2050 (SEAI, 2011)
- Socio-economic Appraisal of the Proposed Skerd Rocks Offshore Wind Farm (KHSK, 2006)

The studies are based on various different assumptions and use different methods to estimate employment potential, so it's difficult to compare the results. One way of doing so is to normalise the projections into employment ratios (jobs per MW). It should be noted, though, that there are differences in categorisations of activities between studies, the types of employment considered (direct, indirect, or induced), the types of developments considered (fixed vs. floating) and the Irish content share. Table 1.1 provides an overview of employment ratios calculated for each of the studies. Direct employment ratios from these studies range from 0.8 to 8.7 jobs/MW. Wide ranges in employment ratios for similar RE developments are not uncommon in the literature (Dalton and Lewis, 2011). While these reflect, on the one hand, differences unique to individual developments or scenarios, they may also call into question the credibility of such projections. Since there is no standardised approach to estimating employment potential from offshore wind developments and the emerging nature of the sector means employment potential is dependent upon factors that may change year on year, it's difficult to explain these inconsistencies. In order for employment projections to be credible, it is important that the assumptions, methods and data employed in such assessments are clearly communicated. It was with this in mind that the economic modelling was undertaken for this study.

[ii] 'Job years' is a metric that is often used in the literature to describe employment, particularly in construction, where employment is usually temporary. One job year equates to one full-time job for one person during one year.

Table 1.1 Employment ratios calculated for offshore wind development in Ireland.

Report/study	Activities considered	Scenarios considered	Range of employment ratios for all jobs associated with development
Estimating Potential Job Creation from ORE Developments in IPORES 2018 A Review of Irish Ports Offshore Renewable Energy Services (IMDO, 2019)	Construction & O&M associated with ORE development (incl. wind + wave)	Low: 1000MW fixed; Baseline: 1000 MW fixed + 500MW floating; High: 3000MW fixed + 2000MW floating Installed from 2020-2030	**Direct jobs (offshore wind):** Low: 8.7 jobs/MW Baseline: 8.4 jobs/MW High: 7.96 jobs/MW
The Value of Wind Energy for Ireland (Pöyry, 2014)	Expansion of wind capacity deployment in the single electricity market (onshore + offshore)	Domestic + export scenarios; up to 7900 GW Installed by 2030	**Direct jobs (onshore + offshore wind):** Domestic scenario: 5.74 jobs/MW Export scenario: 6.6 jobs/MW
An Enterprising Wind: An economic analysis of the job creation potential of the wind sector in Ireland (Siemens, 2014)	Wind industry, grid, and manufacturing jobs	Scenario 1: 4,000MW onshore Scenario 2: 7,000MW onshore + 1000MW offshore Scenario 3: 8,000MW onshore + 4,000MW offshore Installed by 2025	**Direct / induced jobs (onshore + offshore wind):** Scenario 1: 1.66 direct jobs/MW / 0.4 induced jobs/MW Scenario 2: 1.83 direct jobs/MW / 0.3 induced jobs/MW Scenario 3: 1.89 direct jobs/MW / 1.05 induced jobs/MW
Wind Energy Roadmap - 2011-2050 (SEAI, 2011)	Onshore + offshore wind	20,000MW offshore wind Installed from 2011-2050	**Direct jobs (offshore wind)** 0.8 jobs/MW
Socio-economic Appraisal of the Proposed Skerd Rocks Offshore Wind Farm (KHSK, 2006)	Employment in construction and O&M for a proposed development	100MW development Installed by 2010	**Direct jobs:** 1.37 jobs/MW **Indirect jobs**: 0.5 jobs/MW

2 Demographic Profile of Coastal Areas around Irish Ports

The economic impacts of offshore wind development will be felt at the national level and also at the local level. To better understand how this might affect coastal communities, this section of the report provides a demographic overview of the geographical catchment areas around Ireland's ports that will likely be impacted by offshore wind development. It is based on data compiled from the Carbon Trust/IWEA, Enterprise Ireland, and the Central Statistics Office (CSO). First, a summary of the regional distribution of Irish companies with existing capabilities in different elements of the offshore wind farm project lifecycle, from an assessment by Leahy *et al.* (2020), is presented. Then, demographic data from the census is presented to provide a regional overview of the socioeconomic status of coastal areas that could be impacted by offshore wind development. Demographic data have been extracted at electoral district (ED) level (where available) for areas around Irish ports with capabilities, or potential capabilities, in serving the offshore wind sector (table 2.1). This includes capabilities in the following areas:

- **Staging** – the port is capable of storing offshore wind farm components port side prior to being delivered to site for installation
- **Manufacturing** – the port has the ability to support the manufacture of wind farm components (such as, foundations, transition pieces, towers, nacelles, blades, export cables and electrical substations)
- **Staging plus manufacturing** – the port is capable of both staging and manufacturing (maximises the benefit to a wind farm project that is close to the port)
- **Potential cluster** – the port can support multiple project and supply chain activities
- **O&M –** the port can provide a base for wind farm operations and maintenance

Investment requirements include, for example, the provision of additional handling equipment to deal with larger offshore wind turbines at Shannon-Foynes and Killybegs and the purchase of proximal land at Rosslare to accommodate staging/manufacturing (Leahy *et al*., 2020).

Table 2.1 Irish ports with capabilities, or potential capabilities, in offshore wind, as assessed by Leahy *et al.* (2020). Demographics for EDs within 25km of each of these ports were assessed in this study. Green: The port is capable now with little investment/change in strategic direction to meet the offshore wind need. Orange: The port can be capable with significant investment/change in strategic direction to meet the offshore wind need. Red: The port cannot currently meet the offshore wind need.

Port	Staging	Manufacturing Only	Staging plus Manufacturing	Potential Cluster	O&M
Dublin					
Cork					
Shannon-Foynes					
Waterford					
Rosslare					
Arklow					
Drogheda					
Dun Laoghaire					
Galway					
Greenore					
Killybegs					
Kinsale					
New Ross					
Rossaveal					
Fenit/Tralee					
Wicklow					

Census data subsets comprised EDs within 25km of the ports (figure 2.1).

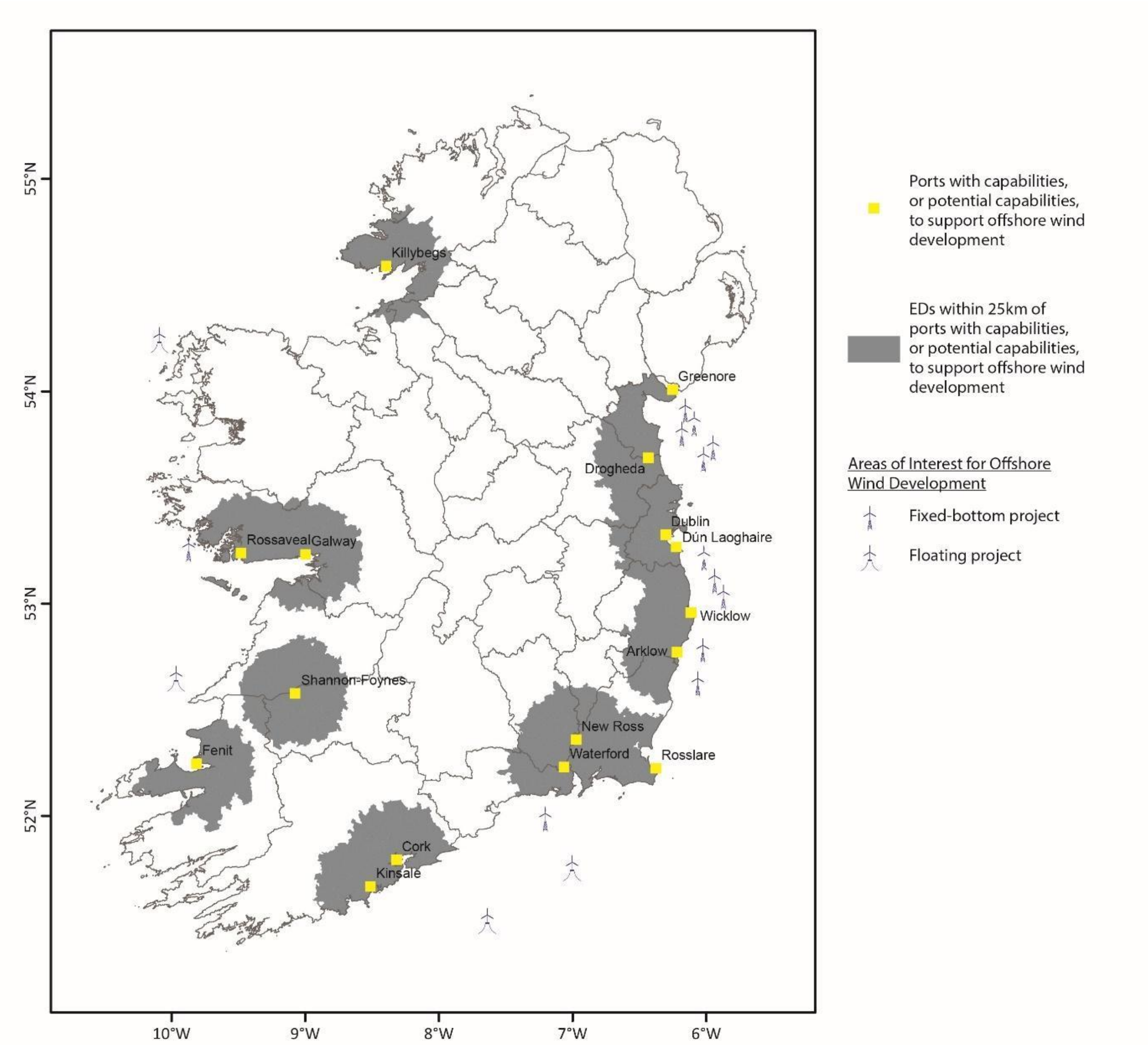

Figure 2.1 EDs within 25km of ports that can serve the offshore wind industry in the Republic of Ireland. In this assessment, demographics for EDs in each geographical catchment area are assessed against national statistics. Current areas of interest for offshore wind development are also shown. While these are currently clustered along the east coast, as the industry and technology develops, development is likely to expand to the south and west coasts. According to the OREDP's Strategic Environmental Assessment, Ireland's greatest offshore wind development potential lies off the north-west coast.

2.1 Regional Distribution of Irish Supply Chain Companies

Leahy *et al.* (2020) mapped the regional distribution of Irish companies with capabilities in different elements of an offshore wind farm project lifecycle. The maps in figure 2.2 show the number of Irish suppliers that are active or have the potential to serve the offshore wind market for the eight NUTS3[3] regions of Ireland. They do not take into account experience in the sector. Overall, the Dublin and southwest regions have the greatest number of Irish companies with potential to serve the Irish offshore wind industry. The mid-east and midlands regions have the least number of companies. A large number of companies have potential in development and consent, operations and maintenance, and, to some extent, installation and commissioning. These life cycle elements combined make up just under half of the total expenditure for a typical project, but given the high cost of projects, they can still represent lucrative regional development opportunities.

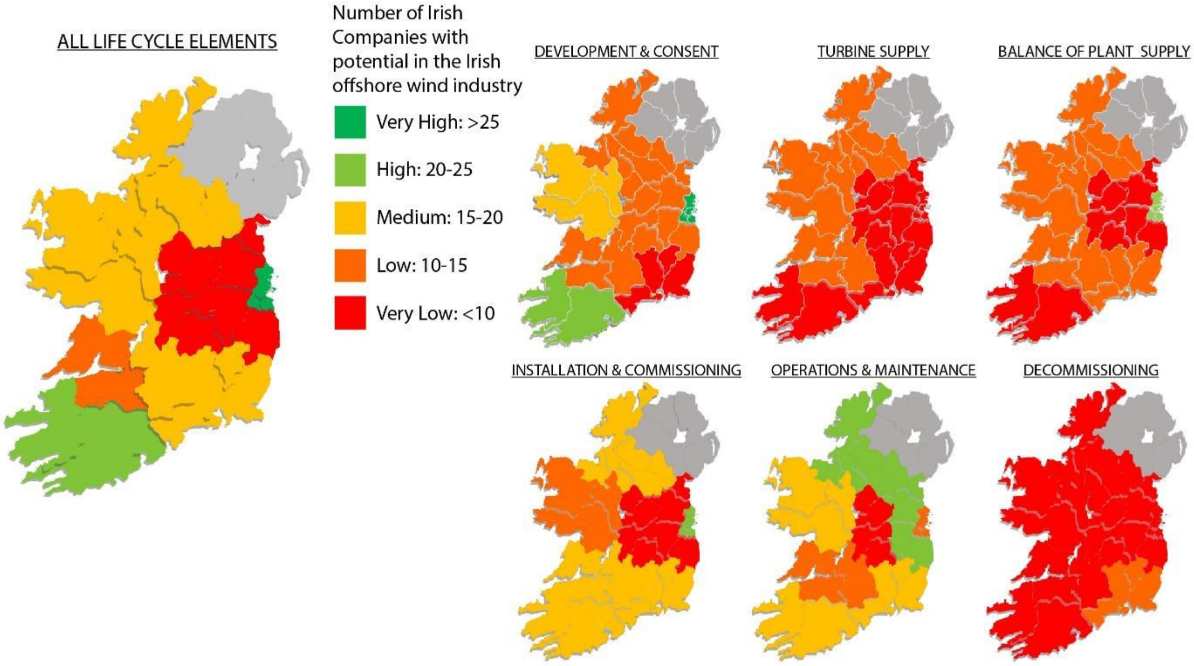

Figure 2.2 Regional distribution of Irish companies with capabilities in different elements of the offshore wind farm project life cycle. Colours are based on number of companies, not experience. [Source: Adapted from Leahy *et al.* (2020)]

2.2 Population

Ireland's population in 2016 was 4.75million (table 2.2). The port areas with the highest populations are Dublin and Dún Laoghaire (c. 1.4million+), followed by Cork and Kinsale (c. 300million). Between 2011 and 2016, the populations of the port areas around Dublin and Cork grew at rates of around 2% higher than the national average. More remote ports, such as Fenit, Co. Kerry, Rossaveal, Co. Galway and Killybegs, Co. Donegal, are much less densely populated, with slower rates of population growth than the national average, and a decline in population around Killybegs. In these rural and remote coastal areas, the development of an offshore wind industry that includes supply chain hubs or clusters around ports may help to address wider socioeconomic issues, such as Ireland's regional economic imbalance and rural

[3] European standard classification for referencing sub-national sub-divisions of Ireland.

depopulation, which have contributed to the decline of many of Ireland's coastal communities (McElduff *et al*., 2013; McDonagh, 2017). This can also provide new opportunities for emigrants who wish to return home, many of whom are skilled professionals with limited opportunities at home (Enríquez and Triandafyllidou, 2016). At Killybegs, the port is already capable with little investment or change in strategic direction to meet the offshore wind need in the areas of staging, manufacturing, and O&M (Leahy *et al.*, 2020), thus representing a locality where there is great potential for maximising social return on investment.

Table 2.2 Population statistics for EDs around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Port area	**Population**		**Population Change**		**Population Density (2016, persons per ha)**
	2011	**2016**	**Absolute**	**%**	
Greenore	62,830	65,846	3,016	4.6%	1.45
Drogheda	248,680	264,062	15,382	5.8%	1.54
Dublin	1,413,768	1,496,466	82,698	5.5%	8.62
Dún Laoghaire	1,345,516	1,422,494	76,978	5.4%	10.18
Wicklow	106,496	111,229	4,733	4.3%	1.05
Arklow	80,395	84,131	3,736	4.4%	0.59
Rosslare	59,463	60,489	1,026	1.7%	0.78
New Ross	156,640	159,814	3,174	2.0%	0.67
Waterford	138,943	141,175	2,232	1.6%	0.75
Cork	327,604	346,330	18,726	5.4%	1.95
Kinsale	300,420	316,297	15,877	5.0%	2.22
Fenit	78,587	78,804	217	0.3%	0.45
Shannon-Foynes	104,708	105,557	849	0.8%	0.43
Galway	161,855	169,309	7,454	4.4%	0.78
Rossaveal	30,481	30,560	79	0.3%	0.22
Killybegs	36,090	35,409	-681	-1.9%	0.23
National	4,580,927	4,754,287	173,360	3.6%	0.68

2016 Population	
Highest	
Lowest	

Above national average	
Below national average	

2.3 Economic Status

The Irish economy has recovered strongly from the economic recession of 2008-2009, although the economic impacts associated with the recent and ongoing COVID-19 pandemic remain to be seen. Given the nascence of the situation, its fast changing nature, and the uncertainties at the present moment, this has not been factored into the research contained in the socioeconomic study. However, it is worth noting that European industry bodies have rallied to propose the integration of coronavirus stimulus packages and the European Green Deal to kick-start the post-COVID economic recovery (Snieckus, 2020). Regardless of how the situation unfolds, Ireland remains committed to its international climate obligations, and a positive outcome of the situation is the heightened public appreciation for climate-related issues.

Prior to the present public health crisis, the Irish economy improved markedly since the global recession of 2008. As of February 2020, unemployment was down from a peak of 15.9% in December 2011 to 4.8% (CSO, 2020). Irish export performance also improved. However, there exists a geographical disparity in this recovery, with growth being heavily concentrated in urban centres, mainly Dublin, and, to a lesser extent, Cork and Galway, while more remote and rural areas lag behind (Hennebry, 2018). This is reflected in the census statistics presented in this section of the report.

Table 2.3 summarises the economic status of the population aged 15+ around ports compared to the national average, including figures for those 'at work' and 'unemployed'. The national unemployment rate (for population aged 15-74) for 2016 was around 7%. Unemployment was higher than the national average in Greenore, Drogheda, Arklow, Rosslare, New Ross, Waterford, Fenit, Rossaveal, and Killybegs and lowest near urban centres, including Dublin, Cork, and Galway. Participation in the workforce is also highest in the areas near Dublin. While some planned commercial developments are located near economically depressed areas on the east and southeast coasts, there are few on the west coast, where the next wave of development is likely to spread and populations could significantly benefit from such developments.

Table 2.3 Economic status of population aged 15+ around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Economic Status of Population Aged 15+ (2016, % of total per geographical catchment area)								
Port area	**At work**	**Looking for first regular job**	**Unemployed having lost or given up previous job**	**Student**	**Looking after home/ family**	**Retired**	**Unable to work due to permanent sickness or disability**	**Other**
Greenore	50%	1%	9%	12%	7%	15%	5%	0.3%
Drogheda	56%	1%	7%	11%	9%	11%	4%	0.3%
Dublin	56%	1%	6%	12%	7%	13%	4%	0.4%
Dún Laoghaire	56%	1%	6%	12%	7%	14%	4%	0.4%
Wicklow	52%	1%	7%	11%	9%	15%	4%	0.4%
Arklow	51%	1%	9%	10%	10%	14%	5%	0.4%
Rosslare	50%	1%	8%	9%	9%	17%	5%	0.3%
New Ross	50%	1%	9%	11%	9%	15%	5%	0.4%
Waterford	50%	1%	9%	11%	9%	16%	5%	0.5%
Cork	52%	1%	6%	14%	8%	14%	5%	0.4%
Kinsale	51%	1%	6%	14%	8%	15%	5%	0.4%
Fenit	50%	1%	7%	11%	8%	17%	5%	0.4%
Shannon-Foynes	55%	1%	7%	11%	8%	14%	4%	0.4%
Galway	55%	1%	6%	15%	7%	12%	3%	0.4%
Rossaveal	50%	1%	8%	12%	9%	17%	4%	0.4%
Killybegs	49%	1%	8%	9%	8%	20%	5%	0.4%
National	53%	1%	7%	12%	8%	15%	4%	0.4%

Above national average	(blue)	Below national average	(pink)

2.4 Sectors of Employment

At the national level, almost 60% of Ireland's workforce is employed in commerce and trade, professional services, or manufacturing (table 2.4). It is estimated that 39% of the occupational requirements for offshore wind development are associated with installation, maintenance, and repair (including marine vessel operatives), 17% are associated with management, and 17% are associated with production (BVG, 2019c). The overlap between Ireland's existing workforce and occupational requirements in the offshore wind supply chain means that Ireland is well positioned, at least at the national level, to support industry requirements. However, Leahy *et al.* (2020) have highlighted occupational shortages within engineering, financial services, and logistics.

At the local level, a greater proportion of the workforce is employed in manufacturing industries in the south and the west than in the east, whereas more are employed in commerce and trade in the east. The greatest proportion of those employed in professional services occurs around Galway and Rossaveal. The high degree of aggregation of the industries and the high proportion of those employed in 'Other' industries makes it difficult to draw further inferences, but more information about social classes and socioeconomic groups is available and presented in the next section.

Table 2.4 Persons at work, by industry, around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Persons at work by industry (2016, % of total)								
Port area	**Agriculture, forestry and fishing**	**Building and construction**	**Manufacturing industries**	**Commerce and trade**	**Transport and communications**	**Public administration**	**Professional services**	**Other**
Greenore	3%	5%	12%	27%	7%	6%	22%	19%
Drogheda	3%	6%	11%	24%	11%	6%	23%	16%
Dublin	0.4%	4%	7%	29%	13%	5%	23%	18%
Dún Laoghaire	0.4%	4%	7%	29%	13%	5%	23%	19%
Wicklow	2%	6%	10%	28%	9%	5%	21%	19%
Arklow	6%	7%	11%	24%	7%	4%	22%	19%
Rosslare	6%	6%	11%	24%	6%	6%	22%	19%
New Ross	7%	6%	15%	22%	6%	4%	24%	16%
Waterford	6%	6%	16%	21%	6%	4%	23%	17%
Cork	2%	4%	16%	23%	9%	5%	24%	16%
Kinsale	2%	4%	16%	23%	9%	5%	24%	16%
Fenit	7%	6%	10%	22%	5%	5%	24%	21%
Shannon-Foynes	7%	5%	18%	19%	7%	5%	22%	15%
Galway	3%	5%	16%	20%	8%	4%	26%	18%
Rossaveal	4%	6%	12%	17%	9%	6%	31%	16%
Killybegs	7%	6%	13%	19%	5%	5%	23%	23%
National	4%	5%	12%	24%	9%	5%	23%	17%

Above national average			Below national average	

2.5 Socioeconomic Groups

Tables 2.5 and 2.6 summarise the breakdown of the populations around ports into social classes and socioeconomic groups, respectively. To better understand how the port areas match the needs of the offshore wind industry, the occupational requirements for offshore wind identified in BVG (2019c) have been reclassified into the social class and socioeconomic group categories of the CSO and are shown in figure 2.3. Skilled manual workers make up the largest share of the occupational requirements associated with offshore wind development. The proportion of these workers is lower than the national average near Dublin, Cork, and Galway and higher outside of the urban centres. Collectively, professional workers and managerial and technical occupations make up the second greatest share of occupational requirements. At the national level, managerial and technical workers make up over a quarter of the workforce, with a greater than average proportion located around Dublin, Galway and Shannon. There are fewer professional workers and managerial and technical workers outside of the urban centres, where the proportions are generally lower than the national average. These occupations are generally of higher quality (*e.g.* better paid, more job security, etc.) than those in the other CSO categories. The commercialisation of offshore wind around the ports outside of Ireland's major urban centres, such as Dublin and Cork, therefore represents an opportunity to create high-quality jobs in areas where such jobs are presently lacking.

Table 2.5 Social class statistics for areas around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Social Class (2016, % of total)							
Port area	**Professional workers**	**Managerial and technical**	**Non-manual**	**Skilled manual**	**Semi-skilled**	**Unskilled**	**All others gainfully occupied and unknown**
Greenore	8%	19%	16%	17%	12%	4%	23%
Drogheda	8%	27%	20%	16%	11%	4%	15%
Dublin	10%	30%	18%	12%	9%	3%	18%
Dún Laoghaire	10%	30%	18%	12%	9%	3%	18%
Wicklow	10%	29%	16%	15%	11%	3%	16%
Arklow	7%	26%	18%	16%	12%	4%	16%
Rosslare	6%	24%	21%	17%	13%	5%	13%
New Ross	7%	27%	16%	16%	11%	5%	18%
Waterford	7%	26%	17%	15%	13%	5%	19%
Cork	11%	26%	18%	14%	11%	3%	17%
Kinsale	11%	26%	18%	14%	11%	3%	17%
Fenit	7%	26%	20%	13%	11%	4%	21%
Shannon-Foynes	8%	28%	18%	14%	12%	4%	17%
Galway	11%	29%	17%	12%	10%	3%	18%
Rossaveal	10%	30%	15%	13%	11%	4%	17%
Killybegs	5%	24%	17%	17%	14%	4%	18%
National	8%	28%	18%	14%	11%	4%	18%

Above national average		Below national average	

Table 2.6 Socioeconomic group statistics for areas around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Socioeconomic group (2016, % of population classified according to head of household)											
Port area	**A Employers and managers**	**B Higher professional**	**C Lower professional**	**D Non-manual**	**E Manual skilled**	**F Semi-skilled**	**G Unskilled**	**H Own account workers**	**I Farmers**	**J Agricultural workers**	**Z All others gainfully occupied and unknown**
Greenore	16%	6%	10%	15%	11%	10%	4%	5%	3%	0.4%	19%
Drogheda	17%	6%	11%	19%	10%	9%	4%	6%	3%	0.6%	14%
Dublin	19%	10%	14%	19%	7%	7%	3%	5%	0.4%	0.1%	15%
Dún Laoghaire	19%	10%	13%	19%	8%	7%	3%	5%	0.3%	0.1%	16%
Wicklow	22%	9%	13%	16%	8%	8%	3%	6%	2%	0.5%	13%
Arklow	16%	6%	11%	16%	10%	9%	4%	6%	5%	1.0%	16%
Rosslare	15%	5%	11%	19%	10%	10%	5%	6%	5%	1.0%	13%
New Ross	13%	5%	11%	17%	10%	10%	5%	5%	7%	0.9%	15%
Waterford	14%	6%	10%	17%	11%	11%	5%	5%	6%	0.7%	16%
Cork	16%	9%	13%	17%	9%	10%	3%	5%	2%	0.2%	15%
Kinsale	16%	10%	13%	18%	9%	9%	3%	5%	2%	0.2%	15%
Fenit	13%	5%	11%	18%	10%	8%	3%	6%	8%	0.4%	17%
Shannon-Foynes	14%	6%	12%	16%	11%	9%	4%	5%	9%	0.4%	14%
Galway	15%	10%	14%	16%	7%	10%	3%	5%	4%	0.2%	16%
Rossaveal	14%	9%	15%	14%	8%	8%	5%	7%	7%	0.4%	14%
Killybegs	12%	4%	10%	17%	11%	11%	4%	6%	7%	0.5%	16%
National	15%	7%	12%	18%	9%	9%	4%	5%	5%	0.5%	15%

Above national average		Below national average	

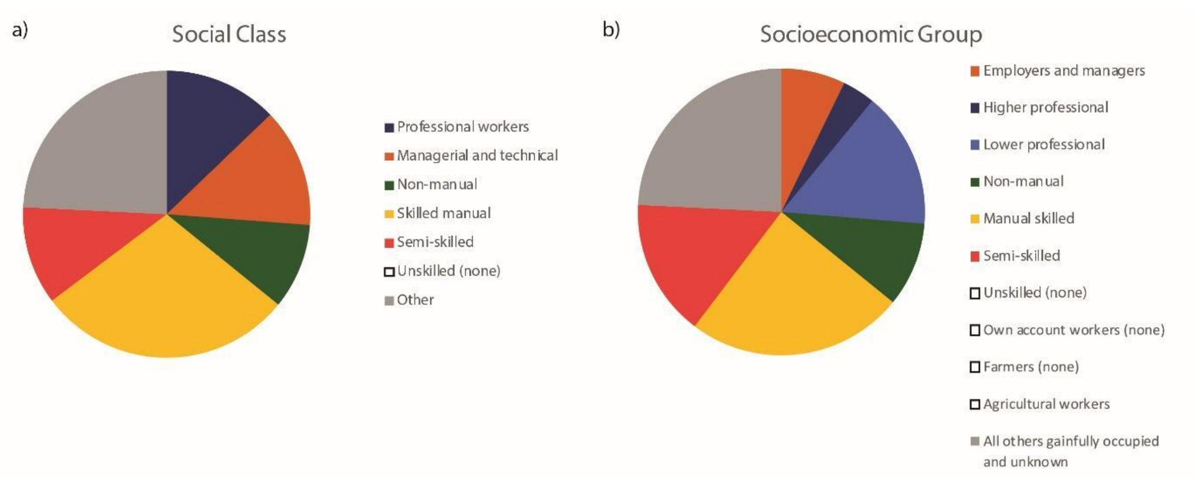

Figure 2.3 Proportion of occupational requirements associated with offshore wind development within CSO (a) social classes and (b) socioeconomic groups. Based on statistics from research by BVG (2019c).

2.6 Education

Apprenticeships and higher education qualifications are important attributes of the offshore wind industry labour force. Twenty-nine percent of Ireland's population have a bachelor's degree or higher, and a further 15% have either a technical or vocational qualification or advanced certificate/completed apprenticeship (table 2.7). The share of the population with higher degrees is generally above the national average for the areas around the urban centres of Dublin, Cork, and Galway, and below the national average for areas outside of the primary urban centres. In these areas, the share of the population with technical or vocational qualifications or advanced certificates/completed apprenticeships tends to be higher than the national average.

Table 2.7 Population (by highest level of education completed) statistics for areas around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Population aged 15 years and over by highest level of education completed (2016, % of population)												
Port area	**No formal education**	**Primary education**	**Lower secondary**	**Upper secondary**	**Technical or vocational qualification**	**Advanced certificate/ Completed apprenticeship**	**Higher certificate**	**Ordinary bachelor degree or national diploma**	**Honours bachelor degree, professional qualification or both**	**Postgraduate diploma or degree**	**Doctorate (Ph.D) or higher**	**Not stated**
Greenore	2%	12%	17%	19%	9%	6%	5%	7%	10%	7%	1%	6%
Drogheda	2%	10%	15%	19%	10%	6%	6%	8%	9%	8%	1%	6%
Dublin	1%	9%	12%	17%	8%	5%	5%	8%	14%	13%	1%	8%
Dún Laoghaire	1%	9%	12%	17%	8%	5%	5%	8%	14%	13%	1%	8%
Wicklow	1%	9%	13%	18%	9%	6%	6%	9%	12%	10%	1%	5%
Arklow	2%	11%	17%	19%	10%	7%	5%	7%	9%	6%	1%	5%
Rosslare	2%	13%	19%	20%	9%	6%	5%	7%	8%	6%	0%	4%
New Ross	2%	12%	18%	19%	10%	7%	5%	6%	9%	6%	1%	5%
Waterford	2%	12%	18%	19%	9%	7%	5%	6%	9%	6%	1%	6%
Cork	1%	8%	14%	18%	8%	6%	5%	8%	12%	11%	1%	6%
Kinsale	1%	9%	14%	18%	8%	6%	5%	8%	12%	11%	1%	6%
Fenit	2%	11%	16%	19%	9%	6%	5%	8%	9%	6%	0%	7%
Shannon-Foynes	2%	11%	16%	20%	10%	7%	5%	8%	7%	7%	1%	5%
Galway	1%	8%	11%	18%	9%	6%	5%	10%	12%	12%	2%	6%
Rossaveal	2%	14%	14%	16%	8%	5%	5%	9%	10%	12%	2%	4%
Killybegs	3%	15%	17%	17%	9%	6%	5%	7%	7%	6%	0%	8%
National	2%	11%	15%	19%	9%	6%	5%	8%	11%	9%	1%	6%

Above national average		Below national average	

According to Leahy *et al.* (2020), fields of study relevant to the offshore wind industry include engineering, manufacturing and construction, information and communication technology (ICT), natural sciences, and business, administration and law. Apprenticeships that are relevant or transferrable to the offshore wind industry include those in the areas of electrical, engineering, motor, and finance.

Table 2.8 shows the breakdown of the workforce by field of study. At the national level, the greatest proportion of the educated labour force in 2016 was in social sciences, business and law, followed by engineering, manufacturing and construction. The proportion of those whose field of study was in social sciences, business and law is higher than the national average in the areas around Dublin and Cork and lower in many remote, rural areas. The greatest proportions of those whose field of study was in engineering, manufacturing and construction occurs around the areas north of Dublin and in Cork, and Galway. This, however, does not give a full picture of the workforce, as it represents only a snapshot in time and the field of study for a large proportion (almost 50%) of the population was not stated in the 2016 census.

Table 2.8 Population (by field of study) statistics for areas around ports with capabilities or potential capabilities to serve the domestic offshore wind industry.

Population aged 15 years and over by field of study (2016, % of population)											
Port area	**Education and teacher training**	**Arts**	**Humanities**	**Social sciences, business and law**	**Science, mathematics and computing**	**Engineering, manufacturing and construction**	**Agriculture and veterinary**	**Health and welfare**	**Services**	**Other subjects**	**Not stated**
Greenore	4%	2%	2%	13%	4%	9%	2%	7%	5%	0.1%	52%
Drogheda	4%	2%	2%	15%	4%	9%	2%	7%	5%	0.1%	49%
Dublin	4%	3%	3%	20%	6%	8%	1%	7%	4%	0.1%	44%
Dún Laoghaire	4%	3%	3%	20%	6%	8%	1%	7%	4%	0.1%	45%
Wicklow	4%	3%	2%	17%	5%	9%	2%	7%	5%	0.1%	46%
Arklow	4%	2%	2%	13%	4%	8%	3%	7%	5%	0.1%	53%
Rosslare	5%	2%	2%	13%	3%	9%	3%	8%	5%	0.2%	51%
New Ross	4%	2%	1%	12%	4%	10%	4%	8%	5%	0.2%	51%
Waterford	4%	2%	1%	12%	4%	10%	3%	8%	5%	0.2%	51%
Cork	4%	2%	2%	16%	6%	11%	2%	8%	5%	0.1%	44%
Kinsale	4%	2%	2%	16%	6%	10%	2%	8%	5%	0.1%	44%
Fenit	4%	1%	1%	11%	4%	9%	4%	8%	5%	0.1%	52%
Shannon-Foynes	5%	1%	1%	12%	4%	10%	4%	7%	4%	0.1%	51%
Galway	5%	2%	3%	15%	7%	10%	2%	9%	5%	0.1%	41%
Rossaveal	6%	2%	4%	12%	5%	8%	2%	7%	4%	0.1%	50%
Killybegs	4%	1%	1%	9%	3%	8%	3%	7%	6%	0.1%	57%
National	4%	2%	2%	15%	5%	9%	3%	8%	4%	0.1%	49%

Above national average		Below national average	

An assessment of more recent and detailed data at the national level by Leahy *et al.* (2020) shows that the number graduates in some engineering related fields of study is declining, which is contributing to skills shortages in the workforce. It is also relevant to note here that in addition this decline, there is a significant gender gap, with only 16% of engineering graduates in Ireland being women (Leahy *et al.*, 2020). In some relevant fields, though, there have been large increases in the number of graduates, including in (1) motor vehicles, ships and aircraft engineering manufacturing and construction, (2) manufacturing and processing, (3) information communication technologies, and (4) physics and physical sciences.

Finally, with regard to apprenticeships, while there is a rapidly growing uptake of apprenticeships in Ireland, there is a clear lack of apprenticeships relating specifically to maritime and marine skills (Leahy *et al.*, 2020). Ireland is well-endowed with facilities for such training (*e.g.* the National Maritime College of Ireland, NMCI, in Cork), but there is a need to introduce and develop new schemes and to raise awareness of the upcoming employment opportunities in offshore wind in Ireland amongst prospective and experienced mariners. Many Irish mariners are highly qualified, taking up international work, for example on cruise ships and tankers, due to limited opportunities at home. Jobs in offshore wind can attract Irish professionals back to Ireland, where they can make a significant contribution to the socioeconomic fabric of rural ports.

2.7 Social Deprivation

While the census data on their own provide useful information about different population characteristics in certain areas, a key socioeconomic indicator that takes into account multiple criteria collectively is the Pobal HP Deprivation Index. The Pobal HP Deprivation Index is a method of measuring the relative affluence or disadvantage of a particular geographical area. It was developed by Haase and Pratschke (2008) and is produced for each census, the latest being 2016 (Haase and Pratschke, 2017). Pobal HP Deprivation Index scores are based on a national average of zero and range from approximately -35 (being the most disadvantaged) to +35 (being the most affluent). The scores are based on the following characteristics, derived from the census data:

- Population Change
- Age Dependency Ratio
- Lone Parent Ratio
- Primary Education Only
- Third Level Education
- Unemployment Rate (male and female)
- Proportion living in Local Authority Rented Housing

The Pobal HP Deprivation data can provide a useful indicator for the geographical locations where the maximum benefits of offshore wind development can be realised. The data have been mapped and graphed at the national level and for EDs within 25km of ports with capabilities or potential capabilities in offshore wind (figures 2.4 and 2.5).

The most affluent areas tend to be around Dublin, Cork, and Galway with the less affluent (or more disadvantaged) being located along the north west, west, and southwest coasts. The greatest proportion of the population in extremely or very disadvantaged areas is in the area around Dublin.

The Pobal data suggest that the greatest opportunities for addressing social deprivation lie around remote ports, where levels of deprivation are higher than the national average. This information can potentially be used to design community benefit schemes.

2.8 Summary

The development of offshore wind energy in Ireland can help to counter Ireland's regional economic imbalance, particularly around south and west coast ports. At present, the majority of planned developments are located on the east coast, but the next wave of developments off the south and west coasts will unlock major opportunities for regional development. Given the high quality of jobs associated with the offshore wind supply chain, offshore wind development presents a significant socioeconomic opportunity for the regeneration of communities in decline. Ports such as Killybegs have great potential, in that (1) the port is already capable with little investment or change in strategic direction to meet the offshore wind need in several areas, (2) the OREDP has identified the northwest as having the greatest potential for offshore wind development, and (3) the local community, which is economically disadvantaged relative to other parts of the country, would benefit significantly from an economic boost.

Several other ports with economically disadvantaged hinterlands also have potential capabilities in different areas. For example, New Ross, Waterford, Rosslare, and Rossaveal are capable now with little investment or change in strategic direction to serve as O&M ports, and Shannon-Foynes has high potential for staging and manufacturing (Leahy *et al*., 2020). Rosslare is already gearing up to support offshore wind development, with Dutch logistics company, Xellz, having recently named the Rosslare Europort Business Park (EBP) its planned offshore wind supply base. Only with significant investment, though, can port activities can be expanded to meet other emerging needs of the sector. According to the Marine Renewables Industry Association (MRIA),

> *"THERE IS NO ESCAPING THE FACT THAT OCEAN ENERGY DEVICES ARE LARGE PIECES OF ENGINEERING KIT AND WILL MAKE A HUGE IMPACT ON THE FACILITIES OF DEPLOYMENT PORTS. Many potential device designs have high deployment costs i.e. they need expensive, hired-in deployment vessels and, therefore, they are sensitive to the distance and steaming times between a support port and a deployment site. Killybegs in south Donegal and the Galway ports of Rossaveal and Galway Harbour obviously could all play a part. But, arising from a possible scenario around 2030, there could be a need to make a significant port investment years beforehand in the west."*
>
> (MRIA, 2014, p. 33)

The high potential for social return on investment, as demonstrated in section 5 of this report, should be a key consideration in relation to strategic planning going forward.

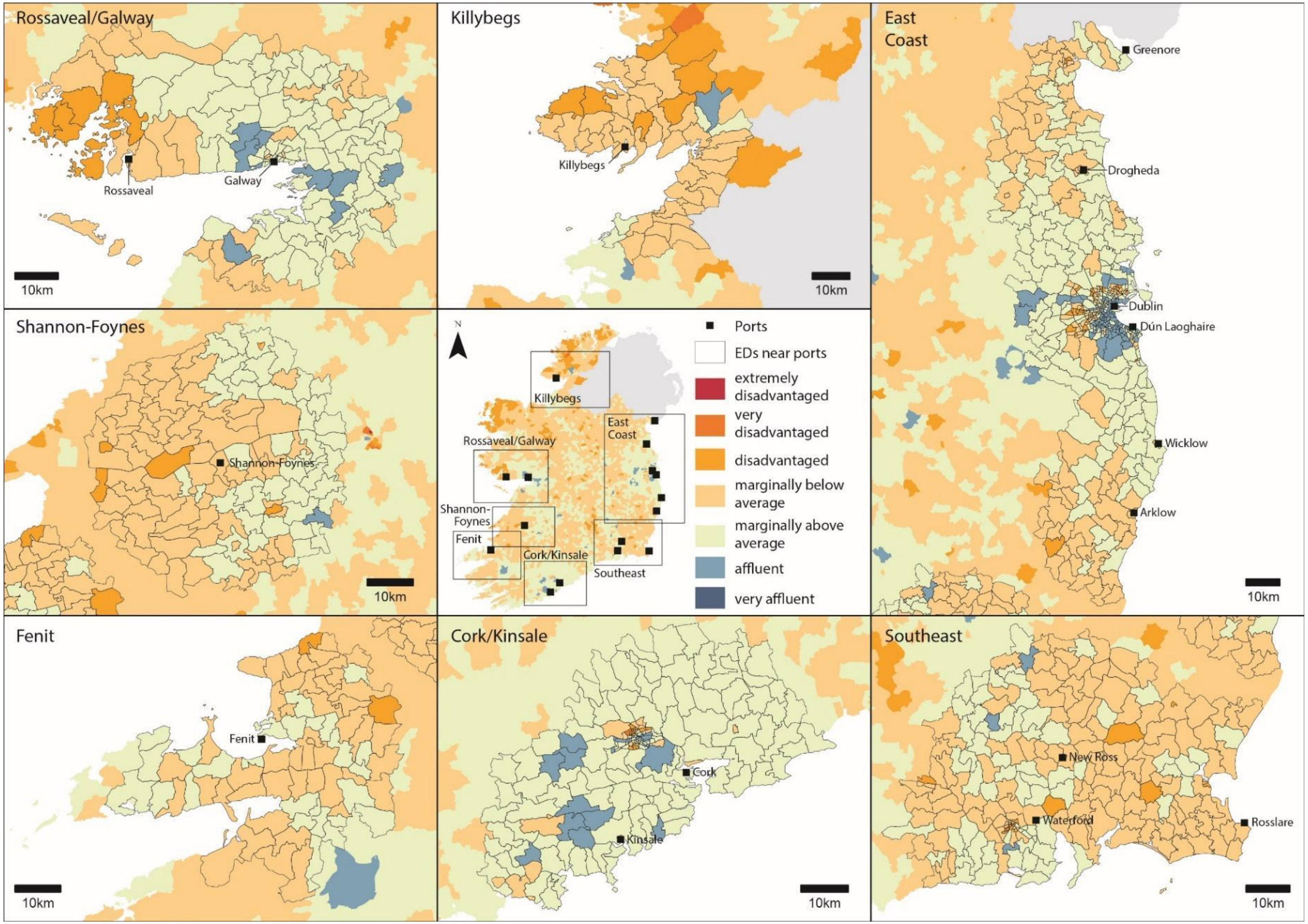

Figure 2.4 Pobal HP deprivation categories for EDs within 25km of ports with capabilities, or potential capabilities, in offshore wind. The HP deprivation index is based on the 2016 census data.

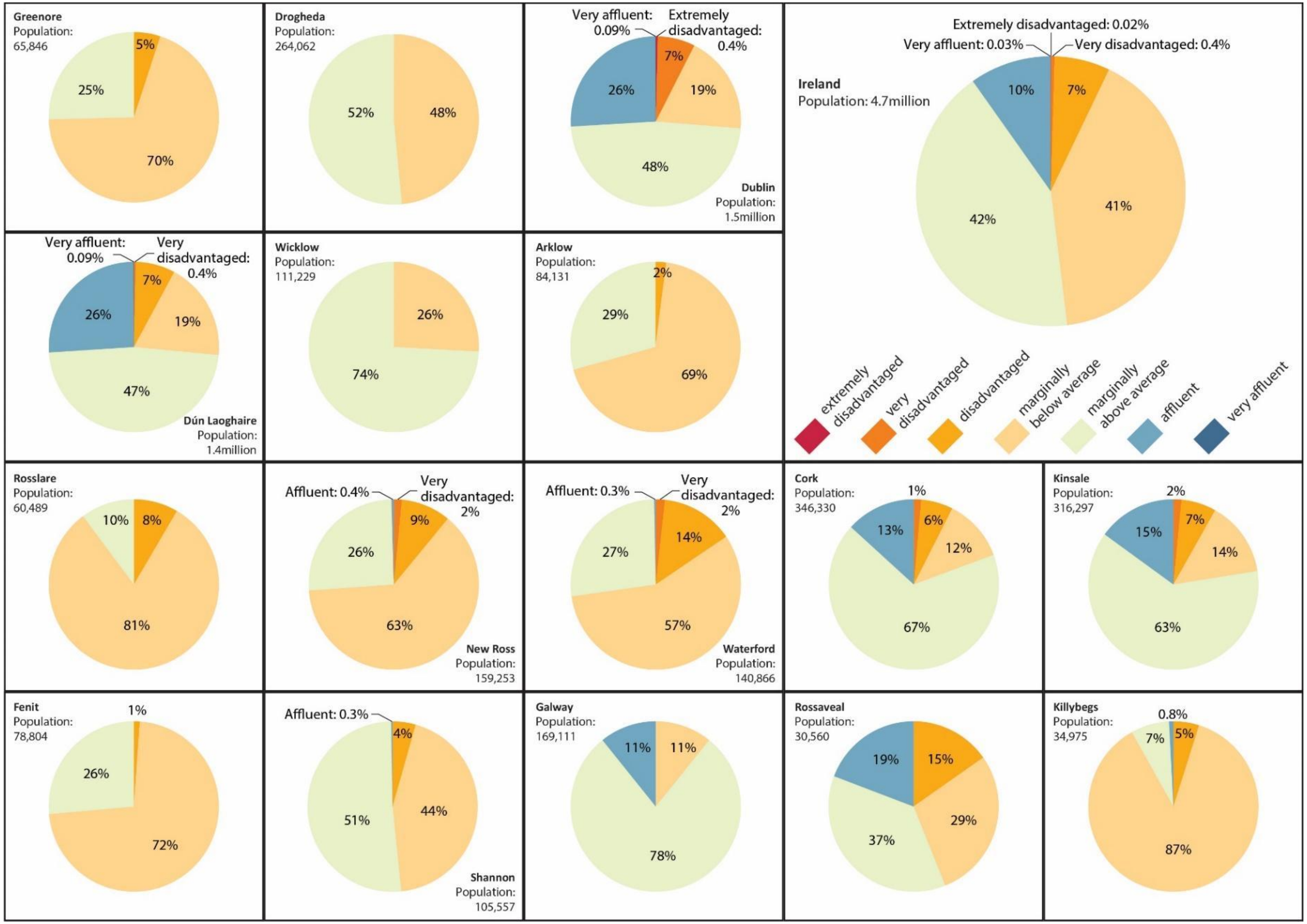

Figure 2.5 Proportion of population in HP Deprivation Index categories in EDs within 25km of ports with capabilities, or potential capabilities, in offshore wind.

3 Socioeconomic impacts of offshore wind: international context

Offshore wind farms are large in scale and require major investment. For any new development, it is important for developers, consenting agencies, and the public to consider the potential implications, both positive and negative, to society and the economy. While it's true that offshore wind developments can be transformative to local economies, creating hundreds, or even thousands, of new jobs and supporting local businesses, they can also have a negative impact on other local activities, such as tourism, recreation, and fishing (although not necessarily, and in some cases, these impacts may be positive). This section of the report explores the socioeconomic impacts of existing offshore wind projects around the globe in regions with experience of the sector. It highlights some of the benefits they have brought to local communities and also examines the issues that have been raised by different stakeholder groups in relation to the social and economic impacts of these projects. It is focussed on past experience (evidence-based), rather than potential or future impacts or benefits.

3.1 UK

The UK is the global leader in offshore wind development, with over 8GW of installed capacity. The earliest commercial developments were installed in the early 2000s, and there has been a steady increase in capacity since. The latest project commissioned, the Beatrice Offshore Windfarm Limited (BOWL), was completed in 2019.

The BOWL project is one of the largest ever private infrastructure investments in Scotland. A joint venture partnership between SSE Renewables, Copenhagen Infrastructure Partners, and Red Rock Power Limited, it is located approximately 13km from the remote Caithness coast in north east Scotland and operated and maintained from its base at Wick Harbour. Its 84 turbines are capable of powering 450,000 homes.

According to SSE (2019), during the development and construction phases, Beatrice contributed £460m to the Scottish economy as part of a total £1.3bn contribution to the UK economy. It was estimated that the project provided 19,110 person-years of employment in the UK, of which 7,180 were in Scotland. These figures include direct (workers directly employed on site), indirect (those employed because of Beatrice's supply chain contracts), and induced (employment supported as a result of these workers spending their salaries) employment. During the construction of the Blackhillock Substation, Scottish-based civil engineering contractor, RJ McLeod, employed over 50 people on the project from the local area and the north of Scotland. Also, over 75% of the workforce involved in the construction of the O&M harbour facility in Wick was sourced from the local community.

The project has also helped to support Scottish and UK companies in the offshore wind supply chain, with 24% of the combined development expenditure (DEVEX) and capital expenditure (CAPEX) spent with companies in Scotland and 49% spent with companies across the UK. Local content is expected to increase to 39% (for Scotland) and over 60% (for the UK) over the lifetime of the project, in line with the UK Offshore Wind Sector Deal, which sets a 2030 target to achieve 60% lifetime UK content.

Apart from supporting Scottish and UK jobs and businesses, the Beatrice project has supported local communities in the north of Scotland through the administration of £6m to local and regional community benefit funds over a five-year period. The benefit funds were set up in consultation with local stakeholders, including politicians, communities and local authorities. In 2018/2019, £783,173 was awarded and 63 projects were supported. Grant money was awarded, for example, to support the expansion of a community food bank to new areas, refurbish an MS therapy centre, and support a social enterprise endeavour to connect vulnerable and isolated people through nature-based activities. To date, project funds have been awarded across a broad spectrum, including for local facilities, arts, education, wellbeing and sport.

Other community benefits of the project are more difficult to quantify. For example, at the O&M base in Wick, two historically important harbour front buildings that had fallen into a state of disrepair were refurbished to house O&M activities, returning the buildings to maritime use. Once considered eyesores, the buildings will serve as the O&M base for at least 25 years (the lifetime of the project), supporting up to 90 full time personnel (with further support staff on occasion) and guaranteeing the Wick Harbour Authority 25 years of rental and harbour fees. The building refurbishments were welcomed by one member of the local community as "a great revival and boost to an area of old town heritage which was becoming run down" (SSE, 2019, p. 18).

Despite efforts to support the local workforce, offshore wind projects often heavily rely on foreign workers. This may be due to local skills shortages, labour costs, or a reliance by foreign Engineering, Procurement, Construction and Installation (EPCI) contractors on their existing experienced, often globally sourced, workforce. Due to the sheer size of offshore wind projects, developers generally rely on EPCI contractors to manage contracts. As a result, they are not always directly involved in sourcing labour for construction activities. In 2018, an investigation by the Guardian found that non-EEA nationals working on one of the Beatrice installation vessels were being paid less than the UK national minimum wage (Lawrence and McSweeney, 2018). SSE Renewables acted swiftly to address this, working with their EPCI contractor and its sub-contractor to ensure the workers were compensated and undertaking a review of its current practices to ensure it would not happen again. Legal loopholes, however, mean that such practices could continue to occur in the UK (Daly, 2019).

The issue of foreign contracts, especially where the UK has the capability to provide products and services to the offshore wind sector, has been highlighted by British trade unions, including GMB. GMB has argued that local companies, in Scotland and the UK, are not benefitting enough from offshore wind development in Britain. For example, in 2019, French developer EDF announced early in the year that they would be awarding contracts on the Neart na Gaoithe (NnG) wind farm project, off the east coast of Scotland. Reports began to circulate that EDF would award a contract for the manufacture of turbine jackets to an Indonesian company, rather than a struggling local competitor, based only 10 miles from the project. This generated criticism from local trade unions, which was widely reported in the press (Lammey, 2019; Smith, 2019). In response to the news, GMB made several recommendations to Parliament in relation to offshore wind development, including:

1. Establish a register of all companies receiving public subsidies and restrict companies registered in offshore tax havens from being on the register.
2. Percentage of agreed supply chain which must be sourced in the UK must be a binding and legally enforceable condition of each project being awarded subsidies.
3. Companies on the register building and running projects, and all their contractors and sub-contractors, must be covered by a new 'national recognition and collective bargaining agreement', which would set forth provisions in regard to, for example, rates of pay, hours of work or other working conditions of employees.

4. To qualify for subsidies, all information on the output and performance of all renewables energy facilities must be available to organisations tasked by Parliament with ensuring the energy grid systems are balanced and can deliver secure, reliable energy in a cost effective manner.
5. Costs and subsidies to achieve decarbonisation should come from progressive general taxation (including corporation tax) and not from the current system of adding costs to household energy bills.

(Lammey, 2019)

In November 2019, EDF announced it would award a contract for the manufacture of around 15 per cent of the jackets to the local company, with the rest going to the Indonesian company (GMB Union, 2019).

Local content policy in relation to offshore wind in the UK has traditionally been market-driven, with no binding local content targets. Leahy *et al.* (Leahy *et al.*, 2020) argue that this approach is what has allowed the UK to become the global leader by installed capacity, despite criticism that greater economic benefit could have been achieved. Developers are under pressure to keep costs down, which ultimately benefits consumers. As such, they must award contracts to the most competitive tenderers. This may not necessarily be popular, but the approach has been successful in the UK (and also in China and elsewhere) in allowing the domestic market to develop, and local content across the UK offshore wind sector has increased from 32% in 2016 to 50% in 2020 (Noonan and Smart, 2017; Leahy *et al.*, 2020). Conversely, local content requirements in France meant early projects were significantly more expensive than projects in other markets at that time (Leahy *et al.*, 2020). With the result, there have been extensive delays to these projects as renegotiations of the contract terms took place.

A key activity that has contributed to the increase in UK content and the overall growth of a globally competitive supply chain is the growth of regional offshore wind clusters. Initially, these developed organically, but more recently, the UK has adopted a more strategic approach to cluster development involving collaboration between developers and regional supply chain companies, the public sector and education bodies. The approach is set out in the UK Offshore Wind Sector Deal, a joint government-industry agreement launched in 2019 to boost productivity and earning power in the UK's offshore wind industry. As part of the deal, developers and regional supply chain companies are working closely with local regional agencies, devolved administrations and economic development agencies to identify areas of UK advantage and define specific infrastructure and investment requirements that would allow them to support increased earning power in local communities. One year on from the launch of the deal, there are eight regional clusters across the UK. In the DeepWind (North Scotland) cluster alone, there are currently over 290 members drawn from industry, academia and the public sector. The success of the collaboration is a result of active participation by industry and government commitment at all levels.

Green Port Hull is a good example of how such collaboration can benefit the local economy. Green Port Hull is a partnership between Hull City Council, East Riding of Yorkshire Council and Associated British Ports, with the support of the University of Hull, that seeks to establish Hull and the East Riding of Yorkshire as a world-class centre for renewable energy. It was formed in 2010 after the announcement of Round 3 of The Crown Estate's commercial leasing programme. In 2012, Hull City Council and East Riding of Yorkshire Council secured £25.7million in funding from England's Regional Growth Fund to support their vision (University of Hull, 2017). This led to the formation of the Green Port Growth Programme, which provided a range of supports to drive business development and investment in renewable energy for the local area, including funding for training, land for site assembly, business support and advice, and support for R&D. The decision by Siemens to locate a manufacturing facility at Alexandria Dock, in partnership with Associated British Ports, was among the catalysts for Green Port Hull and the Green Port Growth Programme. Together, Siemens and Associated British Ports invested £310m in the blade manufacturing facility, which has been in operation since 2017. The University of Hull assessed the social, environmental, and economic impacts of Green Port Hull using the blade factory investment as a case study (Barnard *et al.*, 2018; GIA, 2020). The factory created 1,063 direct jobs and has contributed up to £71.3m to the GVA of the local area. Between 2017 and 2018, 780 apprenticeships were created, with 85% of apprentices between 18 and 19 years of age. In addition, engineering manufacturing Level 3 qualifications increased, with 66.7% growth from 2012/13 to 2016/17. The University of Hull assessment showed that the Green Port Growth Programme exceeded its contracted targets and overachieved on the jobs created/safeguarded and businesses supported targets. The programme ended in 2019.

While offshore wind development has undoubtedly had a positive economic impact on many coastal communities in the UK, one issue that has received widespread attention is the impact of offshore wind projects on fishing activities. In the UK, fishing is not prevented within OWFs. However, fishing activity within OWF boundaries has been affected to some extent. In 2016, the Crown Estate (CE) commissioned the National Federation of Fishermen's Organisations (NFFO) to conduct a study on changes to fishing practices in the eastern Irish Sea as a result of the development of offshore wind farms. Grey *et al.* (2016) analysed vessel monitoring system (VMS) and other fisheries data, circulated questionnaires, and interviewed fishermen whose activities occur within or near the boundaries of the six operating wind farms and export cable routes in the eastern Irish Sea. They found that a majority of fisherman claim to have reduced their efforts within OWFs due to the hazards associated with fishing in these areas, including the risk of snagging trawl gear on cables, rock armouring of cables and general seabed debris, together with the risk of collision with turbines in the event of engine failure. There was evidence of a decline in Nephrops trawling following the construction of the Walney 2 wind farm off the Cumbria Coast, but other declines in fishing activities were not directly attributed to OWFs. The authors suggested several measures that could be taken to help to increase the level of co-existence between the fishing and offshore wind farm industry, including improved mapping of potential seabed hazards, timely provision of seabed maps showing precise location of potential hazards, and proactive identification of clean and cable-free corridors between the turbines that could be suitable for mobile gear.

In the UK, best practice guidance for developers on fisheries liaison is available from the Fishing Liaison with Offshore Wind and Wet Renewables Group (FLOWW) (FLOWW, 2014). FLOWW was set up in 2002 to foster good relations between the fishing and offshore renewable energy sectors and to encourage co-existence between the offshore wind and fishing industries. It is made up of a range of government and industry stakeholders. When implemented strategically, suggested measures can help to limit the negative impacts of OWF development on fishing activities. For example, Grey *et al.* (2016) found that some fishermen appreciated indirect compensation measures taken by developers, including:

- financial compensation for loss of fishing,
- work opportunities arising from guard ship duty and survey work, and
- shore side improvements through the West of Morecambe Fisheries Fund, which financed the installation of ice plants at Maryport and Barrow and contributed to a reduction in the cost of fuel at the Whitehaven Fishermen's Cooperative-leased fuel facility.

However, a majority felt there were no positive impacts of offshore wind farms.

Ongoing research as part of WP3 of the Eirwind project is exploring the potential impacts of offshore wind on the Irish fishing industry and will provide insight into opportunities and constraints in an Irish context.

3.2 USA

There is only one operational offshore wind farm in the US, although, according to the American Wind Energy Association (AWEA), over 26,000 MW were in the pipeline as of December 2019, with 14 projects expected to become operational by 2026 (AWEA, 2019).

The 30MW Block Island offshore wind farm (BIWF) in Rhode Island was completed in 2016 (figure 3.1). Located approximately 5km from the small island community of Block Island and about 26km from the mainland Rhode Island coast, it is comprised of 5 turbines. The project received widespread public support both before and after construction, with the greatest level of support coming from the local Block Island community (Firestone *et al.*, 2018). The Block Island community benefited from the project in several ways. Prior to construction, Block Island was isolated from the mainland electricity grid and relied on four diesel power generators for electricity. As a result, the islanders paid some of the highest power rates in the US, nearly five times the national average in peak months, and the supply of electricity was not reliable (Firestone *et al.*, 2018; ten Brink and Dalton, 2018; Browning *et al.*, 2019). In May 2017, the generators were shut down and the Island began receiving power from the BIWF[4]. Since then, there has been a reduction to Block Island residents' electricity bills by $25-30 per month, although the project has been blamed for an increase in mainland power rates (Trodson, 2018; Browning *et al.*, 2019). The installation of subsea cables also gave islanders access to high-speed internet for the first time. Studies on the social impacts of the project showed that local residents and businesses considered this a key benefit of the project (Klain *et al.*, 2017; Smith *et al.*, 2018). A reduction in air and noise pollution on one part of the island, as a result of the elimination of the diesel power generation, was also considered a benefit (Firestone *et al.*, 2018; Carr-Harris and Lang, 2019).

Block Island is home to a year-round population of around 1,000 residents, but hosts up to 20,000 individuals at the height of the summer tourist season (Firestone *et al.*, 2018). During the planning and public consultation phase of the BIWF project, the potential impact of the project on tourism was a concern. Recent studies suggest, though, that the project actually had a positive (or at least, neutral) impact on tourism (Smith *et al.*, 2018; Carr-Harris *et al.*, 2019). Using a mixed methods approach, including participant observation and stakeholder focus groups, Smith *et al.* (2018) observed seasonal visitors found the wind farm to be appealing, with numerous tourists having expressed an interest in seeing the turbines and having visited sites specifically to view the wind farm. This has opened up opportunities for local mariners and fishermen, who reported adding trips to the wind farm as a special offering, often by request (Klain *et al.*, 2017; Smith *et al.*, 2018). Smith *et al.* (2018, p. 313) quote one charter boat captain:

[4] After BIWF was completed, one local fishermen was quoted: "…as my wife is quick to point out, we're getting a constant flow of electricity. With the generators, it was always going up and down…Nobody on Block Island, when they were running the diesel generators, could use an electric clock, because it would not keep time…That also wore heavy on your appliances.…and now it [electricity] is consistent" (ten Brink *et al.*, 2018)

"It is like a tourist item, an attraction. We fish, but we go to the wind farms to get close to them, to look at them. People are interested in them. It has enhanced my business, that part of my business."

Other businesses, including the Block Island Ferry and local helicopter charters, have also benefited through the addition of new tours around the wind farm (Block Island Ferry, 2020; Heliblock Tours, 2020).

Figure 3.1 Block Island offshore Wind Farm. [Source: https://electrek.co/2016/12/13/americas-first-offshore-wind-farm-powers-up-in-rhode-island-deepwaterwind-will-cut-rates-40-take-island-off-diesel/]

Carr-Harris *et al.* (2019) took a more quantitative approach to analysing tourism impacts using data from AirBnB. They found that post-construction, there was a significant increase in nightly reservations, occupancy rates, and monthly revenues for AirBnB properties in Block Island during the peak-tourism months of July and August. While they argue that this increase is due to the construction of BIWF, there may be other factors at play. However, the findings do suggest, at least, that the project did not have a negative impact on the industry.

Another concern related to the project was the potential impact of BIWF on fishing activities. Prior to construction, commercial fishing activities around Block Island were limited around the BIWF site, with only a small portion of vessels historically fishing in the area. However, tens of thousands of individuals participate in recreational ocean fishing in and around Block Island waters (ten Brink *et al.*, 2018). Fishing activities are not restricted in the area where the turbines are located. ten Brink *et al.* (2018) recently undertook a study to assess the perceptions of commercial and recreational fishers and the potential ecological impacts following the construction of the BIWF. They interviewed 25 fishers who fished in the area. Their findings suggested that the impacts of the BIWF were unevenly distributed among different fishing sectors, with overall positive impacts for recreational fishers and negative impacts for commercial fishers. Following construction, the BIWF attracted an influx of recreational fishermen, who were attracted to the novelty of the turbines and felt the fishing grounds were now more productive due to the turbines acting as artificial reefs. As a result of this influx, though, commercial fishermen felt crowded out, making them feel that they had lost productive fishing ground. During construction, although commercial fishers were compensated by the developer for lost income while certain areas were closed, they were disappointed when they were not compensated further due to delays associated with cable laying activities. Commercial fishers also had similar concerns to those raised by Gray *et al.* (2016) in the UK in relation to turbines as a navigational hazard, although recreational fishers did not share this concern. Recreational fishers reported they noticed a greater abundance and variety of fish in the area, which they attributed to artificial reef building. Both commercial and recreational fishers agreed the BIWF had little to no ecological impact on fisheries. Ongoing research by David Bidwell at the University of Rhode Island, which has yet to be published, echoes these findings (Prevost, 2019). It should be noted, though, that these results are based on a limited number of subjective reports, and only time will tell if there are any long-term ecological impacts on fishing in the area.

The US is currently gearing up to expand its offshore wind capabilities and build a globally competitive supply chain. For example, New Jersey governor Phil Murphy recently announced plans to develop the Wind Innovation and New Development (WIND) Institute, a non-profit centre for education, research, innovation and work force training (New Jersey Wind Council, 2020). Governor Murphy established a council made up of representatives from relevant public bodies tasked with developing and implementing the plan, which, it is hoped, will create a regional hub for New Jersey's offshore wind industry. The WIND Institute will be funded by a combination of state funding, federal funding, and, where appropriate and feasible, philanthropic funding.

3.3 Germany

Second only to the UK in installed capacity, there are 22 commercial wind farms operating in Germany as of January 2020. The industry is quickly becoming a significant contributor to Germany's economy, with turnover along the value chain rising from €5.9 billion in 2010 to €9 billion in 2018 (Stiftung Offshore Windenergie, 2019; Wehrmann, 2019). The latest figures show the industry has created 26,000-30,000 jobs in Germany (BWE, 2018; Klay, 2019; Kriener, 2019). These are not only in operations and maintenance, but also in the manufacture of components such as bearings, gearboxes and generators. Upgrades and expansions to ports on the North Sea and Baltic coasts have further facilitated industry growth, for example in the provision of facilities for building special ships to service the industry (OECD, 2016). In the wake of the German shipyard crisis, a period of economic difficulty for shipyards which peaked during the Great Recession, the offshore wind industry has provided an antidote, saving many yards from imminent closure (Fornahl *et al.*, 2012).

The development of offshore wind in Germany is part of the Energiewende, the country's planned transition to a low-carbon economy. Part of this transition involves the provision of state aid to renewable energy operators to get projects off the ground. This is financed by consumers in the form of the EEG surcharge (renewable surcharge) on their electricity bills. The overall idea is that costs will decrease as renewable energy industries and technologies develop, until eventually there is no need for public support. Facilitated by the transition from fixed feed-in tariffs to auctions, this situation is now playing out in Germany (as well as in the Netherlands), where the first generation 'subsidy-free' windfarms are now being commissioned (Klay, 2019). While the EEG surcharge remains high, it is expected to drop after 2021, when support committed for more expensive projects in the early 2000s will begin to expire (Hein, 2019).

The Energiewende, though, has not been popular amongst some stakeholder groups. Germany remains a world leader in the mining of lignite, or brown coal (Eddy, 2018). The Energiewende, by definition, has had a negative impact on this industry, resulting in the ongoing closure of coal-fired power stations and job losses in the mining sector. This has led to protests in the economically depressed eastern states, where the mining regions sit (Eddy, 2018). The government has set up a special commission to work with those affected by the closures (Reitzenstein and Popp, 2019). The commission recently proposed a number of measures to support lignite mining regions, including improvement of local transport connections, entrepreneurial support, settlement of research facilities, and skills training (Wehrmann and Wettengal, 2019). Germany plans to close all coal-fired power stations by 2026 (Wacket, 2019).

Offshore wind development requires skilled labour, and, in the early days, Germany struggled to keep up with demand (Hockenos, 2017). Several new academic and vocational programmes and special training centres have sprung up in recent years (IWR, 2020). The demand for such training has created new employment and business opportunities. Germany has the third most certified Global Wind Organisation (GWO) training providers in Europe, surpassed only by Spain and the UK[5] (GWO, 2020). In an effort to learn from the German experience and avoid skills shortages ahead of upcoming commercial developments, Norwegian industry, government, and R&D stakeholders are coming together to identify industry requirements and opportunities to diversify from the oil and gas industry (Hanson and Normann, 2019; NOWC, 2019).

In addition to providing employment and business opportunities, offshore wind projects have directly benefited communities in Germany. Through community buy-in of offshore projects, municipalities can profit from offshore renewable developments. German examples include the Global Tech 1 and Trianel Borkum Phase 1 projects. Almost 75% of the Global Tech 1 wind farm shares are owned by three municipal energy providers (Global Tech 1, 2020), and 100% of the Trianel Borkum Phase 1 project is owned by a group comprising 33 municipal utilities and regional energy suppliers from Germany, the Netherlands, Austria and Switzerland (Trianel, 2020). Community co-ownership ensures the benefits of offshore wind projects are distributed locally and equitably (Yildiz *et al.*, 2019).

A final note on the German experience relates to visual impact. Almost all offshore wind farms in Germany are located very far from the coast, and environmental specifications make it nearly impossible to be granted permission to build an offshore wind project close to the coast (within the 12nm zone) (Nkomo, 2018). As a result, the impact of offshore wind farms on coastal landscapes in Germany is extremely limited. This may explain the high levels of public acceptance of offshore wind farms in Germany (Sonnberger and Ruddat, 2017).

3.4 China

China is a world leader in wind power generation and is third in the world in installed offshore wind capacity (deCastro *et al.*, 2019). The industry is in a rapid growth phase, with over 1GW of capacity installed in 2017 alone. This is underpinned at the national level by the Chinese government's 13th Five-Year Plan on Renewable Energy Development (2016-2020), which sets several targets to promote the transition to renewable energy in China. It is also part of the country's efforts to reduce air pollution. According to The Wind Power database (https://www.thewindpower.net/), there are currently 45 operational OWFs, 32 under construction, 79 approved, and 95 planned.

[5] The top three countries with the most certified GWO training providers in Europe are Spain (62), UK (48) and Germany (29). Ireland has four.

The key socioeconomic impacts of offshore wind development in China relate to supply chain development and job creation. Perhaps due to the nascence of the sector, there is a dearth of studies on other observed socioeconomic impacts to date. Through its top down approach to governance, the Chinese government has made efforts to limit stakeholder conflict, which could also potentially explain the lack of available information on the impacts of offshore wind on other sectors, although these are not dissimilar from their European counterparts. For example, regulations on offshore wind specify exclusions zones in areas designated for other commercial or military uses and promote co-location in designated offshore wind zones (Ou *et al.*, 2018; deCastro *et al.*, 2019).

The real strength in China's offshore wind sector lies the development of a well-developed domestic supply chain, where the sector has created new business opportunities, attracted foreign direct investment from European companies, and allowed for the growth and expansion of existing companies already serving the onshore wind sector (He *et al.*, 2016; Teh, 2018). Key areas of activity include manufacturing (*e.g.* turbines, blades, gearboxes, etc.), investment and financing, electricity transmission, and marine construction (He *et al.*, 2016).

The growth of the supply chain has been supported by Chinese policy support at the national, provincial and city level, significant industry and government investment in R&D activities, and a boom in business incubators (Teh, 2018). Provincial and city level support mechanisms for supply chain development include:

- Development of offshore wind industrial zones, including key facilities
- Active inward investment incentives to build local competency
- Direct funding to provincial companies for development activities and infrastructure development
- Development of dedicated port facilities

(Teh, 2018)

The development of industrial wind parks by local governments, such as in Jiangsu and Zhejiang province, has promoted the development of industrial offshore wind clusters, where business is booming (He *et al.*, 2016). Local governments are keen to attract companies to their local area to promote economic development and create jobs (Ydersbond and Korsnes, 2014). Government incentives have attracted China's leading companies in the sector to set up their industrial bases within designated offshore wind industrial zones, for example turbine manufacturer Goldwind in Jiangsu and developers, including Three Gorges Group, CGNC, China Energy Conservation Group and Guangdong Electric Group, in Guangdong (Teh, 2018). It should be noted that the success of the development of the Chinese supply chain, though, is due in large part to the large size of the domestic market (Teh, 2018).

The rapid, ongoing development of the offshore wind supply chain (which is part of the wider wind energy supply chain) has created a new labour market in China. The employment impact of existing offshore wind development has not been quantified, but the government estimated that 800,000 people would be employed in the wind energy industry (includes onshore + offshore) over the course of its 13th Five-Year plan (2015-2020) (IEA, 2017). In an interview as part of a study on wind energy in China, an employee in the energy finance industry stated:

"From the government perspective they are going to have a huge employment problem, and a huge, huge social stability problem unless they can create new sectors that create jobs, and new avenues to ensure economic growth. This is one reason the government has supported China's wind industry."

(Ydersbond *et al.*, 2014, p. 100)

While the rapid industry growth is creating new employment opportunities, China still lacks skilled professionals that can meet the demands of the wind power industry (Wang *et al.*, 2012; Zhao *et al.*, 2016; Wu *et al.*, 2018). This is because there are limited skills training options available in China, with many technicians in the offshore wind power industry coming from other related industries, often with limited professional knowledge of offshore wind energy (Wu *et al.*, 2018). In the past, inadequate training of employees has been linked to accidents which, as the industry is in a rapid growth phase, have been increasing in frequency (Jin *et al.*, 2014; Ydersbond *et al.*, 2014).

3.5 Denmark

Denmark ranks with the UK, Germany and China as a world leader in offshore wind development. It has a relatively long history of operational projects dating back to the 1990s (Danish Energy Agency, 2017). Its status as a first-mover within wind power has led to the development of an advanced supply chain. It is home to the world's largest turbine supplier, Vestas Wind Systems A/S, and a majority of Siemens Wind Power manufacturing takes place in Denmark (Danish Energy Agency, 2017).

Due to its history and experience, Denmark presents an opportunity to examine the longer-term socioeconomic impacts of offshore wind development. Studies have shown that this history of experience of offshore wind farms in Denmark has actually increased public acceptance (Kuehn, 2005; Ladenburg, 2010). As with other countries examined in this report, key benefits of offshore wind development relate to the economic and employment impacts, although issues related to visual impact and the price of electricity remain worthy of attention.

Although Denmark's installed offshore wind capacity trails behind the UK, Germany and China, its supply chain is globally competitive and much of the success of the industry lies in the export market (IRENA, 2019). The Danish wind cluster comprises the whole value chain, from turbine manufacturers (such as Vestas) to developers (such as DONG Energy and Ørsted) to turbine and substation substructure designers and manufacturers (such as Bladt Industries, ISC Consulting Engineers, LICengineering and Semco Maritime). The cluster supplies 4% of Denmark's total exports and supports 33,000 jobs in manufacturing, installation, operations, and maintenance (Mortensen, 2018; Collier *et al.*, 2019). The employment impact of the industry has been cited as one reason for the high level of public support for offshore wind projects, particularly in areas with high unemployment (Kuehn, 2005), and the export opportunity and associated job creation is considered a macro-economic driver for offshore wind energy in Denmark (Danish Energy Agency, 2017). Jobs in the industry are considered high-quality due to the strong support of Danish unions, including the United Federation of Danish Workers (Collier *et al.*, 2019).

Communities and local enterprises have also benefited financially from offshore wind projects, some of which are partly or wholly owned by local wind turbine owners' associations such as Middelgrunden and Samsø (Danish Energy Agency, 2017). Benefits are generated through revenues from partial ownership of the wind farms. For example, 8,500 Danish citizens bought shares in Middelgrunden (built in 2000 outside Copenhagen), raising €23 million euros – half the project's total cost. Investors have recouped their investment and are now earning an approximate 7% annual return (Martin, 2017). In 2011, the Danish government established a law that wind farm owners must offer at least 20% of each project to local residents and enterprises (within 16km offshore) (Danish Energy Agency, 2017). Where projects achieve at least 30% community co-ownership, a higher-feed in tariff is available as an additional incentive. Despite these incentives (and the success of Middelgrunden), local uptake was not as widespread as anticipated. New rules from 2020 will favour compensation over community ownership (Krog Jensen, 2019).

Apart from economic and employment impacts, socioeconomic studies on offshore wind energy in Denmark cite other concerns around (1) the high price of electricity, particularly to industry, as a consequence of subsidies to fund wind power (Kuehn, 2005; Klinge Jacobsen *et al.*, 2019), (2) visual impact (Ladenburg, 2008), and (3) potential impacts on tourism and other sectors (Kuehn, 2005). Like in Germany, offshore wind developments are subsidised by electricity consumers. In Denmark, this comes in the form of the Public Service Obligation (PSO) tariff on consumers' total electricity consumption, which also funds other forms of renewable energy. An EU study on energy prices, costs and subsidies and their impact on industry and households estimates that the cost of financing subsidies for electricity production in Denmark has increased electricity costs for industry by 21-26% and for private households by 4% between 2008-2016 (Rademaekers *et al.*, 2018). These increases have sparked a cost debate on financing renewables, particularly for industry (Ropenus and Klinge Jacobsen, 2015). In response, the government introduced a reduction of the PSO component in 2014, which should decrease electricity costs to industry consumers (Ropenus *et al.*, 2015). A survey conducted by YouGov on behalf of the Danish Energy Association suggests that the majority of the Danish public are willing to pay more to support the green energy transition (Ropenus *et al.*, 2015).

Like elsewhere, visual impact is often a concern that drives public resistance to specific projects in Denmark (Klinge Jacobsen *et al.*, 2019). Despite recommendations by the Danish Energy Authority to locate large wind farms in areas where the visual impacts on the landscape would be limited, it is not always possible to do so (Danish Energy Authority, 1994). Kuehn (2005) found that the strongest argument against the Horns Rev and Nysted offshore wind farms was their interference with the experience of scenery. However, studies have shown that after the projects were commissioned, local residents found them to be acceptable (Kuehn, 2005; Ladenburg, 2008). Where residents can prove a loss in value of real estate induced by the installation of turbines, project developers are required by law to compensate residents (Ropenus *et al.*, 2015). In a study on the impacts of the Nysted and Rødsand II windfarms[6] on local property prices, Jensen (2018) found no impact on prices.

A final issue in the Danish literature relates to the impact of offshore wind on tourism. At Horns Rev, prior to construction, local authorities feared a decline in the tourist industry. However, a sociological study by Kuehn (Kuehn, 2005, p. 22) found:

"After erection of the wind farm, experiences show that the wind farm has not alienated the tourists. Tourists still pay visits to the area, and the fear of a decrease in the summerhouse prices has, this far, proven to be groundless; as the prices here have increased concurrently with the equivalent prices applying to other places in the country."

[6] located 9 km from the Baltic coast

More recently, the Danish wind industry has opened up new tourism opportunities. ‘Energy tourism’, a new niche of industrial tourism, is gaining ground in Denmark (Tornbjerg, 2019). Examples of activities around offshore wind include:

- Public and private tours of wind farms and coastal areas from which they are visible (e.g. Middelgrunden; Hvide Sande Tour-de-Wind; Esbjerg Harbour tour)
- Package tours of manufacturing facilities in West Jutland (see Tornbjerg, 2019)
- Museum and visitor centre exhibitions (e.g. Horns Rev offshore wind farm exhibition at Blåvandshuk; Information Centre at the Nysted harbour; Visitor Center Østerild (opened in 2017) near the Østerild Wind Turbine Test Field)

Commenting on offshore wind tourism, head of tourism in Lolland Municipality, Marie Louise Friderichsen, has said: “We are visited by many foreign delegations that are interested in seeing our green solutions, including offshore wind farms. Therefore, we have experienced a boost in what might be called business tourism as a result of our overall climate efforts. Moreover, we can disprove that setting up the wind turbines has had any negative effects on tourism, which generally continues to grow.” (Offshore WIND, 2016).

3.6 Summary

Table 3.1 provides a summary of the potential positive and negative consequences of offshore wind development, based on international experience from operational projects. These key benefits relate to business and employment impacts. Negative impacts can be avoided or mitigated by learning from past experience.

Table 3.1 Summary of observed socioeconomic impacts of offshore wind farms from UK, USA, Germany, China, and Denmark.

Potential positive impacts	Potential negative impacts
● Local job creation, including direct employment in offshore wind (e.g. Green Port Hull) and new opportunities for existing industries, such as charter tours and guard ship duties for fishermen (BOWL, 2017; Smith *et al.*, 2018) ● Supply chain development creates new business and employment opportunities (BOWL, 2017; Danish Energy Agency, 2017; Teh, 2018) ● Provision of high-quality jobs, where unions support the industry (Collier *et al.*, 2019) ● Establishment of community benefit funds (Beatrice Offshore Windfarm Ltd, 2017) ● Investment in local infrastructure (e.g. refurbishment of historical buildings in Wick Harbour, Scotland; provision of access to high-speed internet on Block Island, RI, USA) (Beatrice Offshore Windfarm Ltd, 2017) ● Decrease in energy costs for remote island communities (e.g. Block Island, RI, USA) ● Provision of a reliable energy source for small island communities (e.g. Block Island, RI, USA) ● Increase in (or neutral impact on) local tourism (e.g. BIWF) (Smith *et al.*, 2018; Carr-Harris *et al.*, 2019) ● Establishment of new, or enhancement of existing, fishing grounds due to turbines acting as artificial reefs (e.g. Block Island, USA) ● Opportunities for existing vocational and educational institutions to add new skills training certifications in offshore wind industry, or for new companies to offer same (creation of further employment and/or new business opportunities) ● Profits retained by communities where co-ownership models employed (e.g. Global Tech 1 and Trianel Borkum Phase 1 projects, Germany; Middelgrunden in Denmark)	● Overreliance on foreign labour/companies at the expense of local communities/businesses (Beatrice Offshore Windfarm Ltd, 2017; Lawrence *et al.*, 2018) ● Loss of jobs in other energy industries, especially where employment in a particular region is heavily dependent upon that industry (e.g. lignite mining in Germany) ● Use of unskilled workforce can result in accidents (*e.g.* China) ● Loss or limited use of fishing grounds, resulting in loss or decline in livelihoods from traditional activities (Gray *et al.*, 2016) ● Hazards posed to fishing vessels and gear (ten Brink *et al.*, 2018) ● Visual impact degrades aesthetic qualities in some areas (Kuehn, 2005) ● Increase in electricity prices for consumers (Rhode Island, USA; Germany; Denmark), although costs are expected to come down (Klay, 2019)

4 Offshore Wind Supply Chain

The lifecycle of a commercial offshore wind farm project can be broken down as follows:

- Project Development and Management
- Turbine Supply
- Balance of Plant Supply
- Installation and Commissioning
- Operation and maintenance (of turbines, foundations, and substation)
- Decommissioning

(BVG, 2019a)

In order to carry out these activities, developers require an effective supply chain – a system comprised of a network of suppliers, information, and resources that supports the delivery of a project from inception to completion. The supply chain can be conceptualised as a pyramid comprised of several tiers (figure 4.1). At the top of the pyramid is the owner/developer. Developers often (but not always) partner with a main contractor, who provides engineering, procurement and installation services, including sourcing and managing contracts with sub suppliers. These are called EPIC (or EPCI or EPC) contractors. EPIC contractors are often involved in other maritime industries, such as oil and gas, so already have experience in offshore engineering. European companies include EPC Management (Denmark), Van Oord (Netherlands), and DEME Offshore (Belgium). There are no EPIC contractors with experience in offshore wind based in Ireland. It is expected that in the coming years, most Irish companies will seek to become suppliers to the developers or EPIC contractors or their lower tier suppliers (Leahy *et al.*, 2020).

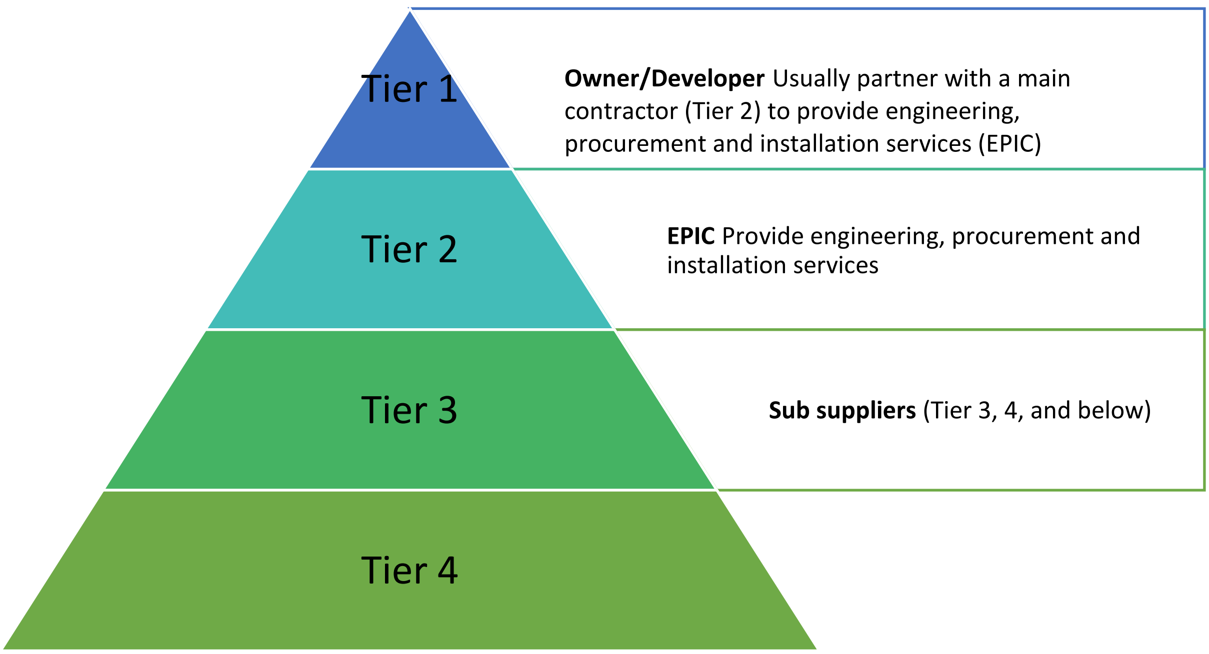

Figure 4.1 Offshore wind supply chain tiers (adapted from O'Neill *et al.*, 2012)

Companies involved in the lower supply chain tiers supply products and services related to structural components, engineering services, marine services, support vessels, storage services, quayside works, etc. These companies may be contracted directly by the developer, under a multi-contract strategy, or by EPIC contractors, under an EPIC strategy, or, for the lower tiers, by the sub-suppliers of the developers or EPIC contractors. Other important elements of the offshore wind supply chain, apart from developers and their suppliers, include financial institutions/investors, R&D institutes, and ports.

The offshore wind supply chain is part of a global market, and very few countries have full supply chain capabilities at the sub-national level. As a result, developers often source much of their needs from foreign suppliers. This has resulted in criticism in some places from some stakeholder groups (see section 3 of this report), which has led to the imposition of statutory or voluntary local content requirements[7]. Local content policies require that a certain percentage of the value of a project is spent on domestically-manufactured goods or domestically-supplied services. On the one hand, this helps ensure money spent on a development is retained locally and supports local business and jobs. On the other hand, it can significantly increase the cost of developments, which may be passed on to consumers or tax payers, and undermine industrial competitiveness and overall employment in the long-run (OECD, 2019). The challenge for policymakers and developers is to achieve a balance between supporting the domestic supply chain and keeping costs down.

In countries with a limited offshore wind supply chain, such as Ireland, there are limited opportunities to source locally. Leahy *et al.* (2020) have called for a flexible approach to local content requirements for Ireland that would allow the market to develop organically, keeping costs down for developers and consumers, but also reward developers for their efforts to supply locally, where practicable. Rather than impose flat or statutory requirements, they have called for the government to consider local content as a basis for awarding support under the Renewable Energy Support Scheme (RESS) award process. Tenderers who demonstrate their efforts to supply locally (through the submission of a supply chain plan) would be scored higher than those who do not. The supply chain plans could then be used by government to identify the specific weakness in the Irish supply chain that should be addressed to increase local content. In a wider context, Ireland's domestic offshore wind market, even with 4.5GW of offshore wind installed by 2030, is small. According to Enterprise Ireland, the greatest supply chain opportunities for Irish companies lie in the export market (Liam Curran, *pers. comm*). However, with little domestic demand as yet, Irish companies have had limited opportunities to gain experience in the market.

This section of the socioeconomic report provides a general overview of existing and potential Irish capabilities in the offshore wind supply chain. This information is primarily derived from a detailed study by Leahy *et al.* (2020) commissioned by the Irish Wind Energy Association (IWEA). Estimates of local content from this study are key inputs in the economic and employment model presented in section 5 of this report. The section also reports on opportunities and requirements for local supply chain development.

[7] Local content is a term borrowed by the OW sector from the oil and gas industry to describe a company's or the government's commitment to build on the capacity and capability of local people and businesses to support the development of the sector.

4.1 Irish Capabilities

To understand where Irish content would sit in the context of a typical project, it is helpful to first have a general understanding of the overall cost breakdown of an offshore wind farm (figure 4.2). The cost of project development (DEVEX) and the capital expenditure (CAPEX) required to bring a project from the planning to the operational stage make up the majority of a projects costs, although the associated activities take place over a relatively short period of time (approximately 5 years). Operational expenditure (OPEX) is spread over the lifetime of the project, from the time the wind farm is commissioned until the time it is decommissioned, typically 25 years. The cost of decommissioning (DECEX) is estimated to make up only a small percentage of project costs. The overall cost of all of these activities together is estimated to be approximately £5bn[8] (c. €6bn) (BVG, 2019a).

Leahy *et al.* (2020) recently undertook an assessment of the existing and potential technical capabilities of all aspects of the Irish supply chain at different stages of an offshore wind farm project. They estimated that up to 22% of a fixed-bottom offshore wind farms supply chain could already be sourced locally. Figure 4.3 summarises Irish capabilities across different elements of the project lifecycle (Leahy *et al.*, 2020). The colours indicate the strength of the Irish supply chain (red=low, amber/orange=medium, green=high), and the percentages indicate the proportion of expenditure per project element[9]. The 'strength' of the Irish supply chain is rated based on an assessment of the number of companies operating (categorised as high, medium, low) and their level of experience in supplying the offshore wind industry (categorised as high, medium, low). The assessment was performed in consultation with Enterprise Ireland and other government and industry stakeholders. Opportunities for the floating offshore wind supply chain are discussed in section 4.2 of this report.

Given the technical capabilities of Irish companies (not taking into account market competition), Leahy *et al*. (2020) estimated that there is a high likelihood that Irish companies could supply ~5% of the CAPEX requirements and ~16% of the OPEX requirements for a fixed-bottom offshore wind development. Irish supply chain capabilities are already strong in some elements of project development and consent, such as environmental impact assessments, and operations and maintenance, particularly vessel and equipment supply, although capabilities are currently limited in other areas. There is potential for Irish companies to participate in some aspects of installation services, such as the provision of vessels for cable and turbine installation and the provision of port facilities for support structure and turbine installation. Capabilities are least developed in the areas of turbine supply and balance of plant supply.

[8] Undiscounted.

[9] The proportions of project expenditure used by The Carbon Trust are slightly different to those presented in figure 4.2 (from BVG), as they are based on different sources, and there will be some variability in costs between projects.

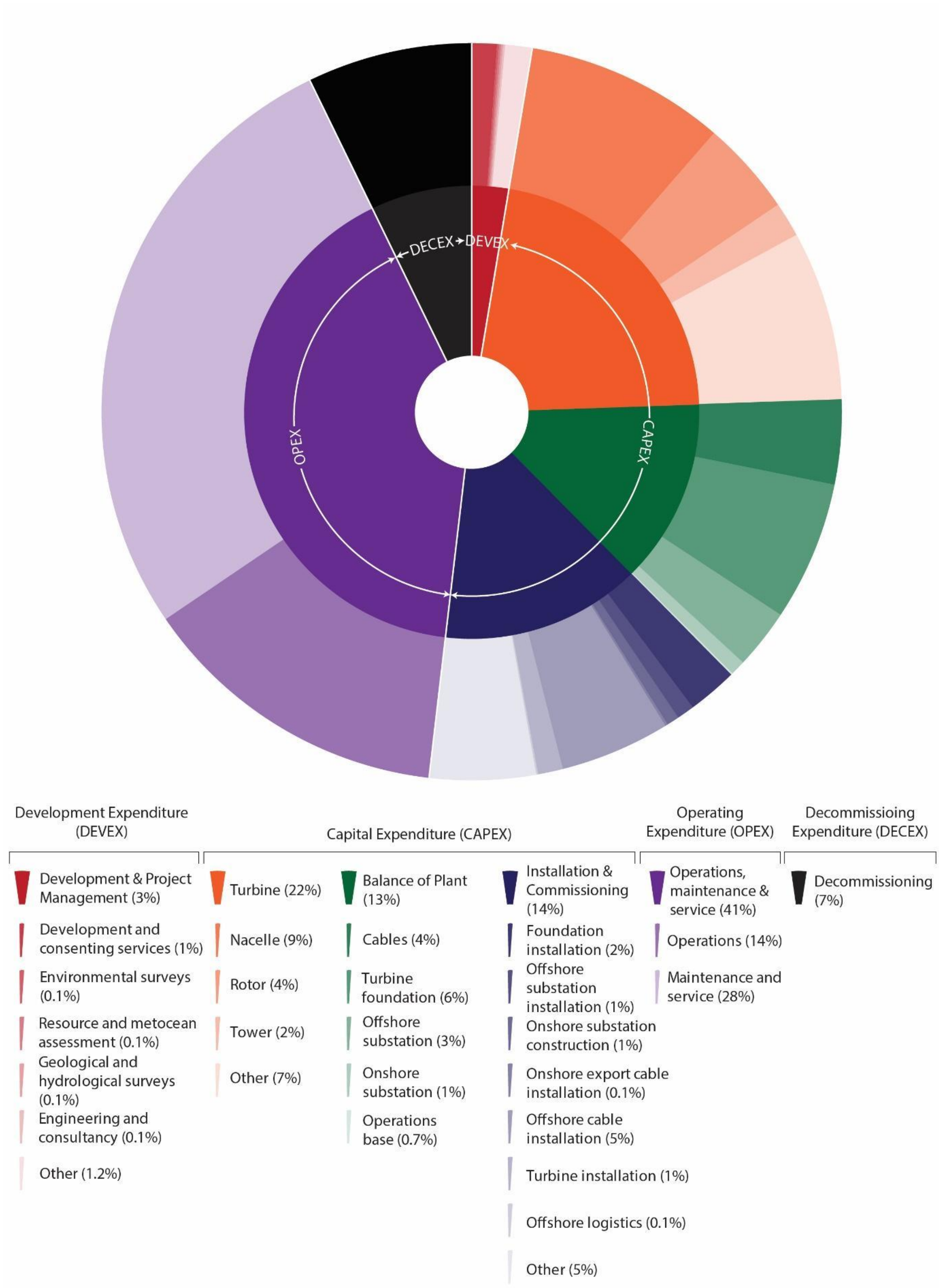

Figure 4.2 Typical breakdown in offshore wind project expenditure. Stated values are indicative, as there can be large variation in costs between projects. Note that figures are rounded, and, as a result, may not add up to 100%. [Data source: BVG (2019b)]

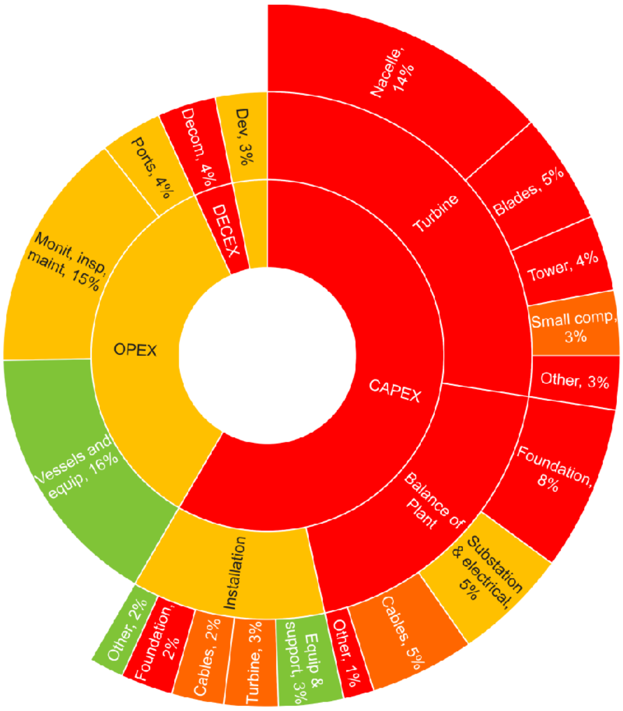

Figure 4.3 Strength of the Irish supply chain for bottom-fixed offshore wind. The colours represent the strength of the Irish supply chain per activity, rated based on an assessment of both the number of companies operating and their level of experience in supplying the offshore wind industry. Red= low, amber/orange = medium, green= high. [Source: Leahy *et al.* (2020)]

4.2 Opportunities for supply chain development

Opportunities exist to increase the capabilities of Irish companies to supply the domestic and export offshore wind markets. From the perspective of Irish companies, the greatest opportunities lie in the export market, as Ireland's domestic market is small. However, Irish companies must gain experience in the sector, which can be gained in the domestic market, to become competitive. As the domestic market develops, learning rates and investment in the supply chain can increase local content. Leahy *et al.* (Leahy *et al.*, 2020) have estimated the near term (up to 2025) and long-term (up to 2030) opportunities for Ireland's offshore wind supply chain, provided there is sufficient government and industry support.

Figure 4.4 shows the potential near-term opportunity for the Irish fixed-bottom offshore wind supply chain. To give an example of how this chart can be read, take operating (O&M) expenditure, which accounts for 35% of an overall project's costs. There is a high probability that just under half (46%) of O&M requirements (specifically, in relation to ports, vessels and equipment) could be sourced domestically, and a medium probability that just over half (54%) of O&M requirements (monitoring, inspection, and maintenance) could be sourced domestically in 2025. There is also a high probability that 100% of DEVEX requirements could be sourced locally. These areas represent the greatest opportunities for near-term domestic supply chain development, particularly in the areas of electrical system installations and other secondary installation services, such as support services and vessel supply. There are also other opportunities for growth in the provision of shipbuilding and repair services, the manufacture of secondary steel components, and cable and substation installation.

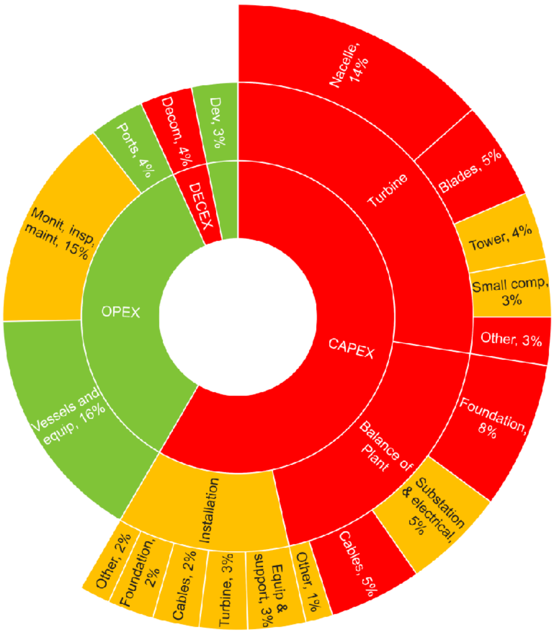

Figure 4.4 Potential near term (up to 2025) opportunity for the Irish bottom-fixed offshore wind supply chain. Red= low, amber/orange= medium, green= high. [Source: Leahy *et al.* (2020)]

Figure 4.5 shows the potential long-term opportunity (up to 2030) for the Irish fixed-bottom offshore wind supply chain. By this time, it is expected that a domestic supply chain could grow to capture approximately half of a project's total value. Such a scenario, though, will require significant supply chain support, including strong commitment from government, upgrades to port infrastructure, a strategic approach to the development of regional clusters at ports, and support for offshore wind related R&D, training and education to ensure there is a continuous supply of expertise (*e.g.* see Eirwind Deliverable D3.1 Initial Issues in the Development of Offshore Wind in Ireland).

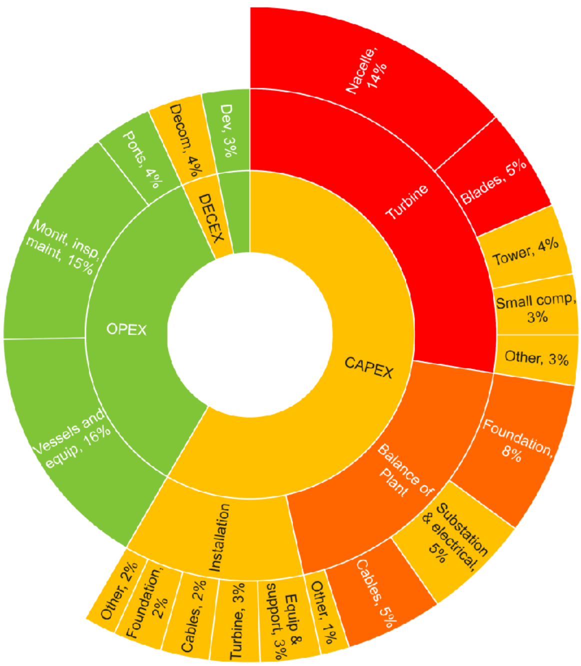

Figure 4.5 Potential long-term (up to 2030) opportunity for the Irish bottom-fixed offshore wind supply chain. Red= low, amber/orange= medium, green= high. [Source: Leahy *et al.*, 2020]

Ireland is also well placed to enter the emerging floating offshore wind energy market, which creates additional supply chain opportunities. If it can establish itself as an early mover in this space, Ireland can take maximum advantage of floating wind deployment across Europe. The first commercial floating projects in Ireland are expected to be commissioned by 2032. Ahead of that, the Atlantic Marine Energy Test Site (AMETS) in Bellmullet, Co. Mayo will be able to accommodate floating wind demonstrations, and the AFLOWT (Accelerating market uptake of Floating Offshore Wind Technology) project aims to have a full-scale floating offshore wind turbine installed in Belmullet by 2022.

Existing supply chain capabilities in this space are low, mainly centred around a few research institutes and engineering companies. However, there are potential long-term opportunities, particularly in O&M and installation (figure 4.6). These opportunities are likely to come from elements that are fully or partially synonymous with the fixed offshore wind long term opportunity.

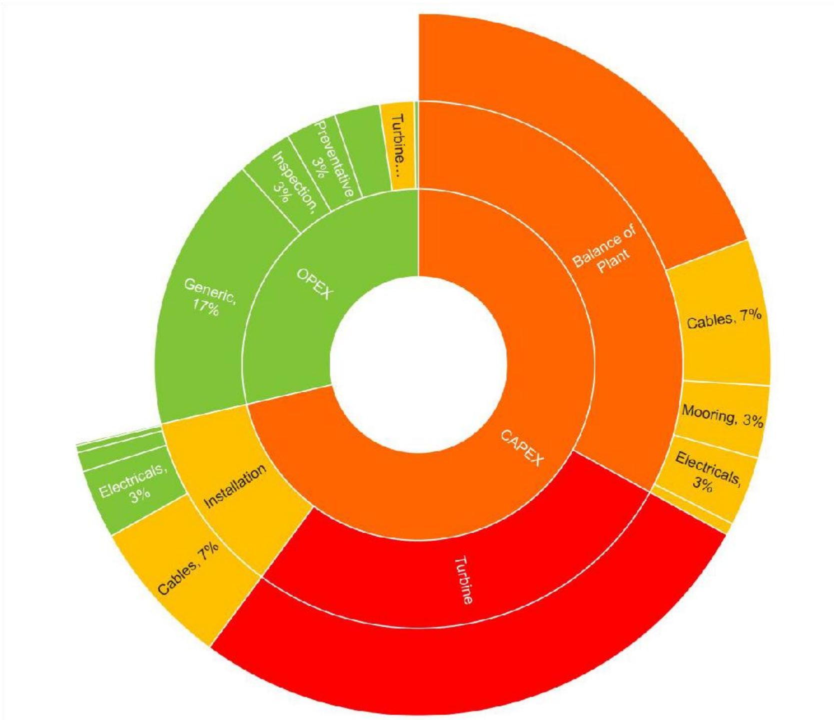

Figure 4.6 Potential long-term (2030 and beyond) opportunity for the Irish floating offshore wind supply chain. Red= low, amber/orange= medium, green= high. [Source: Leahy *et al.*, 2020]

There are clear opportunities for Ireland to maximise the socioeconomic benefits of offshore wind development through the growth of an indigenous offshore wind supply chain, particularly in the areas of project development, O&M, and installation and maintenance. Apart from the domestic market, there are gaps in the global market for innovative companies that can address industry challenges, such as cost reduction, which can be filled by Irish companies (O'Neill *et al.*, 2012).

Measures to support the near-term and long-term growth the supply chain include:

- Establishment of a route-to-market
- A clear consenting regime, to instil confidence in the sector
- Investment in port infrastructure

- Investment in R&D
- Development a skills base through the establishment and promotion of skills training programmes
- Encouragement of partnerships and joint ventures with international companies with experience in the sector
- Tax incentives
- The creation of a national brand for the sector, which could be marketed internationally, and would demonstrate a national commitment to the sector, as recommended by O'Neill et al., 2012.

5 Economic and employment potential for Ireland

One of the key goals of the Eirwind socioeconomic study is to understand and quantify the economic and employment benefits from the development of offshore wind farms in Ireland. To address this, a value chain analysis was undertaken. This involved the development of an economic model that could be used to estimate domestic GVA and employment impacts associated with planned future developments. The model is based on the best available information about development costs, wages, and Irish supply chain capabilities. The rationale for this work is that there is a need for industry and policymakers to understand the potential socio-economic impacts of offshore wind development for Ireland in order to evaluate the social return on investment.

Modelled outputs suggest that by 2030, 2.5-4.5GW of domestic offshore wind development could create between 11,424 and 20,563 supply chain jobs and generate between €763m and €1.4bn in gross value added (GVA). If the scenarios modelled in this study were to be realised and current trends for other ocean economy sectors were to remain constant, direct and indirect GVA from offshore wind development could exceed that of the marine advanced technology products and services sector, the marine manufacturing, construction and engineering sector, the sea fisheries sector and marine retail services sector by 2030. This would contribute significantly to Ireland's Harnessing Our Ocean Wealth target of doubling the value of Ireland's ocean economy by 2030 (Inter-Departmental Marine Coordination Group, 2012).

As the above figures are a forecast, it is important to understand the model assumptions and constraints. For example, modelled outputs are sensitive to changing market conditions, which is an important constraint given the dynamic nature of the global offshore wind energy market. This section of the report details the methods, results, and limitations of the value chain analysis. The Excel-based model can be used by industry and policymakers to explore scenarios outside of those modelled here.

5.1 Approach

There are various methods available for assessing job creation and GVA impacts of renewable energy developments. This paper uses a value chain analysis as it is considered most appropriate for the emerging Irish offshore wind energy sector. Other approaches include employment ratios, input-output (IO) modelling and other complex economic models, such as computable general equilibrium (CGE) models.

Employment ratios (or employment factors) can be used as a first-order estimate of job creation potential. They represent employment generated (in person-years or full-time equivalents) per unit of installed capacity (Jenniches, 2018). Using known employment factors, for example from existing developments, employment impact for a similar proposed development can be estimated by multiplying the planned investment or capacity by the employment ratio for the existing development.

The advantage of this approach is that it is relatively simple. The only required inputs are the planned investment or capacity and a known employment ratio. The drawback of this approach, though, is that there can be large differences between ratios, even for the same technologies (Dalton *et al.*, 2011; Jenniches, 2018). Ratios valid in one geographical area may not necessarily be the same for another, especially in different economies.

In a review of reported ratios of jobs/MW for offshore wind studies across Europe, Dalton and Lewis (2011) found that values can range from 3.9 to 47 jobs/MW. Such variations may arise due to the data used, the modelling method, the size of an economy, technological maturity, technology type, or the types of jobs included (direct, indirect and/or induced).

A more widely employed approach to economic impact assessments is input-output (IO) modelling (for example, Noori *et al.*, 2015; Mukhopadhyay *et al.*, 2017; Varela-Vázquez and del Carmen Sánchez-Carreira, 2017; Faturay *et al.*, 2020). Based on the work of Leontief, IO analysis uses tables of use and supply, known as input-output tables, to model the flow of goods and services between the industries of a national economy. In Ireland (and elsewhere), IO tables are only available at high sectoral aggregation level and are not available at sub-national level. Sectoral data are also only available based on traditional official classifications and so may not be appropriate for newly emerging technologies and sectors. For example, construction of an offshore substation for an offshore wind development could be categorised as 'construction' in the Irish supply and use tables, so any multipliers used in an IO analysis would include all activities in the construction industry. This is not entirely appropriate, as the construction of an offshore substation is a highly specialised activity that will likely impact the supply chain in different ways than more traditional construction activities. This lack of sectoral specificity can result in over- or under-estimation of economic impacts. For example, Roberts and Westbrook (2017) compared employment impacts calculated for wind turbine tower production in the UK using the IO model versus a value chain approach. They showed how the IO model overestimated employment impacts because the particular type of steel used in turbine manufacture is not produced in the UK. The multipliers in the UK supply and use tables are based on the premise that the UK produces much of the steel it uses domestically. Since the steel for the turbines cannot be produced in the UK, the IO model overestimated the impact.

IO table sectors may be disaggregated, where data are available, and some studies such as Lehr *et al.* (2015) have taken this approach, but this requires extensive data gathering where official statistics are unavailable. In Ireland there is an added issue that, because of its size, concerns have arisen about the confidentiality of businesses that may dominate particular sectors, so some sectoral classifications may be unavailable (MacFeely *et al.*, 2011: 70; de Bruin and Yakut, 2019: 8). Complex economic models, such as CGEs, can also be employed to model potential economic impacts, but these are often proprietary and computationally complex (de Bruin and Yakut, 2019). CGE models are more data intensive than other approaches and are hampered, similarly to IO approaches, by a lack of sectoral and/or regional disaggregation (Eiser and Roberts, 2002; Wittwer and Horridge, 2010).

An alternative approach that is perhaps most suited to the nascent Irish offshore wind energy sector is value (or supply) chain analysis. This is a cost-based method for assessing the economic impact of a project (or projects) over a given period (Breitschopf *et al.*, 2011). It is based on five key elements:

(2) expenditure on all products and services related to a development,
(3) the value breakdown, or the percentage of expenditure on labour, materials, and profits,
(4) the occupational breakdown of the labour expenditure for each element of the project(s),
(5) the cost of labour for each of the occupations, and
(6) the proportion of equipment, components and services supplied by domestic firms (local content).

The supply chain approach has been employed in the UK to model the monetary value and labour content associated with the renewable energy supply chain (DTI, 2004) and in the US to model job creation in offshore wind (BVG, 2019c). Roberts and Westbrook (2017) argue that this method is best suited to the offshore wind sector because it can take into account the unique and specific requirements associated with the offshore wind supply chain. These requirements may be overlooked when using conventional economic analyses, such as IO models, because they rely on data derived from established industrial sectors.

For this study, the Irish value chain model is based on the breakdown of expenditure on seven sub elements of offshore wind development:

- Project development and management
- Turbine supply
- Balance of plant supply
- Installation and commissioning
- Wind farm operation
- Turbine maintenance and service
- Foundation and substation maintenance and service

An Excel model was built to calculate annual direct and indirect GVA and employment potential for each sub element for fixed-bottom and floating wind projects, based on specified levels of annual installed offshore wind capacity and the degree of local content. Here, direct impacts refer to those generated by the owners of the wind farm asset and their primary contractors. Indirect impacts are those generated by suppliers and sub suppliers to the owners or their primary contractors. Induced impacts, from personal expenditure of the labour force, have not been considered in this study, although these can be calculated using an induced multiplier (Roberts *et al.*, 2017).

The total expenditure on each sub element of offshore wind development is estimated over the entire period for which associated activities take place. We assume a 5-year period of planning and development. Turbine and balance of plant supply takes place in year 3 of the planning and development period and installation and commissioning takes place in years 4 and 5. Wind farm operation and turbine, foundation and substation maintenance and service take place over a 25-year period. The overall lifetime of the modelled activities for projects installed in any given year is therefore 30 years (5 years of planning and development, including turbine and BOP supply, followed by 25 years of operations and maintenance).

Typical costs for a 1GW project of 100 10MW turbines were provided by BVG (2019a) (Appendix A). These are converted to euros and adjusted based on the modelled annual installed capacity. Annual costs are then adjusted to reflect the competing effects of discounting and learning (the reduction in costs due to a combination of economies of scale and learning-by-doing). The default values are a 4% discounting rate and a 2% learning rate, which can be adjusted if necessary. The proportion of annual expenditure on labour is calculated using the value breakdown (the breakdown of expenditure on labour, materials and profits) estimated by DTI (2004) for renewable energy projects. Annual profits are also estimated using this breakdown. The annual GVA impact is taken as the sum of annual expenditure on labour and annual profits (after Roberts *et al.*, 2017).

Only a proportion of the expenditure on supply chain requirements will be sourced domestically. This proportion represents the local content. As the Irish offshore wind sector develops, the proportion of local content is expected to increase. Existing and future Irish capabilities in the offshore wind supply chain have been assessed by Leahy *et al.* (2020) from consultations with government and industry stakeholders. They scored Irish companies' technical abilities to supply products and services to the offshore wind sector at the time of the research, in the near-term (by 2025) and in the long-term (by 2030) for fixed and floating projects.

Irish supply chain capabilities are categorised as low, medium, or high for each project sub-element. The total GVA content calculated by the model per annum per sub element is broken down according to the potential (low, medium, or high) that products and services for each project sub element can be provided by Irish companies. It should be noted that local content figures represent the technical capabilities of the Irish supply chain, and do not take into account market competition.

Employment is modelled using the estimated annual expenditure on labour, calculated from the total expenditure and value breakdown per sub element. There are different occupational requirements associated with each sub element of offshore wind development. Occupational breakdowns in the offshore wind sector have been estimated, for example, by BVG (2019c). For each occupation in that report, the total annual cost for one full-time equivalent (FTE) to an employer was estimated. This information was obtained from research by PayScale (2019) and the Central Statistics Office (CSO) (2018). The model then calculates the wage per occupation in a given year, taking into account annual increases in wages, with 3% set as the default. The total number of FTEs per annum per occupation is calculated by dividing the total annual expenditure on labour per occupation by the total annual cost to the employer per occupation, as per equation 1.

$$FTE_a = \frac{L_a}{Y_a + W_a} (1)$$

Where:

FTE_a = Annual FTE employment

L_a = Annual labour expenditure (€)

Y_a = Average annual wage (€)

W_a = Non-wage average annual cost of employment (includes statutory employers' social insurance, other social costs, benefits in kind, etc.) (€)

The total number of FTEs per annum per sub element is broken down according to the potential (low, medium, or high) for jobs to be created in Ireland by Irish companies, based on the assessment by Leahy *et al.* (2020).

The modelled outputs are summed into annual GVA and FTE figures, divided into high, medium, or low potential to be supplied domestically, from onshore and offshore projects.

5.2 Scenarios

Two scenarios were modelled for Ireland, based on installed capacity. The low scenario assumes Ireland's installed offshore wind capacity will reach 2.5GW by 2030 (e.g. after Eirgrid, 2019) and the high scenario assumes it will reach 4.5GW by 2030 (e.g. after DCENR, 2014). For both scenarios, operations commence in 2024 and the annual installed capacity remains constant until 2040 (figure 5.1). It is assumed that 25% of the annual installed capacity from 2026 onward is from commercial floating projects (Eirgrid, 2019; e.g. after EU NWE, 2019).

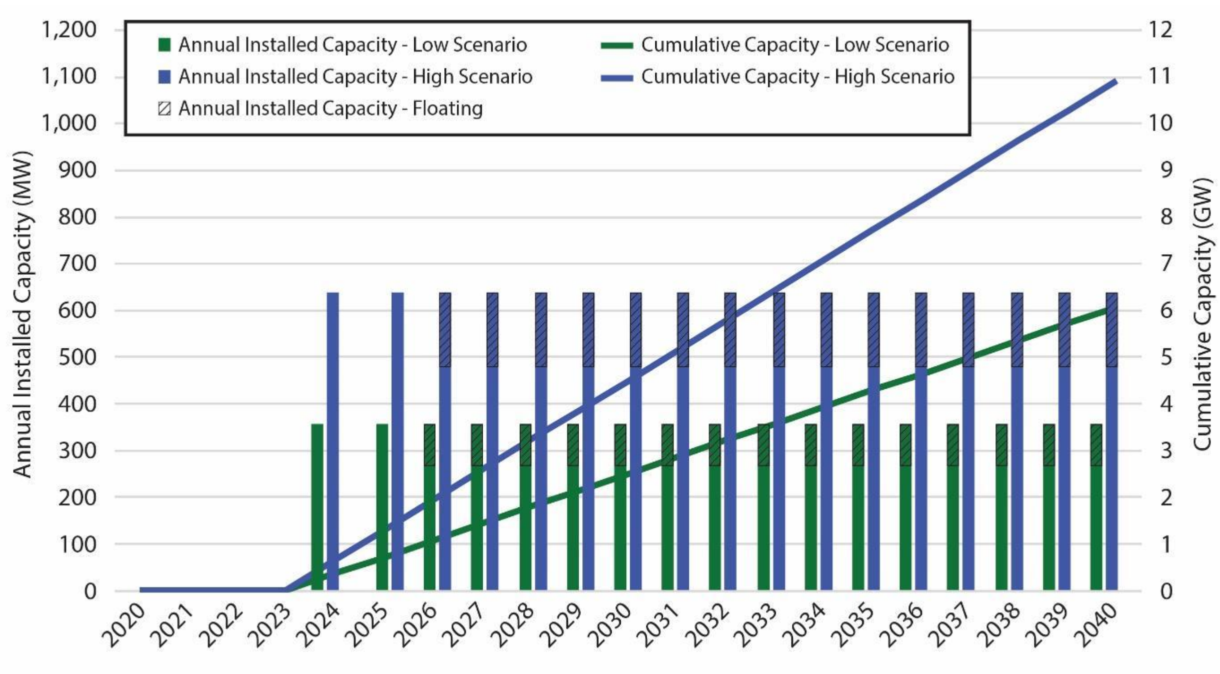

Figure 5.1 Forecast annual and cumulative offshore wind capacity in Ireland under the low and high scenarios.

Table 5.1 shows the proportion of potential domestic supply for each category of likelihood (high, medium, or low) that supply could be domestically sourced. The proportions are derived from research by Leahy *et al.* (2020). These were calculated by dividing the total cost to deliver each project requirement into the proportion of that cost associated with high, medium and/or low capabilities to supply associated products or services. For example, operations and maintenance costs account for approximately 35% of a project's total lifetime cost. Of this 35%, 46% of the expenditure is spent on vessels and equipment, 43% is spent on monitoring, inspection and maintenance, and 11% is spent on port services. According to the assessment by Leahy *et al.* (2020), Ireland currently has strong capabilities in relation to the supply of vessels and equipment, and medium potential to supply services related to monitoring, inspection and maintenance and port services. As such, it is assumed that there is a high likelihood that Irish companies can supply 46% of the O&M requirements and a medium likelihood that they can supply the remaining 54%.

Table 5.1 Proportion of potential domestic supply for each category of likelihood that supply can be domestically sourced. To give an example of how to read the table, for turbine supply for a fixed-bottom wind farm built between 2020-2024, there is a low likelihood that 90% of the supply could be sourced domestically and a medium likelihood that 10% of the supply could be sourced domestically. There is a high likelihood that none of the supply could be sourced domestically. Figures represent technical capabilities, and do not take into account market competition. Proportions have been calculated from research conducted by Leahy *et al.* (2020). Where capabilities are categorised as 'low', it is virtually certain that the corresponding proportion of associated requirements will not be supplied domestically.

		Project development and management	Turbine supply	Balance of plant supply	Installation and commissioning	Operations and maintenance
Fixed-bottom + Floating projects 2020-2024	Low	-	90%	47%	17%	-
	Medium	100%	10%	53%	42%	54%
	High	-	-	-	42%	46%
Fixed-bottom + Floating projects 2025-2029	Low	-	76%	32%	-	-
	Medium	-	24%	68%	100%	43%
	High	100%	-	-	-	57%
Fixed-bottom projects 2030 and beyond	Low	-	66%	-	-	-
	Medium	-	34%	100%	100%	-
	High	100%	-	-	-	100%
Floating projects 2030 and beyond	Low	-	100%	-	-	-
	Medium	-	-	100%	64%	7%
	High	100%	-	-	36%	93%

Where domestic capabilities are categorised as 'low', it is virtually certain that the corresponding proportion of associated requirements will not be supplied domestically. For example, Ireland currently has limited to no capabilities in relation to turbine and balance of plant supply. As a result, there is a low to medium likelihood that much of the turbine and balance of plant requirements will be sourced domestically for early projects. Domestic capacity in these areas is expected to increase as the supply chain develops, although it will likely remain limited for turbine supply due to the barriers to this market (Leahy *et al.*, 2020).

Where capabilities are categorised as 'high', the proportion of domestic share represents the maximum potential that could be achieved based on current capabilities and future supply chain development. The local content proportions represent technical capabilities and do not take into account market competition.

5.3 Results

Figure 5.2 shows the modelled potential domestic GVA impact under the (a) low and (b) high scenarios. In the near term (pre-2030), there is a high potential that domestically supplied products and services could result in a domestic GVA impact of between €763m (low scenario) and €1.4bn (high scenario) by 2029, with a mean annual domestic GVA impact of between €76m and €137m. This equates to c. 27% of the total GVA impact for activities carried out in the period 2020-2029. There is a medium potential for Ireland to secure an additional 46% of the total GVA impact, but it is not likely that Irish-based businesses will supply the remaining 27%.

In the longer-term (2030-2035), there is a high potential that domestically supplied products and services could result in a domestic GVA impact of between €2.6bn (low scenario) and €4.8bn (high scenario), with a mean annual domestic GVA impact of between €440m and €793m. This equates to c. 66% of the GVA impact for activities carried out in the period 2030-2035. There is a medium potential for Irish-based businesses to supply an additional 24% of the total GVA impact, but it is not likely that they will supply the remainder.

The increase in domestic GVA impact over time results from an increase in the number of operational projects coming on stream. Given Irish businesses' strong capabilities in O&M, which accounts for a large share of a project's lifetime cost, there is a high likelihood that Ireland can benefit greatly from offshore wind development. This is contingent on installed capacity reaching current targets, continuing to increase beyond 2030, and Irish companies ability to secure a significant share of the domestic market.

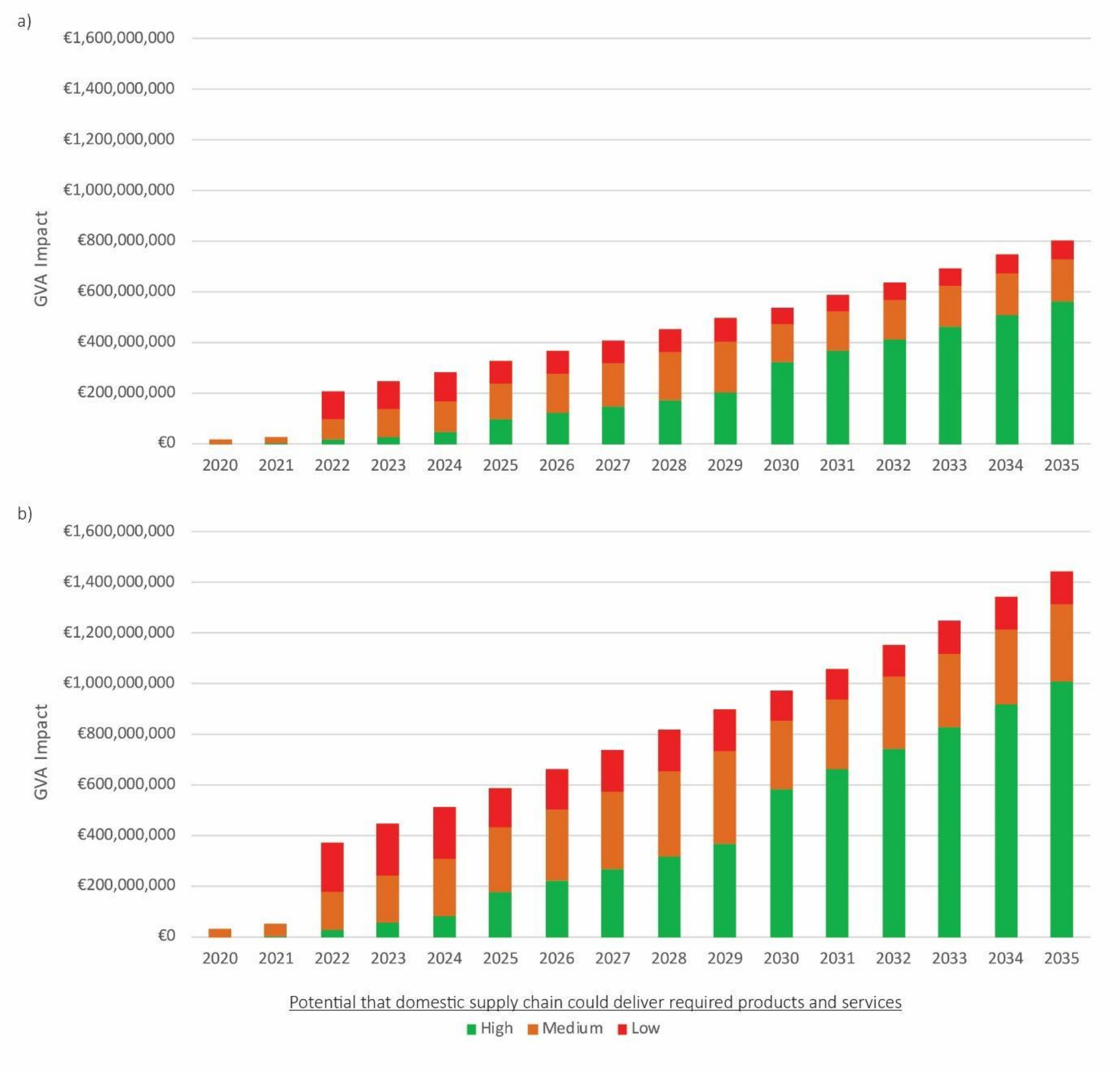

Figure 5.2 Potential GVA impact associated with the domestic supply of products and services for Irish offshore wind projects for (a) low and (b) high cumulative installed capacity scenarios. GVA impact is broken down by the potential for domestic suppliers to supply the required products and services.

Figure 5.3 shows potential domestic employment impact under the (a) low and (b) high scenarios. In the near term (pre-2030), there is a high potential that offshore wind development could create between 11,424 (low scenario) and 20,563 (high scenario) FTEs by 2029, supporting an average of 1,142 to 2,056 FTEs per annum. This equates to c. 33% of the total employment impact for activities carried out in the period 2020-2029. There is a medium potential for Ireland to secure an additional 46% of the total employment impact, but it is not likely that Ireland will secure the remaining 21%.

In the long term (2030-2035), there is a high potential that offshore wind development could create between 34,952 (low scenario) and 62,914 (high scenario) FTEs, supporting an average of 5,825 to 10,486 FTEs per annum. This equates to c. 76% of the total employment impact for activities carried out in the period 2020-2029. There is a medium potential for Ireland to secure an additional 16% of the total employment impact, but it is not likely that Ireland will secure the remaining 8%.

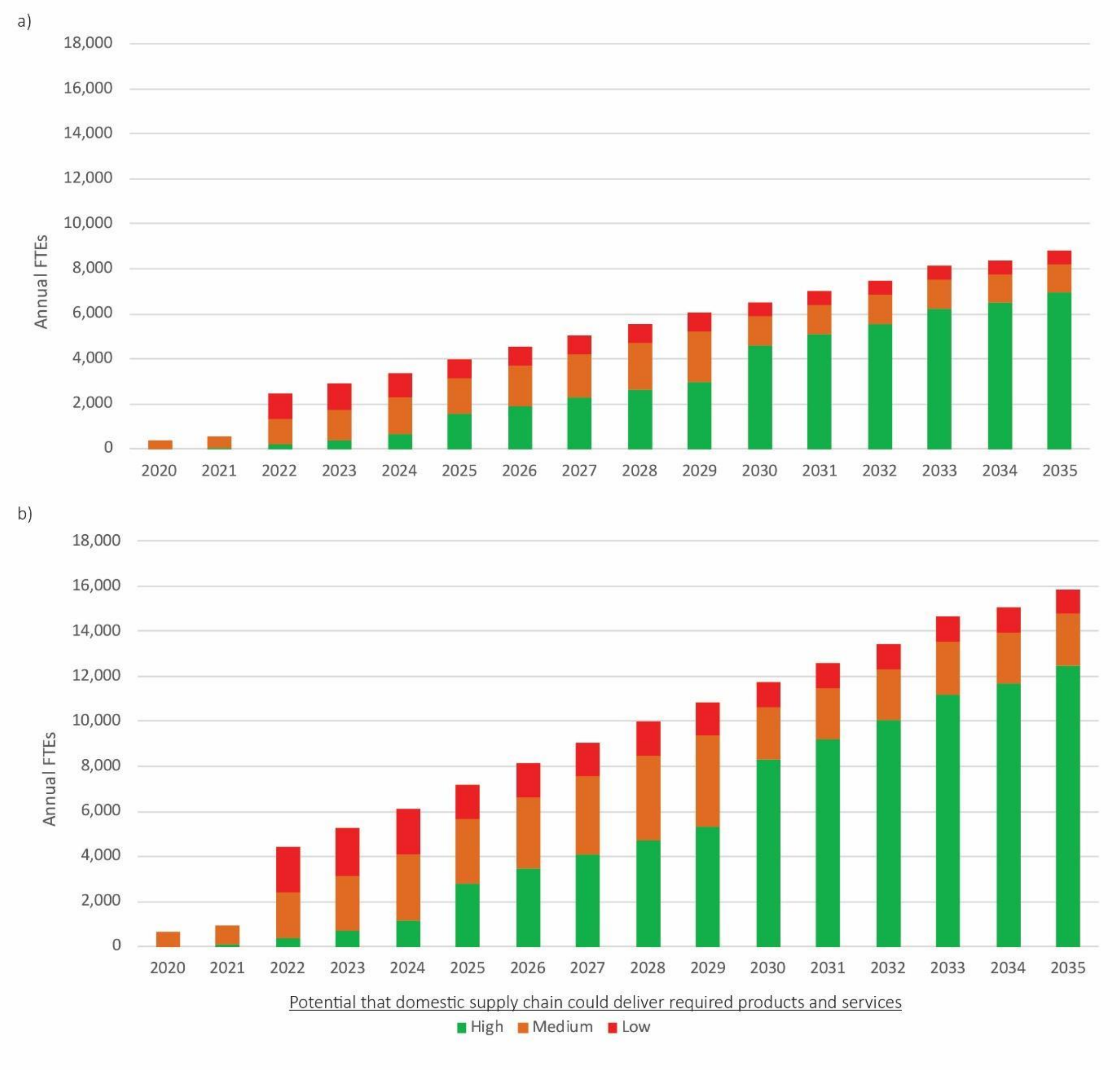

Figure 5.3 Potential employment impact associated with the domestic supply of products and services for Irish offshore wind projects for (a) low and (b) high cumulative installed capacity scenarios. Employment impact is broken down by the potential for domestic suppliers to supply the required products and services.

5.4 Significance

Irelands marine renewable energy sector accounted for 1.4% of Ireland’s ocean economy in 2018 (Tsakiridis *et al.*, 2019). Direct and indirect GVA for the sector amounted to c. €57m, and the sector directly employed 467 FTEs. Compare this to the largest contributor to Ireland’s ocean economy, the shipping and maritime transport sector, which generated c. €1.7bn in direct and indirect GVA and directly employed 5,055.

If the scenarios modelled in this study were to be realised and current trends for other ocean economy sectors were to remain constant, direct and indirect GVA from offshore wind development could exceed that of the marine advanced technology products and services sector, the marine manufacturing, construction and engineering sector, the sea fisheries sector and marine retail services sector by 2030.

This would contribute significantly to Ireland's Harnessing Our Ocean Wealth target of doubling the value of Ireland's ocean economy by 2030 (Inter-Departmental Marine Coordination Group, 2012).

The modelled results suggest that the return on initial investment for offshore wind development in Ireland would be positive. Leahy *et al.* (2020) estimated that an initial total investment of €8.6 billion would be required to deliver the 3.5GW of offshore wind energy required under the Climate Action Plan. In return for this investment, the offshore wind industry could support c. 10,000 direct and indirect jobs per annum by 2035 and generate €4.8bn in GVA, according to our model, provided 3.5GW is installed by 2030. If a quarter of the initial investment requirement came from public support, the return for this investment would represent €2 of GVA for each €1 invested, although the return on investment is likely to be higher if induced impacts are considered.

Given this enormous potential, it is important to consider the reliability of the estimates of economic impact generated by the model presented in this study. The modelled outputs are broadly in line with those referenced in the existing literature (KHSK, 2006; SEAI, 2011; Pöyry, 2014; Siemens, 2014; IMDO, 2019). It is not possible to directly compare modelled outputs with those reported in these studies, though, because they are based on different ranges of assumptions and use different methods, models, and timeframes to estimate impacts.

There are also differences in how activities associated with offshore wind development are categorised, the types of employment considered (direct, indirect or induced; permanent or temporary), the types of developments considered (onshore and/or offshore; fixed or floating), and the Irish content share. Since this is the first study to estimate the potential domestic GVA impact of offshore wind development for Ireland, there are no Irish benchmarks from which to compare figures. However, some inferences can be drawn from the UK experience.

Our model suggests that the GVA impact for Ireland could grow from c. €261m per GW in 2025 to €1.6bn per GW in 2035, at which time cumulative installed capacity would range from 4.2GW (low scenario) to 7.7GW (high scenario) and local content (with a high likelihood to be sourced domestically) would be 37%. Noonan and Smart (2017) estimated that the total direct + indirect GVA impact to the UK from offshore wind in 2017 was £1.8bn per GW. At that time, the cumulative installed capacity in the UK was 5.1GW and UK content was 32%. Our modelled GVA ratio is only slightly lower than that of Noonan and Smart (2017) and our local content figures are slightly higher. This can be explained by differences in the breakdown of the value of the products and services for different project sub elements that could be captured by Irish companies versus that of UK companies. For example, blade manufacturing in the UK is already established. Our model does not assume that there is a high likelihood that Irish companies will manufacture any turbine components by 2035. Nevertheless, the similarity of the GVA figures for somewhat comparable situations suggests that the model may be reasonably able to simulate GVA impact for the Irish case.

With regard to employment, our modelled figures are in line with estimates of Irish workforce requirements presented by Leahy *et al.* (2020). Based on international data from the International Renewable Energy Agency (IRENA), they estimate that a workforce comprised of 20,068 FTEs would be required to deliver 3.5GW of offshore wind for Ireland. This includes jobs created in planning and development, manufacturing, transport and logistics, installation and connection, and operations and maintenance. Compare this with our model, which estimates a requirement of 22,462 FTEs to deliver

3.5GW of offshore wind. Leahy *et al.*'s estimates are based on workforce requirements for a typical offshore wind farm and the share of domestically supplied content from their assessment of Irish supply chain capabilities. Our model differs in that it takes wage data, discounting, and technological learning into account.

It is important, though, to acknowledge the limitations of the model presented. First and foremost, the modelled outputs are sensitive to changing market conditions. For example, changes in the discounting rate, technological learning rate, or wage increases could affect modelled output. The inputs are based on the best available information, but if this should change, the model can be easily updated to reflect these changes or a sensitivity analysis could be undertaken to explore how such changes might affect modelled outputs.

It is also important to consider what is being modelled and what is not. This model does not take into account decommissioning, as there is limited information about this and, given the lifetime of upcoming projects, it would not be reflected in the modelled timeframe anyway. Information about the costs of commercial floating wind projects is also limited. As such, these are treated like fixed bottom projects in the model except for differences in the potential domestic capabilities to supply products and services to the floating projects. Differences in costs and occupational breakdowns between fixed and floating projects may affect modelled outputs.

Finally, GVA and employment are only modelled for the domestic market for offshore wind, and thus represent a lower boundary on the likely overall impact of offshore wind development on the Irish supply chain. KPMG (2018) and SEAI (2011) expect that the export market will far exceed that of the domestic market for offshore wind for Ireland. However, this can only materialise if companies have an opportunity to gain experience in the domestic market.

5.5 Conclusion

Given the recent policy developments and the level of interest from offshore wind developers off Ireland's coast, there is a growing public interest in what benefits offshore wind will bring to the Irish economy and to local communities. For public consumption, a robust and transparent assessment of the potential economic impacts of the sector is needed. This study helps to fulfil this requirement. The value chain model can easily be adjusted to fit changing conditions. Modelled outputs can be used by developers and policy makers to evaluate the socio-economic impacts of offshore wind development and to design community benefits schemes, tailored to coastal communities' specific needs. Further research could include an assessment of sensitivity of modelled outputs to changing conditions, use of the model to explore the export market (assuming the Irish supply chain could capture a share of the European or global market offshore wind markets), or an assessment of the induced GVA and employment impacts of modelled development.

6 Conclusion and recommendations

6.1 Opportunities

The development of offshore wind in Ireland represents a sizable opportunity to counter the decline of the country's peripheral, economically disadvantaged coastal communities and play a central role in the country's post-COVID recovery. This study has highlighted regional economic imbalances between east and west coast ports and their urban and rural hinterlands, whereby access to high-quality employment opportunities is limited around the western, rural ports. These areas tend to be socially disadvantaged when compared to the country as a whole and to the urban centres of Dublin and Cork. As a result, they suffer from depopulation, which not only contributes further to economic decline, but also to the less tangible decline of the social fabric of these coastal communities.

While physical conditions on the west coast remain a challenge to floating offshore wind development, the potential return on investment is significant. The economic and employment impacts associated with future development, as demonstrated in section 5 of this report, have the potential to catapult the sector to a position whereby it is a major contributor to Ireland's ocean economy. Model outputs suggest that by 2030, 2.5-4.5GW of domestic offshore wind development could create between 11,424 and 20,563 supply chain jobs and generate between €763m and €1.4bn in gross value added (GVA). Apart from the economic value, offshore wind development can help to address challenges related to coastal communities in decline, such as depopulation, and it can contribute to the enrichment of Ireland's maritime heritage.

6.2 Challenges

The key challenges for maximising the socioeconomic benefits of offshore wind development for Ireland relate to investment in ports, R&D, and training. Several ports (*e.g.* Shannon-Foynes, Waterford, Rosslare, Killybegs, Fenit/Tralee) require strategic investment in order to enable them to serve as staging, manufacturing, and O&M bases. There is also a need to support R&D to make Ireland globally competitive, particularly in relation to floating wind. Finally, there is a need to build a skilled labour force to be ready to deliver offshore wind for Ireland.

6.3 Pathways

In order to maximise the socioeconomic benefits for socially and economically disadvantaged coastal communities around the ports examined in this study, we put forward the following recommendations:

1. ***Create an offshore wind supply chain stimulus package***

An economic stimulus package could simultaneously accelerate Ireland's transition to renewable energy, create tens of thousands of jobs, and play a central role in the country's post-COVID recovery. This could include tax incentives for the supply chain and strategic investment in ports, training, and R&D. The EU is already considering such a plan at the European level (European Green Deal Investment Plan).

2. ***Invest in port infrastructure to support manufacturing (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs), staging (e.g. at Shannon-Foynes, Waterford, Rosslare, and Killybegs), and O&M (e.g. at Shannon-Foynes, Waterford, Rosslare, Killybegs, New Ross, Rossaveal, and Fenit/Tralee).***

While there is scope for ports around the country to take a strategic view of the opportunity in offshore wind, those that can raise funds to develop in a timely manner will reap the benefits. Ports with socioeconomically disadvantaged hinterlands that are already capable with little investment or change in strategic direction to meet the offshore wind need include:

- Shannon-Foynes (staging or manufacturing)
- Waterford (staging, manufacturing, or O&M)
- Rosslare (O&M)
- Killybegs (staging, manufacturing, or O&M)
- New Ross (O&M)
- Rossaveal (O&M)

Ports that can be capable with significant investment or change in strategic direction to meet the offshore wind need include[10]:

- Shannon-Foynes (staging plus manufacturing or as a potential cluster)
- Waterford (staging plus manufacturing or as a potential cluster)
- Rosslare (staging or manufacturing)
- Killybegs (staging plus manufacturing or as a potential cluster)
- Fenit/Tralee (O&M)

These ports could act as triggers for economic development to regenerate peripheral coastal communities, stem depopulation, attract skilled emigrants home, and ultimately address the imbalances outlined in this study.

3. ***Take a strategic approach to development of regional clusters around ports in preparation for the next wave of projects on the south and west coasts.***

This will require a shift from a developer-led to a government-led approach to development. A key feature of this would involve partnerships between developers and regional supply chain companies, the public sector, and education bodies, as per, for example, the UK Offshore Wind Sector Deal. Offshore wind clusters near west and south coast ports would benefit local communities by creating new business and employment opportunities in areas where these are currently limited.

4. ***Support R&D and the development of skills training programmes***

In order to meet the emerging needs of the sector, Ireland will need to invest in R&D and the development and promotion of skills training programmes. To incentivise developers to undertake R&D activities, R&D plans could be assessed as part of the consenting process. R&D funding could also potentially come from a levy, for example, on the oil and gas industry, *à la* the Brazilian model[11]. South and west coast ports could serve as innovation hubs linked to regional clusters, supported by universities and technical institutes such as NUIG, GMIT, Sligo IT, and Letterkenny IT. In order to keep up with labour demands, there is a need to introduce, develop and promote training opportunities, especially in areas where there are gaps in the availability of skilled labour, such as offshore wind turbine technicians. The New Jersey WIND Institute could serve as a model for such a programme.

[10] Ports that are already capable with little investment or change in strategic direction and ports that can be capable with significant investment or change in strategic direction to meet the offshore wind need have been identified as such by Leahy *et al*. (2020). Examples of such investments include the provision of additional handling equipment to deal with larger offshore wind turbines at Shannon-Foynes and Killybegs and the purchase of proximal land at Rosslare to accommodate staging/manufacturing.

[11] Petroleum Law and Federal Decree 2705

Appendix A: Offshore Wind Farm Costs

Table A1: Typical costs for a 1GW project (after BVG, 2019a).

		Estimated UK cost for a 1GW Project	Estimated cost in euros
	Spend Breakdown		
CAPEX	Project development and management	£120,000,000	€133,462,320
	Turbine supply	£10,000,000 per turbine	€11,121,860 per turbine
	Balance of plant supply	£600,000,000	€667,311,600
	Installation and commissioning	£650,000,000	€722,920,900
OPEX	Wind farm operation	£25,000,000 per annum	€27,804,650 per annum
	Turbine maintenance and service	£50,000,000 per annum	€55,609,300 per annum
	Foundation and substation maintenance and service	£18,000,000 per annum	€20,019,348 per annum

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