

Pentland floating offshore wind farm

Volume 3: Appendix A.19.1

Supply Chain Study Assessment
(Quantification) Methodology



OFFSHORE EIAR (VOLUME 3): TECHNICAL APPENDICES

APPENDIX 19.1: SUPPLY CHAIN STUDY ASSESSMENT

(QUANTIFICATION) METHODOLOGY

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Pentland Floating Offshore Wind Farm EIA

Technical Appendix: Supply Chain Study Assessment (Quantification) Methodology

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London

Cheapside House
138 Cheapside . London
EC2V 6BJ . UK

T +44 (0)207 246 2990

E 

www.xodusgroup.com



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ABBREVIATIONS

Acronym	Definition
CAPEX	Capital Expenditure
DEVEX	Development Expenditure
EIA	Environmental Impact Assessment
FOU	Foundation
FTE	Full Time Equivalent
GVA	Gross Value Added
H&I	Highlands and Islands
HWL	Highland Wind Limited
IOAT	Input-Output Analytical Tables
OPEX	Operational Expenditure
SIC	Standard Industrial Classification codes
SPV	Special Purpose Vehicle
WTG	Wind Turbine Generator



TECHNICAL APPENDIX 19.1: SUPPLY CHAIN STUDY ASSESSMENT (QUANTIFICATION) METHODOLOGY

1.1 Introduction

The following Technical Appendix outlines the approach and methodology undertaken to develop the supply chain assessment for the 100 MW Pentland Floating Offshore Wind Farm (PFOWF).

This report was prepared for Highland Wind Limited (HWL), a Special Purpose Vehicle (SPV) established for the delivery of the Pentland Floating Offshore Wind Farm (PFOWF) Project. HWL is majority owned by a fund managed by Copenhagen Infrastructure Partners (CIP) (90%) with HexiconAB as a minority shareholder (10%). Project development activities are being led by CIP's development partner, Copenhagen Offshore Partners (COP).

The report focuses on:

- A description of and rationale for the underlying base and high case scenarios to assess impacts within the Socio-Economics, Recreation and Tourism EIA Chapter (Chapter 19);
- A description of the method utilised to assess economic impacts; and
- A summary overview of the scale of economic impacts, provided in GVA and FTEs.

Supply chain scenarios and economic impacts were considered across the following spatial levels/geographies:

- Caithness;
- Highlands and Islands (H&I);
- Rest of Scotland; and
- Rest of UK.

The assessment covered the Development, Construction, and Operations and Maintenance (O&M) phases of the PFOWF Project, with the Decommissioning phase not considered at this stage.

In general, the scale and type of effects expected during the decommissioning phase could be expected to be similar to those anticipated to occur during the Construction phase. However, the considerable potential for future technological innovation and progress relating to decommissioning activities over the next 30 years or so years means that it is not currently possible to predict the scale and duration of expenditure that would be required to decommission the Project. Another principal source of uncertainty concerns the potential future locations of a decommissioning supply chain that would have the equipment, skills, expertise, and workforce to undertake large scale offshore decommissioning activities. The consequence of these types of uncertainty mean that it is not possible to produce meaningful quantified estimates of the employment and GVA consequences of a Decommissioning phase of the Project in the same way that has been done for the construction and O&M stages.

1.2 Impact Scenario Descriptions and Underlying Supply Chain Assumptions

Using information provided by PFOWF and verified by Xodus Group, an estimate of lifetime costs associated with the expenditure for different project categories were used in the supply chain and economic assessments. The categories were broken down into distinct phases as per Table 1 below.



Table 1 - Categories used to estimate lifetime costs associated with the PFOWF

CATEGORY	
Development	Project management
	Project development and consenting
	Surveying
	Engineering and design
CAPEX Project Management	HWL Project Management
Manufacturing	Turbine
	Foundations
	Moorings
	Anchors
	Array cable
	Export cable
	Onshore substation
Installation	Turbine integration
	WTG/FOU installation
	Anchor/mooring installation
	Cable installation
	Onshore construction
	Ports and logistics
Operations	Operations
	Maintenance

Capital expenditure estimates and associated percentage spend for each category were used to inform the establishment of two impact scenarios for the PFOWF Project – a base case and a high case scenario for supply chain and economic impacts. Development of the scenarios was carried out between August and September 2021 and included considerations of ongoing discussions between PFOWF and the supply chain within that time frame. Due to the early stage of the Project and its supply chain engagement at the time of assessment, a level of uncertainty is associated with both the expenditure estimates and final supply chain decisions, which has been accounted for in assumptions for the base and high case scenario.



The scenarios were developed by Xodus and agreed with PFOWF, representing a view on the likelihood of procurement across the selected spatial areas, taking into account current and potential future supply chain capability. Further considerations included existing Project engagements with supply chain companies as part of the project's ambition to function as a steppingstone project. Steppingstone projects are designed at a scale of hundreds of MW in capacity or smaller to enable a gradual technology and supply chain development ahead of full-scale commercial deployment, thereby reducing project risks and cost. HWL worked with Xodus to provide a percentage likelihood of contracting certain companies and their locations for the supply chain categories captured in Table 1 to develop an initial overall projected local content figure. Criteria and factors considered for each scenario included:

- Existing companies within spatial area with track record in offshore wind or associated industries;
- Existing discussions as part of project development to use certain suppliers or technologies; and
- Potential for capability within the supply chain to be developed in line with project timeframes of construction commencing in mid-2020s.

Supply chain categories considered as part of the impact scenarios included Tier 1 to Tier 3 contracting levels, covering manufacturing, transport and logistics, equipment and service providers, and port infrastructure. Current supply chain capabilities were informed using Xodus' in-house supply chain mapping, Scottish Enterprise supply chain directory, membership and supply chain directory information from the DeepWind and Forth and Tay Offshore clusters, as well as contracting information from existing Scottish offshore wind projects.

Sections 1.2.1 and 1.2.2 provide additional descriptions and details for the base and high impact scenarios respectively. Existing supply chain engagement that was factored into the impact scenario assumptions include the following:

- **Development, consenting and surveying:** contracts awarded for Environmental Impact Assessment (EIA) scopes and environmental and archaeological surveys to UK and Scottish companies, including *Anatec Ltd*, *HiDef Aerial Surveying*, *Coleman Aviation*, *Subacoustech Environmental Ltd*, *Optimised Environments Ltd (OPEN)*, *Caledonian Conservation Ltd*, *Orkney Research Centre for Archaeology (ORCA)*, *Atlantic Ecology Ltd*, *Hoare Lee*, *Foundation Scotland* and *Xodus Group*;
- **Foundations:** floating foundation technology designer outside of the UK;
- **Mooring lines:** consideration of Scottish synthetic mooring line provider;
- **Array and export cable:** high likelihood of Danish headquartered supplier;
- **Installation:** high likelihood of Danish headquartered provider, with some consideration on use of UK-flagged vessels provided in scenarios;
- **Foundation and Turbine integration:** assumption, but still to be confirmed, on use of Port of Nigg and Global Energy Group services, with assembly and some extent of foundation component supply also originating from Port of Nigg; and
- **Operations:** at the time of analysis both Wick and Scrabster Port under consideration for O&M base, at this stage neither has been confirmed.

Applied methodology for the supply chain and local content assessment is based on current industry approach from BVG Associates 2015 "Methodology for measuring the UK content of UK Offshore wind farms¹".

¹ Guidance methodology available at https://cdn.ymaws.com/www.renewableuk.com/resource/resmgr/Publications/Guides/uk_content_methodology.pdf



1.2.1 Base Case Scenario

The assumptions utilised in the development of the supply chain sourcing scenarios for the four spatial areas for the base case scenario are summarised below. Existing procurement arrangements and capital spent on project development were taken into consideration, as were the split of internal and external costs on the Project. The main areas for local engagement identified included development, some engineering scopes, local assembly of foundations and turbine integration, mooring line supply as well as operations and maintenance.

The following general assumptions and factors were applied:

- **Development:** HWL undertook a majority of the management and development work in-house, with an 80/20 split for internal/external spend assumed, and an 80/20 split between UK and Danish teams for internal spend. Rest of UK spend of 10% for insurance, legal and financial services and sub-contracting of small Project Management (PM) scopes. The figures used also account for the presence of a local Scottish team and already committed spend for EIA and environmental surveys to Scottish and UK suppliers. Limited scope for additional Scotland/UK spend on surveying and engineering due to technology choice and committed survey spend.
- **Manufacturing and installation:** Higher local sourcing and spend for Scotland and UK assumed for foundation and mooring scopes based on assumptions for Port of Nigg as fabrication site and potential for supply of secondary steel and foundation components, similarly for UK for anchor system supply owing to some existing capability. Array cable supply identified as likely being outside the UK by HWL, limited spend to ancillaries, connectors or cable protection scopes. Majority of turbine value chain outside of the UK, with blade supply assumed possible from production in Hull or Isle of Wight.

Installation scopes for foundations and cables currently assumed for outside UK suppliers, with some potential for Scottish and UK vessel and port-side support services. Foundation assembly likely Port of Nigg, resulting in high assumed local spend for H&I. Onshore construction and manufacturing assumed to favour use of local employment and contractors.

- **Operations and maintenance:** Assumptions based on option of either Scrabster or Wick Harbour at the time of analysis, with assumption for HWL to use local office space for small operations team. Inspection and maintenance assumed to be largely localised for Scotland and H&I, with major component replacement outside of UK.

1.2.2 High Case Scenario

The high local sourcing and spend scenarios were based on assumptions of additional capability and capacity building in time for construction and installation scopes, considering existing companies and track record in the spatial areas. The following general assumptions and factors were applied:

- **Development:** Limited increase in scale of local sourcing due to internal-external spend split for HWL and already committed expenditure, but higher scenario assumes greater emphasis on local use of engineering and design scope as well as Scottish/UK survey providers for additional campaigns pre-construction.
- **Manufacturing and installation:** Higher H&I spend attributed to potential for turbine tower manufacturing, as well as greater foundation component and potential for primary steel supply capability at Port of



Nigg/Global Energy Group. Similar reasoning behind increase in anchor system spend, with some capability assumed to be moving to Port of Nigg. Higher Scotland/UK installation spend attributed to potential for UK-flagged vessels and support services even under non-UK contractor.

- **Operations and maintenance:** Potential for construction of new O&M base increases local spend under high scenario, with a final decision pending at the time of analysis. Increase in maintenance spend for Caithness and H&I points to some potential for greater local employment and training for inspection, drones, maintenance services and vessels.

1.3 Supply Chain Impacts Assessment Methodology

The supply chain impacts assessment was conducted by Steve Westbrook in partnership with the University of Highlands and Islands.

Economic impacts were estimated for the PFOWF using two scenarios:

- Scenario 1 - Low based on current supplier capabilities; and
- Scenario 2 - High, which reflects potentially increased supplies within the UK and constituent impact areas from 2024.

Assessments were carried out during the period of early to mid-September 2021 and values are representative of the project and supply chain status within this time frame.

Impacts relate to the costs provided by HWL and span the development phase (DEVEX), the manufacturing and installation phases (CAPEX), and the operational phase (OPEX). The overall DEVEX, CAPEX, and OPEX categories are derived from 20 categories of spend in total as outlined in Table 1 in the previous section. The PFOWF Project OPEX totals span thirty years of operation and were derived from average annual estimates of OPEX expenditures over this period.

Estimated impacts for each category are totals across the years in which expenditures will have been incurred, and are given in 2021 prices. Impacts were calculated and summarised for:

- Net outputs – which exclude, from businesses' gross outputs, the value of supplies and services that are purchased from outside the impact area through all tiers of supply chains;
- FTEs (full time equivalent job years) generated within Caithness, the H&I as a whole, Scotland, and the UK as a whole. A full-time equivalent job year is broadly a person working 7-8 hours per day over 220-230 days of a year;
- Related remuneration of employees, and gross earnings (which exclude employer's NI and pension payments from remuneration); and
- Related GVA (Gross Value Added) generated in the impact areas. The GVA for a business is its contribution to national Gross Value Added as measured by its operational profit over a year plus its remuneration of employees, and with its depreciation and business rates added back.

The FTEs relate to jobs that would be provided within the study areas, and include employees within the areas who are not normally resident (although permanent in-migration by workers, and their families, for the relatively well paid work that should be sustained for an extended period will tend to be a positive feature).

The impact tables have been produced considering the contracted spend anticipated by HWL with suppliers based in Caithness, the rest of the H&I, the rest of Scotland, and the rest of the UK by category. These spend values include assumptions on the proportions of expenditure expected to be incurred with Tier 1 suppliers in the study areas based



on the initial supply chain assessment. They further include an adjustment to these totals to reflect significant Tier 2, Tier 3, and other suppliers to the contractors based outside of the study areas (net output), and the estimated remuneration of employees, FTEs, and GVA estimated to derive from these net outputs by category. These impacts are aggregations of direct impacts, indirect impacts (through supply chains), and induced impacts (through the additional spending in the impact areas of direct plus indirect proprietors and employees from their additional earnings).

Induced FTE year impacts are assumed to add 0.3 to direct plus indirect FTE impacts for the UK, 0.25 for Scotland, 0.225 for the H&I, and 0.2 for Caithness. The induced impact ratio of 0.25 for Scotland corresponds to the ratios from Scottish Input-Output tables², dividing Type II by Type I multipliers for the types of activity covered by the assessment. Type I multipliers sum together direct and indirect effects, while Type II multipliers also include induced effects. Induced multiplier tables are no longer available for the UK, nor are they available for H&I and Caithness, and the induced multipliers are upscaled and downscaled respectively based on Scotland impacts and the analysts' knowledge. This led to an assumption of 0.3 FTE induced impacts for the UK, 0.225 for H&I and 0.2 for Caithness.

The assumptions behind the FTE, remuneration of employees, and GVA projections were based on an appropriate combination by category of spend of:

- Impact reports that have been produced on comparable projects (including up-to-date published reports whose impact calculations/estimates have been independently appraised by Steve Westbrook and UHI);
- Views on how provision of particular supplies by Caithness, Other H&I, Scotland and UK producers might evolve from their new capital investments and the reductions in cost per MW installed that might be achieved for particular items through technical improvements and economies of scale, and possible reductions in OPEX costs per MW installed in the average year after turbines will have become operational; and
- Use of data from national official surveys (including multipliers from Input-Output tables for Scotland and the UK) that show average FTEs, the remuneration of employees and GVA associated with particular levels of output for relevant sectors (as defined by Standard Industrial Classification codes) – taking account of how close a fit the activities analysed are with such sectoral averages. Ratios from the Scotland Input-Output tables were adjusted as considered appropriate for the H&I region and Caithness.

An overview of the utilised GVA, employment and remuneration effects and ratios for the supply chain impact assessment across project spend categories for the UK and Scotland is provided in Table 2 and Table 3.

The employment and GVA effects relate to £1m of spend.

² Input-Output tables and respective data and approach was taken from <https://www.gov.scot/publications/input-output-latest/capturing-2018-data>.



Table 2 – Subcategory effects and ratios for UK Industry

SUBCATEGORY TO UK INDUSTRY		IOAT SIC	Income / remuneration effect	Employment effect	GVA effect	Recalculated FTE Effect (adjusted from IOAT)	GVA to FTE ratio	GVA to remuneration ratio
Development	Project Management	70	0.59	13.83	0.86	14.75	0.06	1.45
	Development & Consenting	70	0.59	13.83	0.86	14.75	0.06	1.45
	Surveying	71	0.64	14.55	0.86	16.07	0.05	1.35
	Engineering & Design	71	0.64	14.55	0.86	16.07	0.05	1.35
	HWL PM	70	0.61	13.83	0.80	1.45	0.06	1.45
CAPEX PM	Turbine	23						
	Blades	23	0.45	20.85	0.64	11.24	0.06	1.42
	Tower	25	0.48	10.72	0.71	10.72	0.07	1.47
	Other	28	0.46	9.00	0.72	9.00	0.08	1.58
	Foundations	25	0.48	10.72	0.71	10.72	0.07	1.47
	Moorings	13	0.45	12.70	0.78	11.27	0.07	1.72
	Anchors	25	0.48	10.72	0.71	10.72	0.07	1.47
	Array Cable	27	0.50	7.54	0.71	7.54	0.09	1.42
	Export Cable	27	0.50	7.54	0.71	7.54	0.09	1.42
	Onshore Substation	25	0.48	10.72	0.71	10.72	0.07	1.47



SUBCATEGORY TO UK INDUSTRY									
Installation	Turbine integration	41-43	0.42	13.45	0.85	10.49	0.08	2.02	
	WTG/FOU Installation	50	0.5	9.15	0.66	9.15	0.07	1.31	
	Anchor/ mooring installation	50	0.5	9.15	0.66	9.15	0.07	1.31	
	Cable installation	50	0.5	9.15	0.66	9.15	0.07	1.31	
	Onshore construction	41-43	0.42	13.45	0.85	10.49	0.08	2.02	
O&M	Ports & Logistics	41-43	0.42	13.45	0.85	10.49	0.08	2.02	
	Operations	74	0.59	17.85	0.87	14.68	0.06	1.48	
	Logistics	74	0.59	17.85	0.87	14.68	0.06	1.48	
	Facilities	52	0.61	13.0	0.9	13.05	0.07	1.41	
	Administration	82	0.5	23.53	0.82	14.18	0.06	1.66	
	Insurance	65	0.28	5.28	0.75	5.28	0.14	2.65	
	Environmental costs	71	0.64	14.55	0.86	16.07	0.05	1.35	
	Fees, leases, taxes (incl. TNUs)	33	0.5	10.57	0.76	10.57	0.07	1.53	
	Maintenance	33	0.5	10.57	0.76	10.57	0.07	1.53	
	Averages			0.51	12.35	0.77	11.46	0.07	1.54



Table 3 - Subcategory effects and ratios for Scotland Industry

SUBCATEGORY TO SCOTLAND INDUSTRY		IOAT SIC	Income / remuneration effect	Employment effect	GVA effect	Recalculated FTE Effect (adjusted from IOAT)	GVA to FTE ratio	GVA to remuneration ratio
Development	Project Management	70	0.61	13.83	0.80	15.18	0.05	1.31
	Development & Consenting	70	0.61	13.83	0.80	15.18	0.05	1.31
	Surveying	71	0.46	14.55	0.75	11.46	0.07	1.64
	Engineering & Design	71	0.46	14.55	0.75	11.46	0.07	1.64
	HWL PM	70	0.61	13.83	0.80	15.18	0.05	1.31
CAPEX PM	Turbine							
	Blades	23	0.45	20.85	0.64	11.24	0.06	1.42
	Tower	25	0.47	10.72	0.65	10.72	0.06	1.38
	Other	28	0.42	9.00	0.59	9.00	0.07	1.41
	Foundations	25	0.47	10.72	0.65	10.72	0.06	1.38
	Moorings	13	0.42	12.70	0.66	10.46	0.06	1.58
	Anchors	25	0.47	10.72	0.65	10.72	0.06	1.38
	Array Cable	27	0.41	7.54	0.53	7.54	0.07	1.31
	Export Cable	27	0.41	7.54	0.53	7.54	0.07	1.31
	Onshore Substation	25	0.47	10.72	0.65	10.72	0.06	1.38



SUBCATEGORY TO SCOTLAND INDUSTRY										
Installation	Turbine integration	41-43	0.40	13.45	0.69	9.90	0.07	1.73		
	WTG/FOU Installation	50	0.48	9.15	0.65	9.15	0.07	1.35		
	Anchor/ mooring installation	50	0.48	9.15	0.65	9.15	0.07	1.35		
	Cable installation	50	0.48	9.15	0.65	9.15	0.07	1.35		
	Onshore construction	41-43	0.40	13.45	0.69	9.90	0.07	1.73		
O&M	Ports & Logistics	41-43	0.40	13.45	0.69	9.90	0.07	1.73		
	Operations	74	0.49	17.85	0.85	12.19	0.07	1.74		
	Logistics	74	0.49	17.85	0.85	12.19	0.07	1.74		
	Facilities	52	0.44	13.0	0.8	13.05	0.06	1.70		
	Administration	82	0.54	23.53	0.83	15.47	0.05	1.53		
	Insurance	65	0.22	5.28	0.60	5.28	0.11	2.69		
	Environmental costs	71	0.46	14.55	0.75	11.46	0.07	1.64		
	Fees, leases, taxes (incl. TNLoS)	33	0.45	10.57	0.72	10.57	0.07	1.60		
	Maintenance	33	0.45	10.57	0.72	10.57	0.07	1.60		
	Averages			0.46	12.35	0.69	10.83	0.07	1.53	



1.4 Summary Impacts: GVA and Employment

The following tables provide an overview of the results from Direct, Indirect and Induced Impacts and assessment and overall FTE years across the project phases (Table 4 to Table 7) and spatial areas (Table 8), representing the key outputs from the supply chain impacts assessment and current standard methodology as outlined in Section 1.3. The results highlight key potential impacts of the PFOWF Project across the Construction and O&M phases for the Highlands & Islands region and rest of Scotland scopes. The figures are based on current Project design considerations and associated supply chain assumptions as of September 2021 and is likely to see further update as the Project progresses. However, as evidenced by the following summary output tables, the Project is already presenting key supply chain impact benefits in terms of GVA and FTEs created across the four assessed geographies.

Table 4 - Impact Summary Table for Development Phase

DEVELOPMENT								
Impact	Caithness		H&I		Scotland		Rest of UK	
	Low	High	Low	High	Low	High	Low	High
Net Output (£m)	0	0	0.5	0.5	11.4	12.6	16.7	18.4
Direct & Indirect	0	0	8.2	8.2	183.5	204.1	272.2	301.5
Induced	0	0	1.8	1.8	45.9	51.0	81.8	90.4
Total FTE Years	0	0	10	10	229.4	255.2	354.5	391.9

Table 5 - Impact Summary Table for Manufacturing Phase

MANUFACTURING (INCL. CAPEX PROJECT MANAGEMENT)								
Impact	Caithness		H&I		Scotland		Rest of UK	
	Low	High	Low	High	Low	High	Low	High
Net Output (£m)	0.8	1.5	53.6	92.5	85.0	124.9	125.2	173.0
Direct & Indirect	10.5	20.9	746.4	1289.3	1206.1	1758.8	1790.3	2454.0
Induced	2.1	4.2	167.9	290.1	301.5	439.7	537.1	736.2
Total FTE Years	12.5	25.1	914.4	1579.4	1507.7	2198.5	2327.4	3190.2



Table 6 - Impact Summary Table for Installation

INSTALLATION								
Impact	Caithness		H&I		Scotland		Rest of UK	
	Low	High	Low	High	Low	High	Low	High
Net Output (£m)	0.4	0.9	22.7	23.7	27.8	32.6	32.6	45.9
Direct & Indirect	4.6	12.0	261.3	275.0	327.7	387.6	387.7	555.9
Induced	0.9	2.4	58.8	61.9	81.9	96.9	116.3	166.8
Total FTE Years	5.5	14.4	320.1	336.9	409.7	484.6	504.0	722.6

Table 7 - Impact Summary Table for Operational Phase

O&M								
Impact	Caithness		H&I		Scotland		Rest of UK	
	Low	High	Low	High	Low	High	Low	High
Net Output (£m)	51.0	53.4	77.8	94.8	131.4	156.9	211.6	237.1
Direct & Indirect	634.8	665.8	973.6	1188.1	1651.2	1971.6	2653.0	2973.3
Induced	127.0	133.2	219.1	267.3	412.8	492.9	795.9	892.0
Total FTE Years	761.7	799.0	1192.7	1455.5	2064.1	2464.5	3448.8	3865.3

Table 8 - Impact Summary for GVA, FTE and Renumeration across Spatial Areas

SPATIAL AREA SUMMARIES								
Impact	Caithness		H&I		Scotland		Rest of UK	
	Low	High	Low	High	Low	High	Low	High
Total renumeration (£m)	30.6	32.9	93.7	130.3	159.2	205.6	247.7	307.3
Total GVA (£m)	49.8	53.4	148.9	203.8	249.9	319.5	388.0	476.0
Total FTE Years	780	838	2437	3382	4211	5403	6635	8170