Case studies to support scenario mapping for offshore renewable energy development economic benefits

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Case studies to support scenario mapping for offshore renewable energy development economic benefits

Study report for Marine Scotland

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- BVG Associates was formed in 2006 at the start of the offshore wind industry.
- We have a global client base, including customers of all sizes in Europe, North America, South America, Asia and Australia.
- Our highly experienced team has an average of over 10 years' experience in renewable energy.
- Most of our work is advising private clients investing in manufacturing, technology and renewable energy projects.
- We have also published many landmark reports on the future of the industry, cost of energy and supply chain.

Disclaimer

1. Preface

Note on publication

This project was commissioned by Marine Scotland in 2019 and aimed to identify, measure and value the delivered and potential economic impact for Scotland from offshore wind and tidal energy projects. The report is now being published as part of the evidence base to support the development of new Socio- Economic Impact Assessment Guidance for Offshore Renewable Energy that Marine Scotland has developed (to be published shortly).

Some important aspects of the report are now out of date, including the status of the projects being analysed, and the capability of the offshore wind supply chain in Scotland.

The original intention was to use a case study approach with actual data to assess the economic impact of four existing renewable energy projects. The project faced a number of challenges in terms of acquiring data due to GDPR and commercial confidentiality requirements. As a consequence the analysis undertaken was based on modelled data, using qualitative data from developers and public sources. The results of the modelling therefore represent an estimate of actual and potential economic impact.

The methodology consists of the development of case studies for “as-is” and “what-if” economic impacts scenarios based on the existing supply chain in Scotland at the time of writing and provides an estimated and maximum Scottish content.

Although this methodology is unique to this report, it follows some of the same principles as those used in the forthcoming SEIA guidance. For example, the SEIA guidance asks for the assessment of economic impacts to be presented at the local, regional, Scottish and UK level.

The report also illustrates the types and scale of expected economic impact as well as the potential areas for increased value added in Scotland, which will be helpful for socio-economic impact assessment and will assist future supply chain and Scottish content work.

While every effort has been made to make this publication accessible to all, some sections may remain inaccessible due to the nature of the content. If you are unable to access any content you require, please contact ScotMER@gov.scot

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2. Introduction

A consideration in marine planning is the economic impacts associated with different uses. Offshore renewables are likely to become an increasingly important user of Scottish marine space and Marine Scotland wished to identify, measure and value the potential economic impact for Scotland from offshore wind and tidal energy projects. It commissioned this analysis from BVG Associates to provide an evidence base.

The approach taken was to model the delivered and potential economic impacts of major offshore renewable energy projects in Scotland using qualitative data from developers or in the public domain. It considered four projects:

- Beatrice offshore wind farm – an operational fixed-bottom offshore wind farm in the Moray Firth
- Neart na Gaoithe (NnG) – a pre-construction phase fixed-bottom offshore wind in the outer Firth of Forth.
- Hywind Scotland – an operational floating offshore wind farm located in the North Sea 25km off Peterhead, and
- MeyGen Phase 1A – an operational tidal energy project in the Sound of Stroma, near John o'Groats.

The work then analysed the present capability of the Scottish supply chain to deliver offshore renewable energy projects to establish what could have been achieved if this capability had been fully utilised. It did not consider the impact of greater utilisation of the Scottish supply chain on project cost and risk

The project identified opportunities and barriers to delivering Scottish content and makes recommendation for the future.

3. Approach

This study was structured around four offshore renewable energy projects in Scotland:

- Beatrice Offshore Wind farm (588MW)
- Neart na Gaoithe (NnG) Offshore Wind farm (448MW)
- Hywind Scotland (30MW), and
- MeyGen Phase 1A (6MW).

The four projects were chosen as the highest profile and furthest developed projects so far undertaken in Scotland for each technology and location at the time.

Beatrice is the largest offshore project in operation in Scotland in 2020. Offshore construction began in April 2017, and the wind farm was fully commissioned in 2019.

NnG is the furthest developed offshore wind farm in the Firth of Forth and is scheduled to start operation in 2022. The Firth of Forth has significant potential capacity of projects, notably the Seagreen projects, the first of which was successful in CfD Allocation Round 3. This analysis looked to see what differences, if any, there are between this project and a fixed offshore wind project in the Moray Firth.

Hywind Scotland was chosen because it is the furthest developed floating wind project in Scotland, and indeed globally. Hywind Scotland was commissioned in 2017.

MeyGen is the furthest developed Scottish tidal project. The Phase 1A development was completed in April 2018 and Phase 1B (4MW), also known as Project Stroma, is currently under construction. Further phases are planned.

For each project we developed a case study. Each case study modelled the ‘as-is’ economic impacts from the projects and the supply chain used, and a ‘what-if’ assessment, which identifies the economic impacts of a similar project using the maximum realistic Scottish content from the existing supply chain.

These case studies were used to inform recommended actions the Scottish Government could take to increase the economic impacts in Scotland from existing and planned developments.

For the purposes of this study, we defined a Scottish company as one in which the activity relevant to the development project was based in Scotland.

We defined 'local' as the local authority area in which the installation base, operations and maintenance base, and export cable landfall are located.

We defined ‘national’ as referring to Scotland.

The Scottish content includes local content, and therefore should not be interpreted as ‘rest of Scotland’.

3.1. Methodology

The work was undertaken in the following stages:

- Develop supply chain taxonomy
- Undertake an as-is economic impact analysis for the selected projects
- Identify current and future potential Scottish supply chain activity
- Undertake a what-if economic impact analysis for the selected projects, and
- Identify potential opportunities for and barriers to increasing the economic impact in Scotland from existing and planned projects.

Develop supply chain taxonomy

The supply chain was broken down into a hierarchical structure with six level 1 categories, 27 level 2 categories and around 130 level 3 categories. The level 1 and level 2 categories were suitable for all the case studies, however there were variations in the level 3 categories depending on the technology. This level of detail was important because many of the business opportunities and jobs in Scotland are at the lower tiers of the supply chain. A higher-level analysis would focus attention on major components such as turbines and foundations, potentially missing the contribution of Scottish small and medium enterprises (SMEs).

The six level 1 categories cover all phases of a project's life and are:

- Development and project management
- Turbine (generating device) supply
- Balance of plant (including transmission)
- Installation and commissioning
- Operations, maintenance and service (OMS), and
- Decommissioning.

The level 2 and level 3 categories are listed in Appendix B.

Measure economic impacts for selected projects

We modelled the economic impacts of the case study projects using a methodology (see Appendix B) based on a detailed understanding of renewable energy generation and transmission industry supply chains and qualitative information from developers. Developers were given the opportunity to review the data modelled for their projects. We used a structured 'content' analysis based on a methodology developed by BVGA for the Offshore Wind Programme Board[1].

We analysed the following:

- Direct, indirect and induced gross value added (GVA)
- Direct, indirect and induced earnings, and
- Direct, indirect and induced full-time equivalent (FTE) job years.

Direct impacts arise from the work undertaken by the developer and their Tier 1 suppliers.

Indirect impacts relate to employment generated by the purchase of supplies and services by the companies that create the direct impacts.

Induced impacts relate to the employment created through the personal expenditure of the direct and indirect workforce.

For each Level 3 category and offshore renewable energy technology, we tried to identify the Scottish companies (including Scottish subsidiaries of non-Scottish headquartered companies) that were successful suppliers, along with their locations. We included specialist renewable energy companies only (not, for example, caterers and transport companies).

By aggregating data, we produced a Scottish content figure for each project and level 1 category.

For each case study we attempted to get as much observed data from the developers as possible, including information on their supply chains.

We discovered that the developers encountered challenges in giving us all the data required. Some cited GDPR restrictions on facilitating conversations with their suppliers or providing contact details. Others reported that for commercial confidentiality reasons they could not give us values of contracts, salaries or location of jobs. For this reason, the analysis relied more on modelled data than was originally planned. For the three offshore wind projects the costs were estimated using BVGA's internal cost model, based on costs from similar projects. The economic impact numbers are very sensitive to spend, and there is a potential margin of error. Modelled data was sent to developers to validate, and one of the developers was able to respond to this request. We also compared results with similar studies. To avoid developer bias, we used our internal knowledge of the Scottish supply chain to sense-check the input.

[1] Methodology for measuring the UK content of UK offshore wind farms, May 2015, BVG Associates for Department of Energy and Climate Change, The Crown Estate and RenewableUK. Available online at BVG Associates Publications. Last accessed January 2019

The analysis only considered the impacts from building, operating and decommissioning the case study projects and from the owners' contributions to the maintenance of the transmission grid. It did not consider the impacts of profits made by project owners.

OPEX was assumed to be spread evenly over the operating life of the wind farm.

The impacts were offset from the date of turbine commissioning.

Our modelling used data from our own research on workers' salaries and profit margins to establish employment figures

Gross value added are in 2019 prices.

Identify current and future potential Scottish supply chain activity

The companies involved in each case study project were identified through input from project developers or from research of publicly available information.

Using the breakdown of level 2 categories from the supply chain taxonomy we assessed the Scottish renewable energy supply chain using our supply chain assessment tool, which considers the criteria below.

Scottish supply track record

The extent to which Scottish-based companies have supplied the offshore renewable energy industry either in the UK or abroad and the extent to which the capability exists to supply any scale of project with contracts being signed within the next year.

Market readiness of suppliers for commercial scale projects

The extent to which Scottish-based companies have existing capability or plans in place to invest that would enable them to supply commercial scale projects, either in the UK or abroad, with contracts being signed within the next year.

Availability of Scottish expertise in parallel sectors

How strong Scottish-based companies' expertise is in parallel sectors in Scotland, such as marine and subsea engineering, and oil and gas.

Logic of Scottish supply

To what extent there is a logistics benefit from supply from Scottish coastal locations close to the areas of renewable energy developments and from a close proximity to customers. This also considers the logic of Scottish suppliers supporting projects in the rest of the UK and overseas.

Scottish investment risk

The confidence level in the size and sustainability of the market required for investment in Scotland. A high score indicates the investment risk is small and therefore more attractive to Scottish suppliers.

Size of the opportunity

The likely fraction of total expenditure that is in Scotland for Scottish projects. The size of opportunity does not reflect competition.

The size of the opportunity was calculated by the product of:

- The potential Scottish content in which Scottish suppliers could provide goods or services, and
- The likely market share of Scottish companies for Scottish projects.

For each of these criteria, we developed a scoring system to provide clarity and consistency (see Appendix A).

For each case study project and supply chain level 3 category, we identified Scottish capability. We then estimated potential Scottish content if the available Scottish supply chain was used.

The analysis of the current and future potential Scottish supply chain activity does not seek to discuss the gap between supply and demand.

What if analysis

Using the model and methodology from the ‘as-is’ economic impact analysis, we undertook a retrospective economic impact analysis of the projects in the case studies. We used the supply chain assessment to model the ‘what-if’ impacts, which were the maximum realistic impacts that could be achieved by similar projects at the same timescale as the case study projects, using the current Scottish supply chain.

Developers choose a supplier based on:

- The technical capability of the supplier
- The price of a bid
- The capacity of the supplier to deliver to the project schedule
- The ability of the supplier to meet quality thresholds, and
- The risk to the project.

This study concluded that a developer could use a supplier that met the first of these criteria but did not consider the other criteria.

Identify potential opportunities for and barriers to increasing the economic impacts in Scotland from existing and planned projects

The outputs from the supply chain assessment and the 'what-if' analysis showed where the opportunity is the greatest and where the progress has been slow. We engaged with the developers to discuss where they see the greatest barriers to increasing the economic impacts in Scotland, and two of the developers were able to provide input.

For each case study project, we then identified the main opportunities and made recommendations for the actions to realise those opportunities. These recommendations considered:

- Market. Is the opportunity sensitive to Scotland's home market?
- Competitiveness. What can be done to strengthen Scottish companies' market position?
- Inward investment. Is the opportunity dependent or linked to a major investment in Scotland?
- Technology. Is the opportunity linked to innovation in the Scottish supply chain?
- Parallel sectors. Is the opportunity linked to Scottish companies making the transition from sectors where Scotland has strengths?

The opportunities and recommendations were identified through internal discussion in the project team and through engagement with the developers of the case study projects.

Social impacts from offshore renewables developments complement the economic impacts that are assessed and quantified in this report – in Scotland as a whole, but particularly in local areas where economic impacts generate social impacts or where social impacts are directly generated through expenditures related to offshore renewables. Social impacts take time to emerge and for the projects considered it is too early to speculate on future impacts.

4. As-is analysis

4.1. Beatrice Offshore Wind Farm

Scottish supply chain used for Beatrice wind farm included the following:

- A number of activities during the development phase were carried out in Scotland, including SSE's internal project management, and some of the surveys.
- Wick was selected as the OMS base, and the port of Nigg was used as an installation port.
- Burntisland Fabrications (BiFab) supplied 26 of the jacket foundations for the project.

We drew primarily on SSE's published report by Biggar Economics on the economic impacts of Beatrice[2].

The costs used for the Beatrice project were based on figures for a similar UK project. We adjusted the costs to reflect the differences between this original project and the Beatrice project using BVGA's experience of cost modelling.

Scottish and content

Our analysis of Beatrice wind farm shows that the overall Scottish content for the project was 29.6%, of which the local content was 11.7%. Figure 1 and Table 1 show these figures broken down by area of supply chain. It includes both generation and dedicated transmission assets. Expenditure on transmission assets ultimately owned by the Offshore Transmission Owner (OFTO) is included in balance of plant, installation and commissioning, and OMS, as appropriate.

The highest Scottish content is in project development and management, where 68.5% of the total spend was in Scotland.

The highest local content was in OMS, where 21% of the spend was local.

[2] SEE Economic Impact of Beatrice Offshore Windfarm Limited

Source: BVG Associates

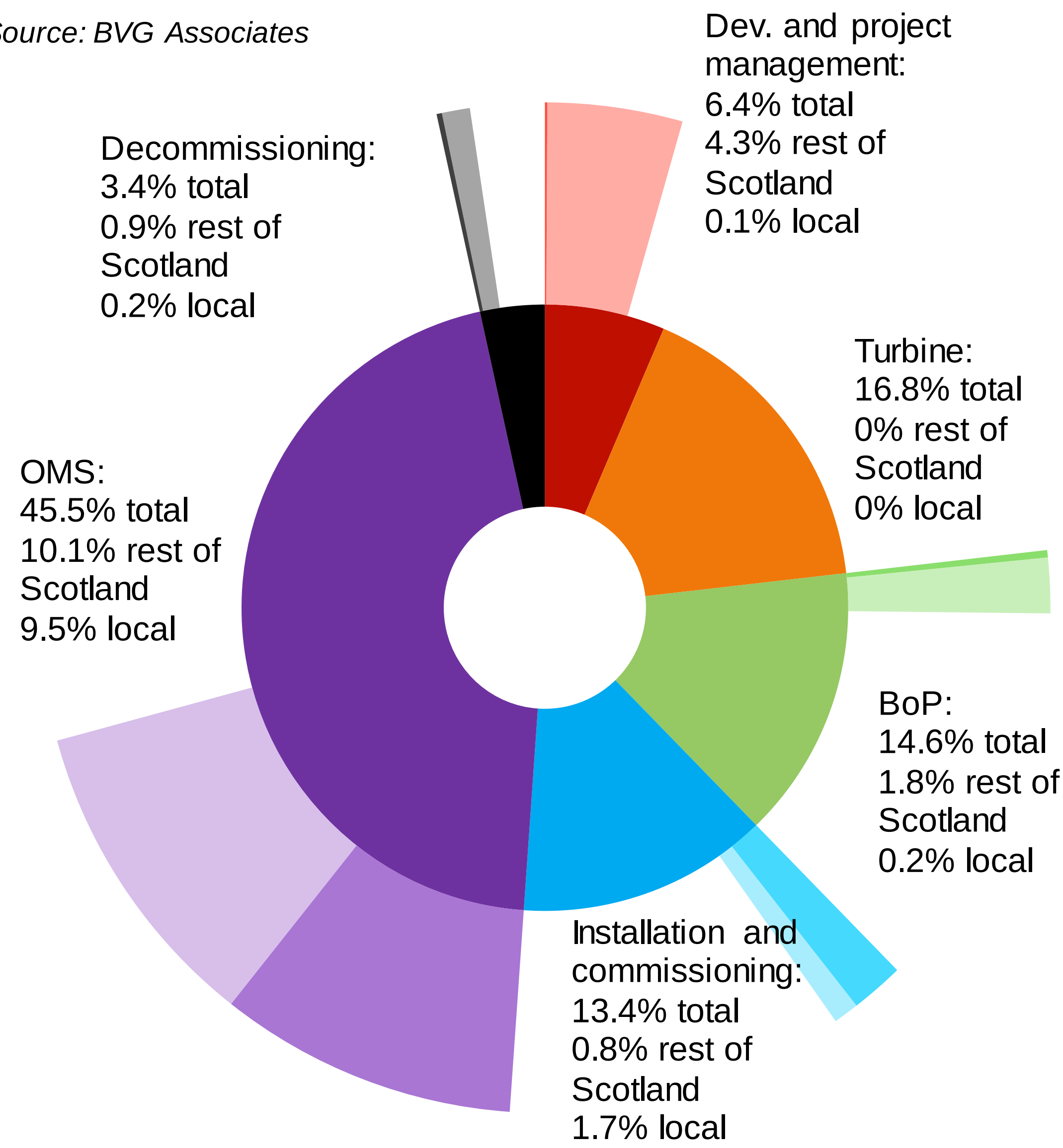

Figure 1 Scottish and local content in Beatrice Offshore Wind Farm by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	6.4%	Scotland	68.5%	4.4%	Local	1.2%	0.1%
		Non-Scotland	31.5%	2%	Rest of Scotland	67.4%	4.3%
Turbine supply	16.8%	Scotland	0%	0%	Local	0%	0%
		Non-Scotland	100%	16.8%	Rest of Scotland	0%	0%
Balance of plant	14.6%	Scotland	13.8%	2%	Local	1.6%	0.2%
		Non-Scotland	86.2%	12.5%	Rest of Scotland	12.1%	1.8%
Installation and commissioning	13.4%	Scotland	18.8%	2.5%	Local	12.7%	1.7%
		Non-Scotland	81.2%	10.9%	Rest of Scotland	6.1%	0.8%
Operation, maintenance and service	45.5%	Scotland	43.2%	19.7%	Local	21%	9.5%
		Non-Scotland	56.8%	25.8%	Rest of Scotland	22.2%	10.1%
Decommissioning	3.4%	Scotland	31%	1.1%	Local	5%	0.2%
		Non-Scotland	69%	2.4%	Rest of Scotland	26%	0.9%
Total	100%	Scotland	29.6%	29.6%	Local	11.7%	11.7%
		Non-Scotland	70.4%	70.4%	Rest of Scotland	17.9%	17.9%

Table 1 Scottish and local content in Beatrice Offshore Wind Farm by supply chain category.

GVA, earnings and employment

Table 2 summarises the economic impact on Scotland and locally from the Beatrice project.

Gross value-added

We concluded that Beatrice will generate about £1,300 million direct, indirect and induced GVA in Scotland, of which £444 million is local, over the lifetime of the wind farm. Figure 2 shows that Scottish GVA peaks at £175 million in 2018. The main contributors are balance of plant, mainly from turbine and substation foundations, and installation and commissioning, mainly from the construction of the onshore substation and cable route.

OMS will generate the greatest amount of Scottish GVA at £850 million, comprising 24% direct, 59% indirect and 17% induced GVA (see Figure 3). OMS will create £360 million locally.

Table 2 Summary of direct, indirect and induced economic impacts generated by Beatrice Offshore Wind Farm.

Impact	Scotland				Local			
	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£422	£643	£235	£1,300	£309	£113	£22	£444
Earnings (millions)	£256	£180	£70	£506	£189	£31	£7	£227
FTE years	4,830	4,980	1,810	11,620	3,970	880	220	5,070

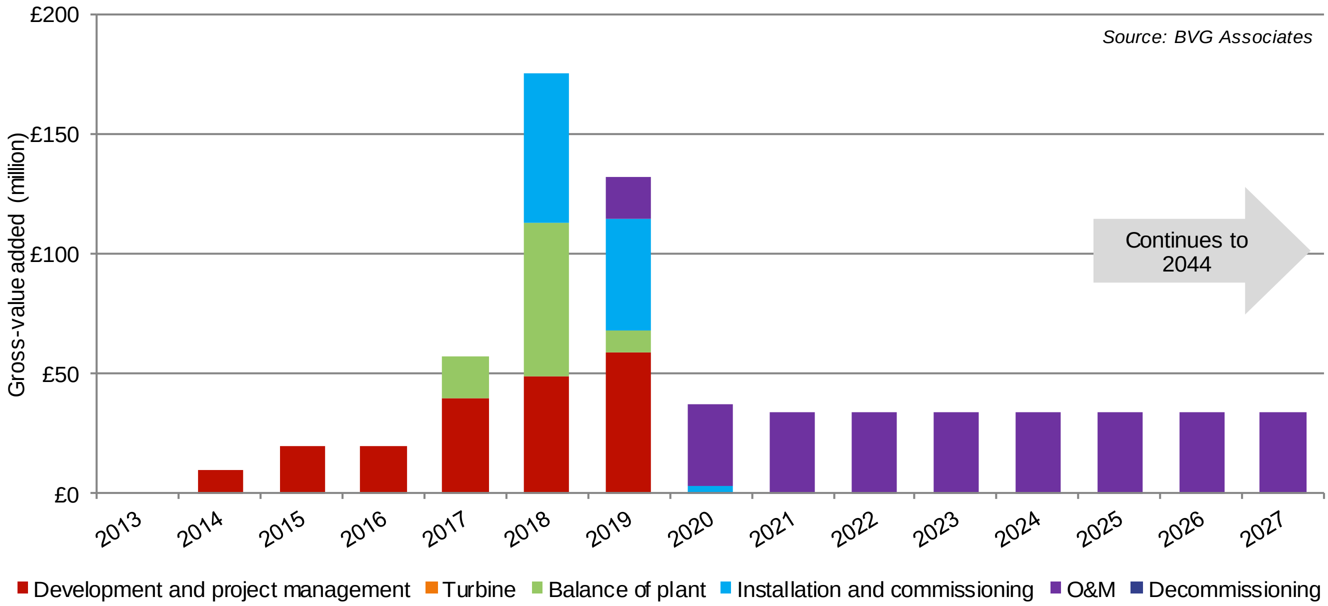

Figure 2 Gross-value added generated in Scotland by Beatrice Offshore wind farm split by supply chain area.

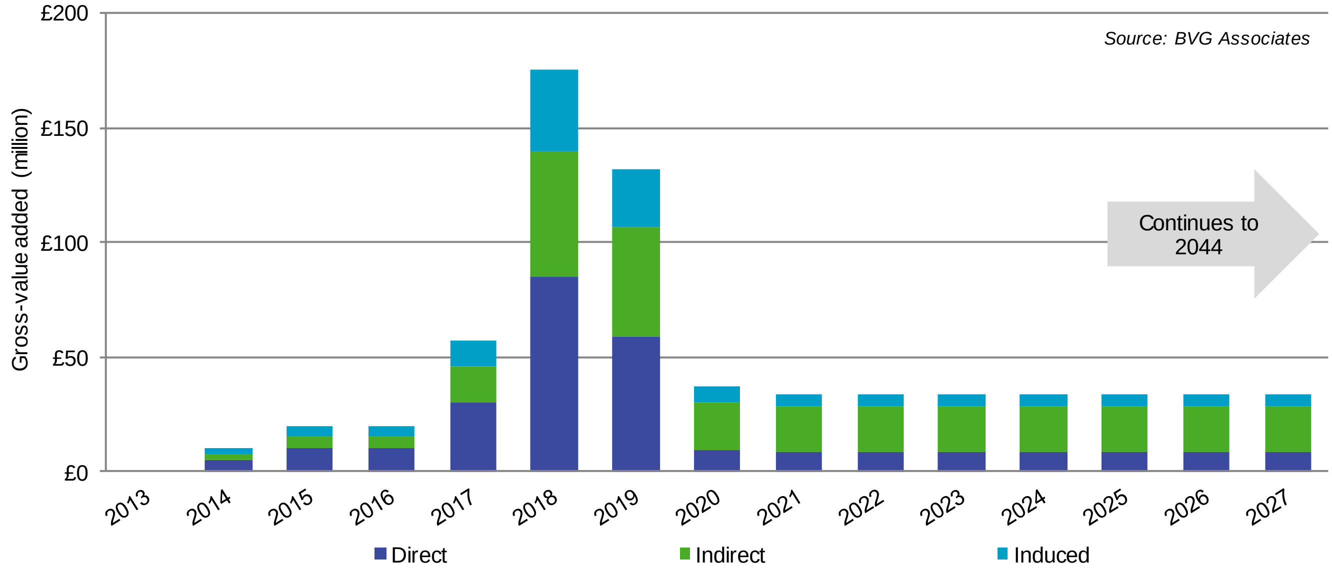

Figure 3 Gross-value added generated in Scotland by Beatrice Offshore Wind Farm by direct, indirect and induced impact.

Employment

Over the lifetime of the wind farm 11,620 FTE years will have been created in Scotland, of which 5,070 will have been local. The number of FTEs created each year between 2014 and 2044, broken down by supply chain, is shown in Figure 4.

Scottish FTEs peaked in the construction and installation phase in 2018, when 1,800 FTE years were created. This comprised 56% direct, 26% indirect and 18% induced FTE years (see Figure 5).

OMS will create around 7,400 FTE years over the lifetime of Beatrice, including the permanent local work force, developer back office functions and periodic work on the wind farm. 4,070 of these OMS jobs will be local**.**

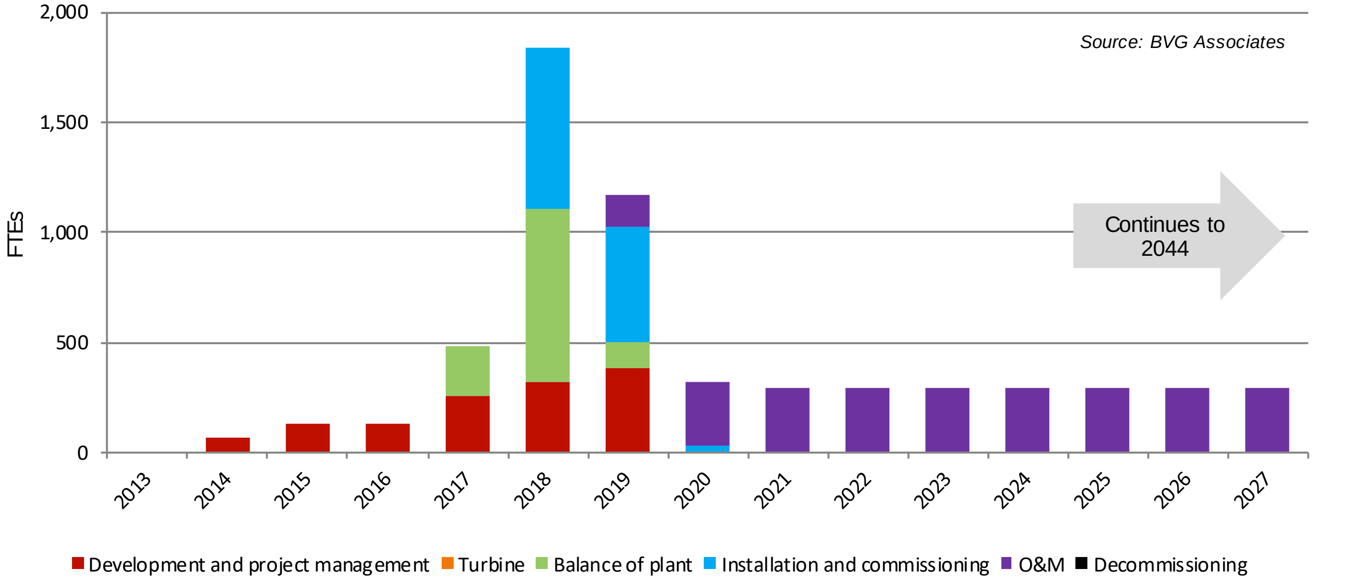

Figure 4 Full-time equivalent years employment created in Scotland by Beatrice Offshore Wind Farm by supply chain area.

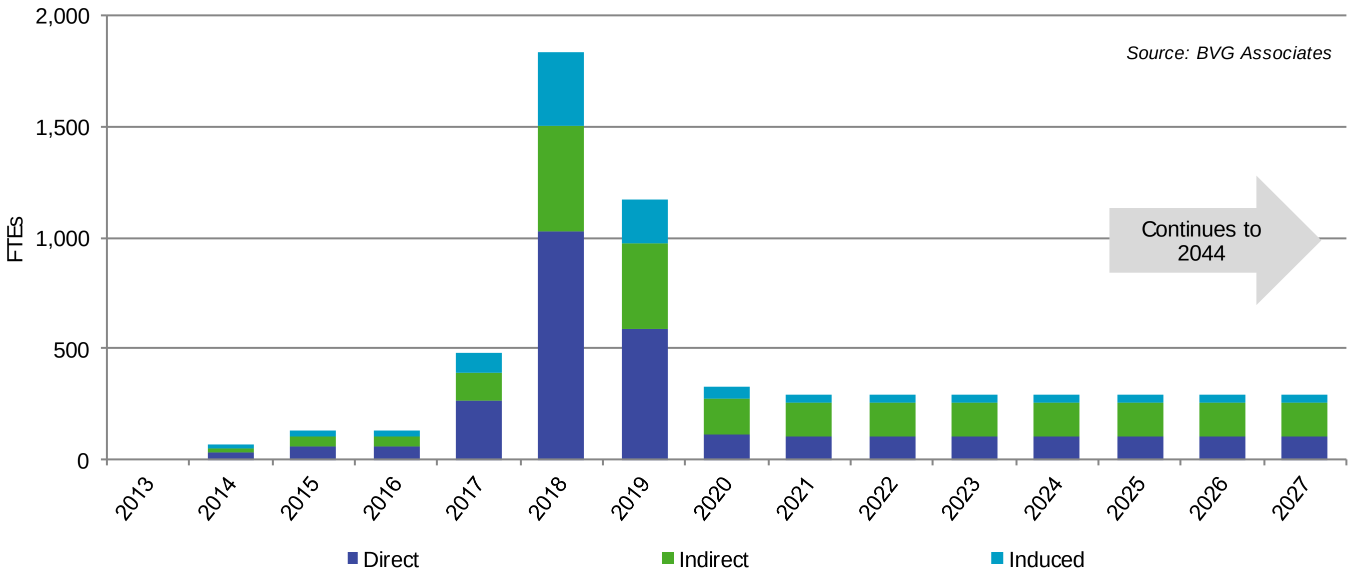

Figure 5 Full-time equivalent years employment created in Scotland by Beatrice Offshore Wind Farm by direct, indirect and induced impact.

4.2. Neart Na Gaoithe Offshore Wind Farm

Scottish supply chain used for NNG offshore wind farm includes the following:

- The assembly of the turbines will be carried out in Port of Dundee.
- BiFab will fabricate eight of the jacket foundations.
- Eyemouth Harbour will be the OMS base.

We drew on publicly available information about contracts placed, which was used to validate the modelling.

The costs used for the NNG project were based on figures for a similar UK project. We adjusted the costs to reflect the differences between this original project and the NNG project using BVGA's own experience of cost modelling.

Scottish and local content

Our analysis of NNG shows that the overall Scottish content for the project was 29.3% and that 11.9% was local content. Figure 6 and Table 3 show these figures broken down by area of supply chain.

The largest Scottish content by percentage is in project development and management, where 59.6% of the total spend in the category was in Scotland. Although Scottish content is only 44.5% for OMS, the large lifetime spend means OMS delivers the largest total value to the Scottish supply chain. OMS also provide the highest local content, at 21%.

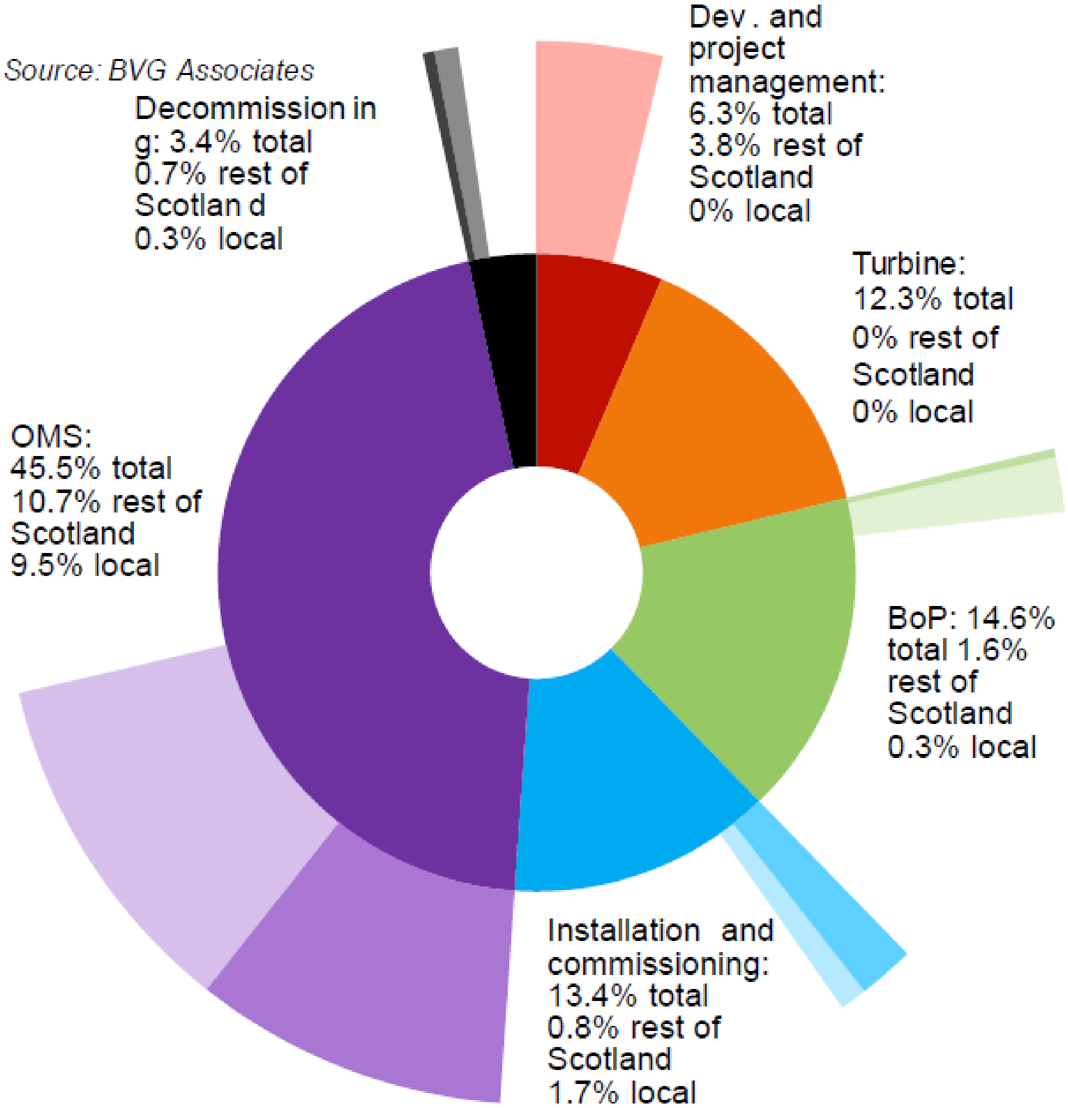

Figure 6 Scottish and local content in Neart Na Gaoithe Offshore Wind Farm by supply chain category.

Table 3 Scottish and local content in Neart Na Gaoithe Offshore Wind Farm by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	6.3%	Scotland	59.6%	3.8%	Local	0.7%	0%
		Non-Scotland	40.4%	2.6%	Rest of Scotland	58.8%	3.8%
Turbine supply	12.3%	Scotland	0%	0%	Local	0%	0%
		Non-Scotland	100%	14.8%	Rest of Scotland	0%	0%
Balance of plant	14.6%	Scotland	11.6%	1.9%	Local	1.6%	0.3%
		Non-Scotland	88.4%	14.6%	Rest of Scotland	10%	1.6%
Installation and commissioning	13.4%	Scotland	18.8%	2.5%	Local	12.7%	1.7%
		Non-Scotland	81.2%	10.9%	Rest of Scotland	6.1%	0.8%
Operation, maintenance and service	45.5%	Scotland	44.5%	20.2%	Local	21%	9.5%
		Non-Scotland	55.5%	25.2%	Rest of Scotland	23.5%	10.7%
Decommissioning	3.4%	Scotland	31%	1.1%	Local	10%	0.3%
		Non-Scotland	69%	2.4%	Rest of Scotland	21%	0.7%
Total	100%	Scotland	29.3%	29.3%	Local	11.9%	11.9%
		Non-Scotland	70.7%	70.7%	Rest of Scotland	17.5%	17.5%

GVA, earnings and employment

Table 4 summarises the economic impact locally and on Scotland from the NNG project.

Gross-value added

NNG will generate £980 million direct, indirect and induced GVA in Scotland over the lifetime of the wind farm, of which £342 million will be local.

Figure 7 shows that Scottish GVA peaks during the construction and installation phase in 2021, at around £120 million.

Over the lifetime OMS generates the greatest amount of Scottish and local GVA at £670 million and £275 million respectively, comprising of 25% direct, 58% indirect and 17% induced GVA (see Figure 8).

Table 4 Summary of direct, Indirect and induced economic impact generated by Neart Na Gaoithe Offshore Wind Farm.

	Scotland				Local			
Impact	**Direct**	**Indirect**	**Induced**	**Total**	**Direct**	**Indirect**	**Induced**	**Total**
Value-added (millions)	£320	£483	£177	£980	£236	£89	£17	£342
Earnings (millions)	£194	£135	£53	£382	£145	£24	£5	£174
FTE years	3,700	3,940	1,400	9,040	3,030	710	170	3,910

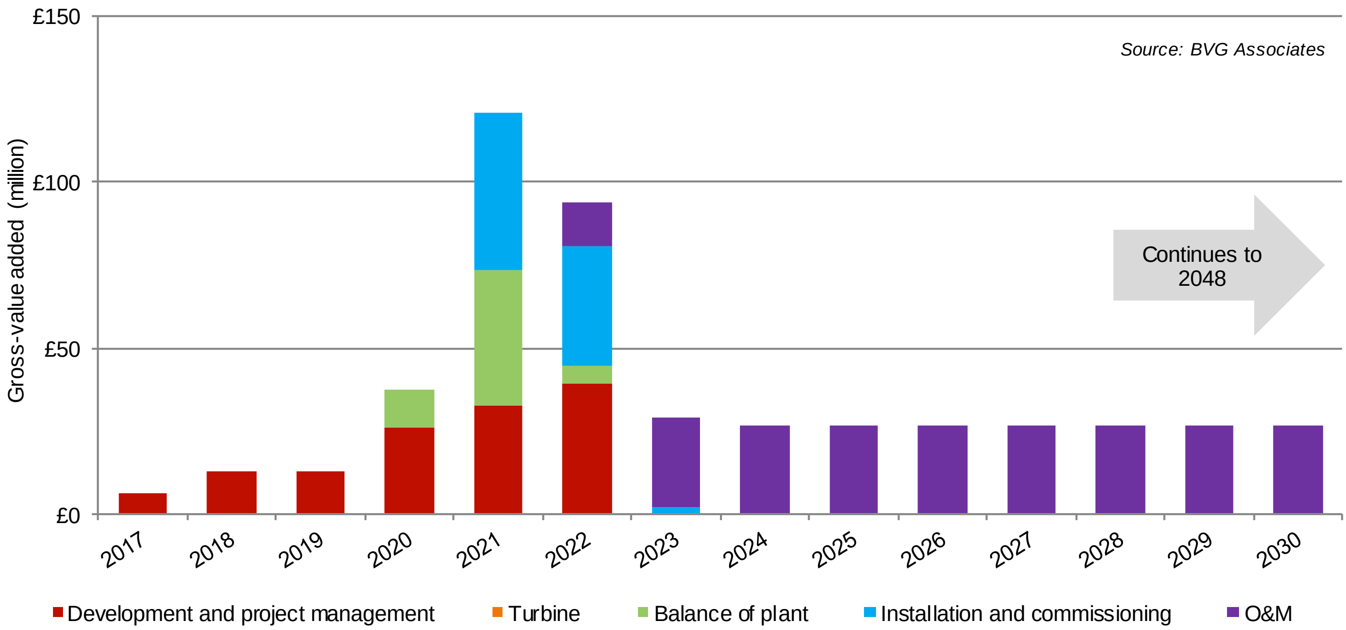

Figure 7 Gross-value added generated in Scotland by Neart Na Gaoithe Offshore Wind Farm split by supply chain area.

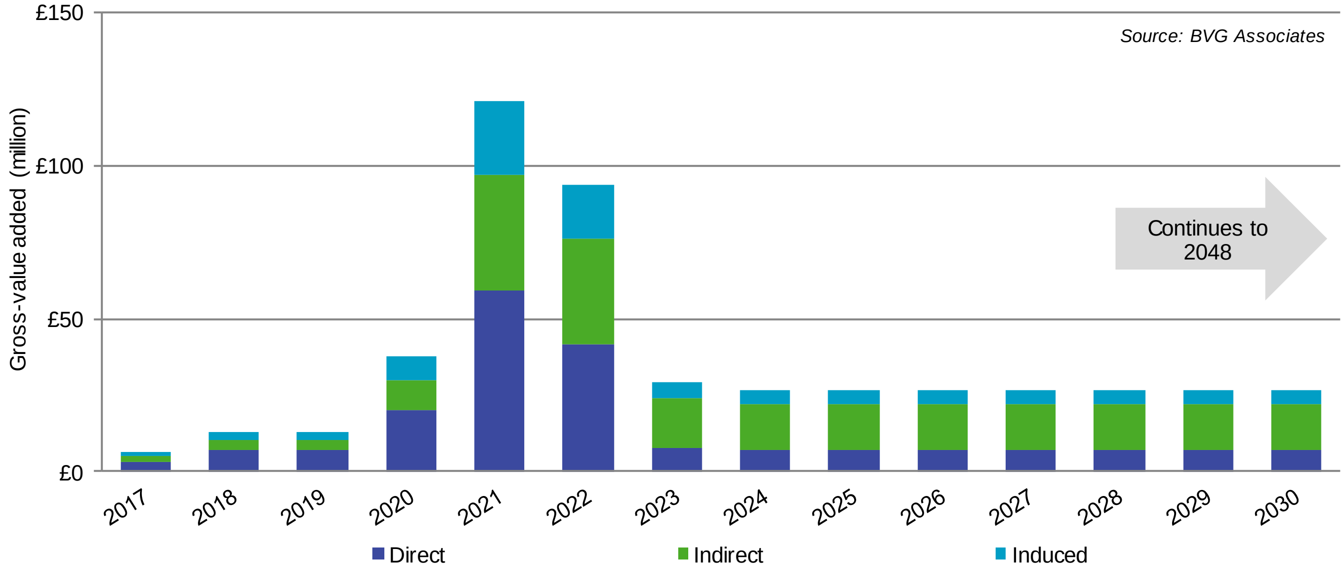

Figure 8 Gross-value added generated in Scotland by Neart Na Gaoithe Offshore Wind Farm by direct, indirect and induced impact.

Employment

Over the lifetime of the wind farm 9,040 FTE years will be created in Scotland, of which 3,910 will have been local. The number of FTE years created each year between 2017 and 2048, broken down by supply chain, is shown in Figure 9. Scottish FTE years peak in the construction and installation phase in 2021, when 1,270 FTE years will be created. This comprises 56% direct, 26% indirect and 28% induced FTE years (see Figure 10).

OMS will create 6,100 FTE years over the lifetime of NNG in Scotland, and this includes the permanent local work force, developer back office functions and periodic work on the wind farm. OMS will create 3,110 FTE years locally.

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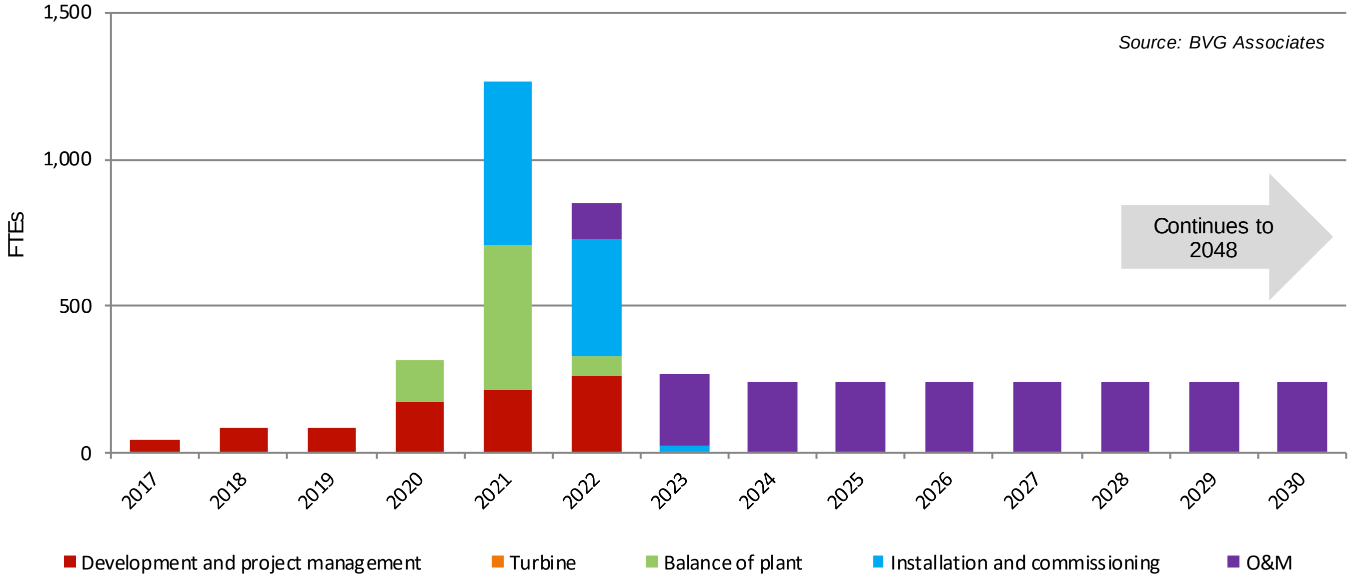


Figure 9 Full-time equivalent years employment created in Scotland by Neart Na Gaoithe Offshore Wind Farm by supply chain area.

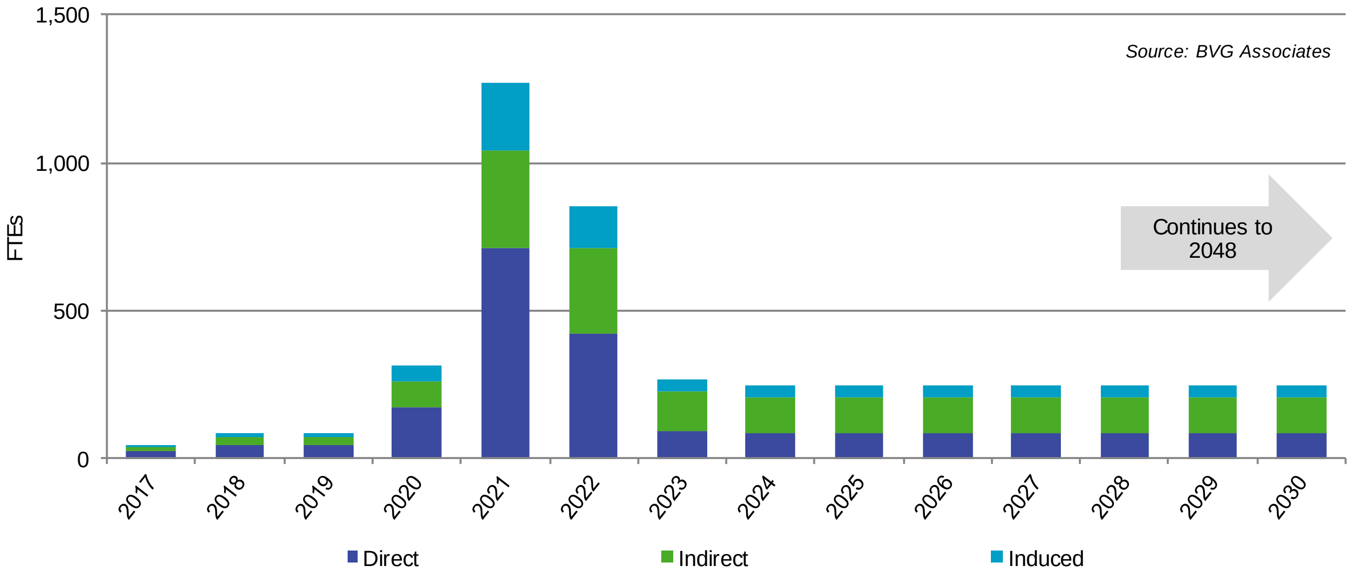


Figure 10 Full-time equivalent years employment created in Scotland by Neart Na Gaoithe Offshore Wind Farm by direct, indirect and induced impact.

4.3. Hywind Scotland

Scottish supply chain used for Hywind Scotland offshore wind farm included the following:

- The suction anchors were fabricated by Isleburn.
- The trenching for the export cable was undertaken by Fugro UK from Aberdeen.
- The offshore cable installation engineering was undertaken by Subsea 7 from Aberdeen.

Equinor provided us with some information about suppliers used and contracts placed, as well as some information around costs.

The costs used for the Hywind Scotland project were based on a percentage breakdown of cost provided by Equinor for the project and adjusted and validated using BVGA's own experience of offshore wind farm cost modelling.

Hywind Scotland is a demonstration project. It is unlikely that a commercial scale project would be delivered in the same way and this would have implications for the selection of Scottish suppliers.

Scottish and local content

The overall Scottish content for the project was 19.9%. The local content was 9%. Figure 11 and Table 5 show these figures broken down by area of supply chain. It includes both generation and transmission assets.

The largest Scottish content by percentage is in OMS, where 42.4% of the total spend in the category was in Scotland.

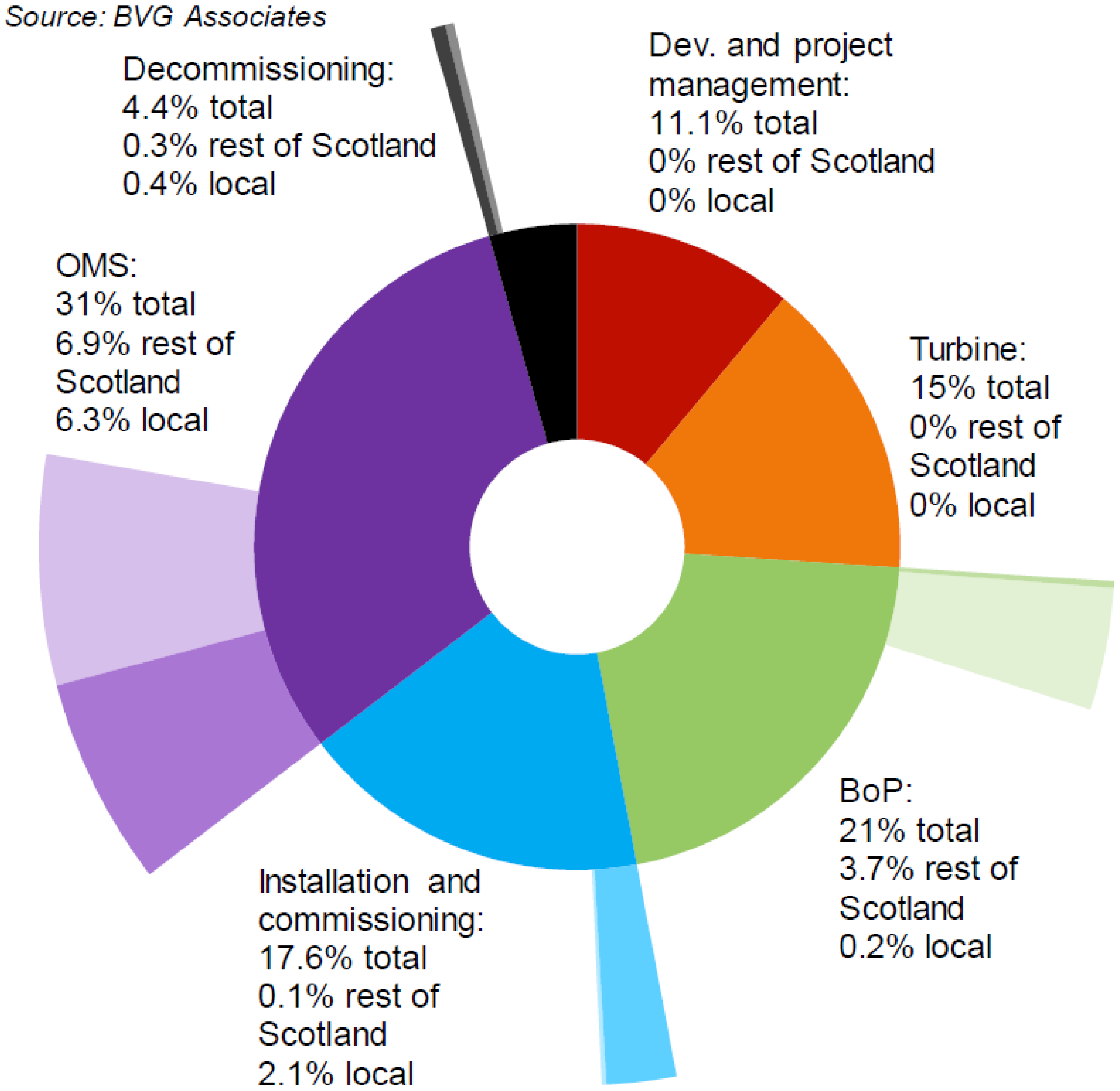


Figure 11 Scottish and local content in Hywind Scotland by supply chain category.

Table 5 Scottish and local content in Hywind Scotland by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	11.1%	Scotland	0%	0%	Local	0%	0%
		Non-Scotland	100%	11.1%	Rest of Scotland	0%	0%
Turbine supply	15.0%	Scotland	0%	0%	Local	0%	0%
		Non-Scotland	100%	15%	Rest of Scotland	0%	0%
Balance of plant	21.0%	Scotland	18.3%	3.9%	Local	0.9%	0.2%
		Non-Scotland	81.7%	17.2%	Rest of Scotland	17.4%	3.7%
Installation and commissioning	17.6%	Scotland	12.7%	2.2%	Local	11.9%	2.1%
		Non-Scotland	87.3%	15.3%	Rest of Scotland	0.7%	0.1%
Operation, maintenance and service	31.0%	Scotland	42.4%	13.1%	Local	20.2%	6.3%
		Non-Scotland	57.6%	17.9%	Rest of Scotland	22.2%	6.9%
Decommissioning	4.4%	Scotland	16%	0.7%	Local	10%	0.4%
		Non-Scotland	84%	3.7%	Rest of Scotland	6.0%	0.3%
Total	100%	Scotland	19.9%	19.9%	Local	9%	9%
		Non-Scotland	80.1%	80.1%	Rest of Scotland	10.9%	10.9%

GVA, earnings and employment

The economic impacts have been assessed between 2015 and 2038, which is the projected decommissioning date for Hywind Scotland. Table 6 summarises the impact of the wind farm over Hywind Scotland's lifetime.

Gross-value added

Hywind Scotland will generate £68 million direct, indirect and induced GVA in Scotland over the lifetime of the wind farm, of which £26 million will be generated locally. GVA peaked during the construction and installation phase in 2016, at around £13 million (see Figure 12).

Over the lifetime OMS generates the greatest amount of GVA at £41 million, comprising of 25% direct, 58% indirect and 17% induced GVA (see Figure 13). Locally this would generate £17 million.

Table 6 Summary of direct, Indirect and induced economic impact generated by Hywind Scotland.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£24	£31	£13	£68	£15	£10	£1	£26
Earnings (millions)	£14	£9	£4	£27	£9	£3	£0.5	£12.5
FTE years	310	270	110	690	185	95	15	295

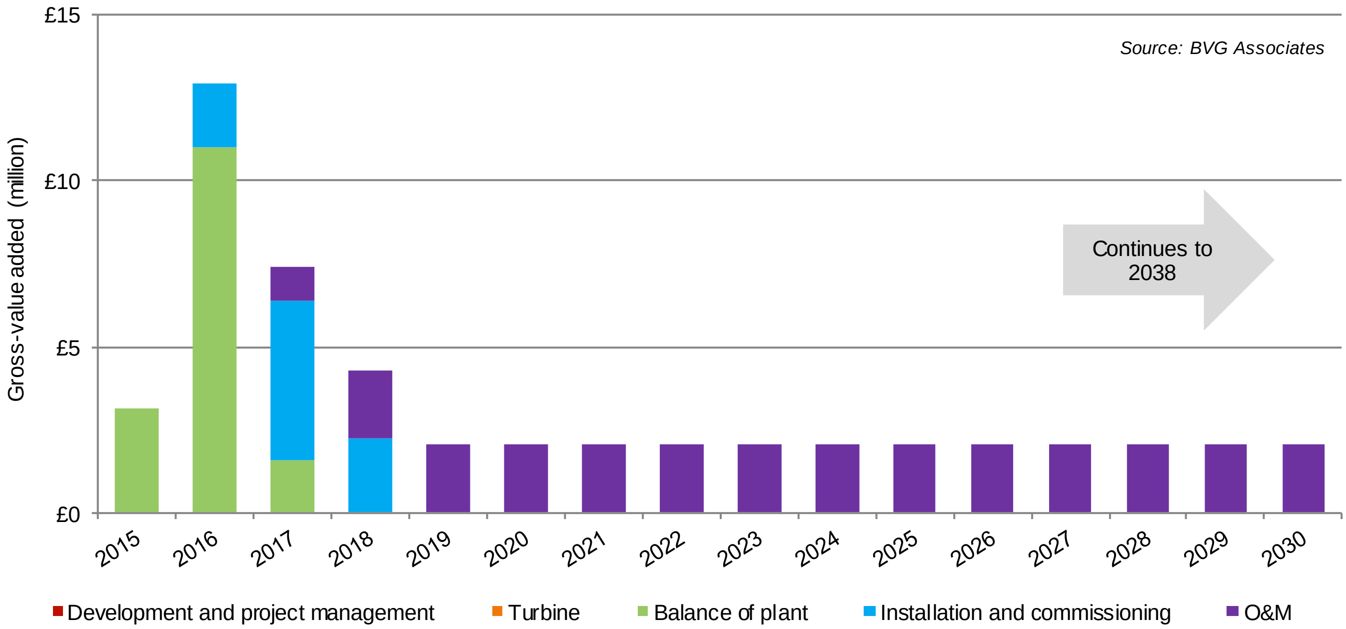


Figure 12 Gross-value added split generated by Hywind Scotland by supply chain area.

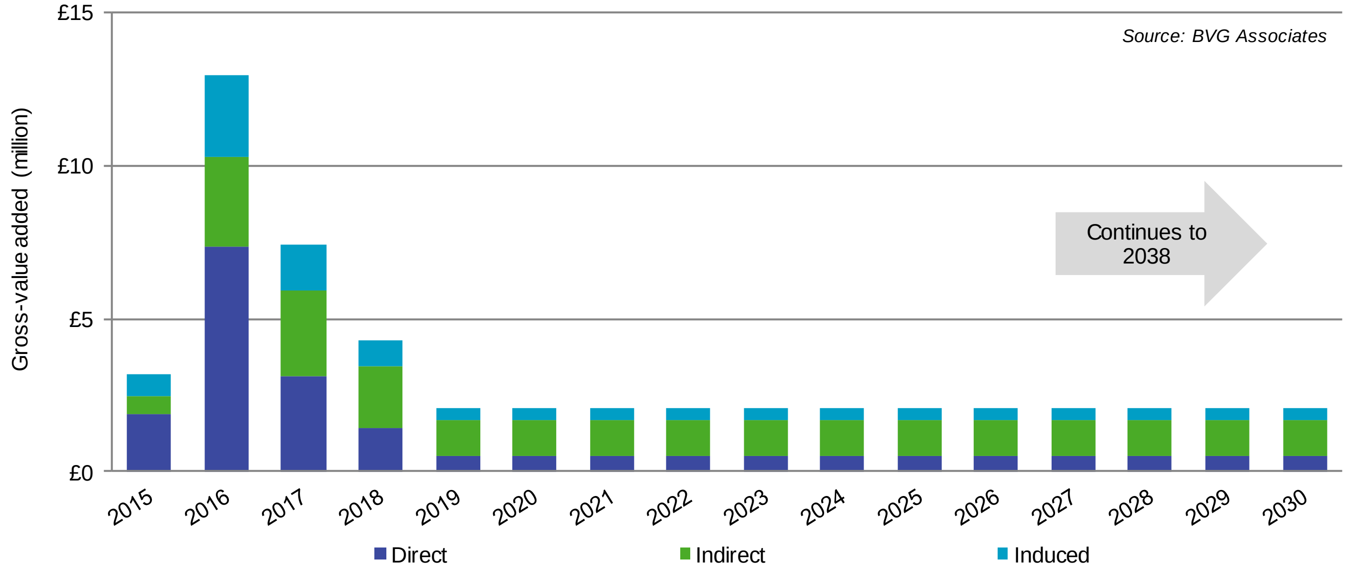


Figure 13 Gross-value added generated in Scotland by Hywind Scotland by direct, indirect and induced impact

Employment

Over the lifetime of the wind farm 690 FTE years will have been created in Scotland, of which 295 are local. The number of FTEs created in Scotland each year between 2014 and 2038, broken down by supply chain, is shown in Figure 14.

FTE years in Scotland peak in the construction and installation phase in 2016, when 152 FTE years were created. This comprises 64% direct, 18% indirect and 18% induced FTE years (see Figure 15).

OMS will create 375 FTE years in Scotland over the lifetime of the wind farm, and this includes the permanent local work force, developer back office functions and periodic work on the wind farm. Of these, 190 will be local.

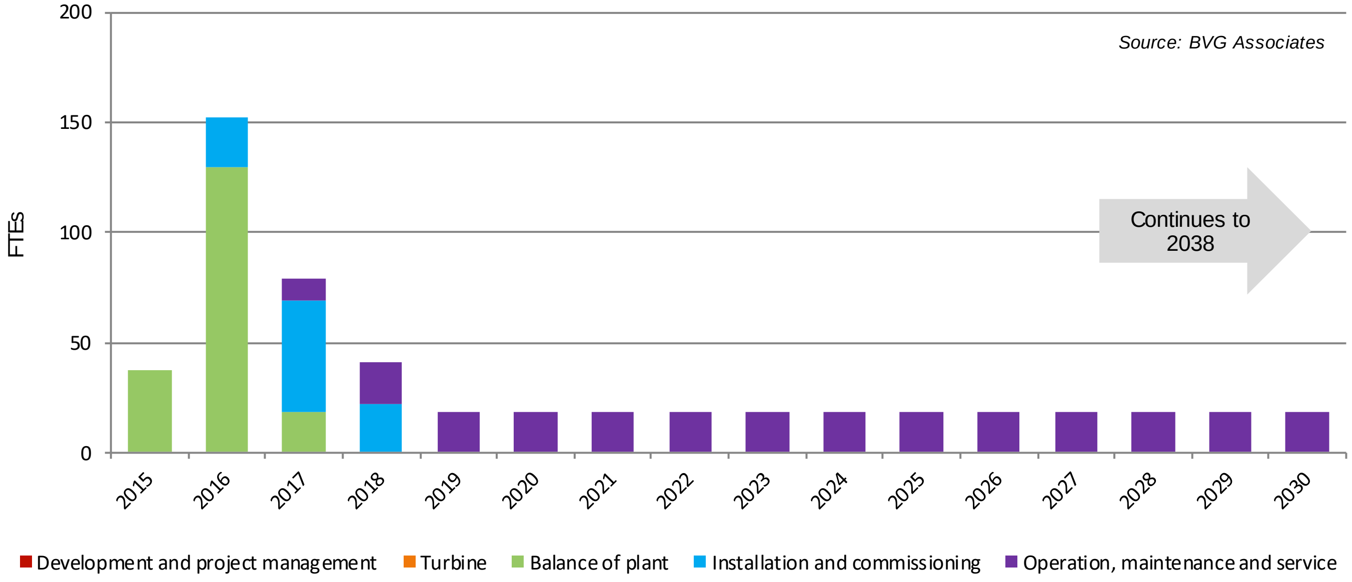


Figure 14 Full-time equivalent years employment created in Scotland by Hywind Scotland by supply chain area.

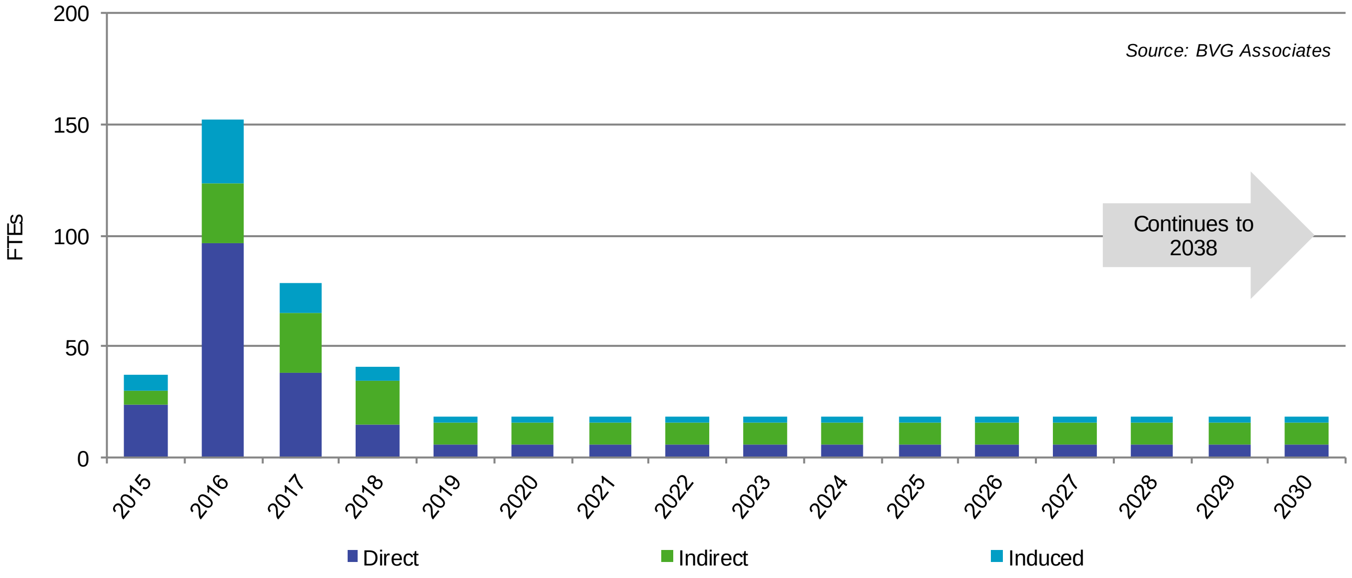


Figure 15 Full-time equivalent years employment created in Scotland by Hywind Scotland by direct, indirect and induced impact.

4.4. MeyGen Phase 1A

Scottish supply chain used for MeyGen Phase 1A includes:

- A large part of the fabrication of the turbine support structure work was undertaken by Global Energy Group.
- The fabrication of the ballast blocks for the turbine support structure was mainly carried out by JGC.
- Fabrication and assembly of the one of the turbines was performed in Scotland.
- More than half of the project delivery work by MeyGen was carried out in Scotland.
- SHEPD installed 15km of 33kV onshore cable.

We had access to cost data and content information used in a previous study for HIE, which was used to inform and validate our modelling. The costs used for the MeyGen Phase 1A project were based on costs provided by the developer of the project.

MeyGen Phase 1A is a demonstration project, and therefore procurement decisions might not be representative of a commercial scale tidal project.

Scottish and local content

Our analysis of MeyGen shows that the overall Scottish content for the project was 40%, of which the local content was 14.5%. Figure 16 and Table 7 show these figures broken down by area of supply chain. It includes both generation and transmission assets.

The largest Scottish content by percentage is in development and project management, where 70.7% of the total spend in the category was in Scotland. Although Scottish content is only 44.6% for OMS, the large lifetime spend means OMS delivers the largest total value to the Scottish supply chain.

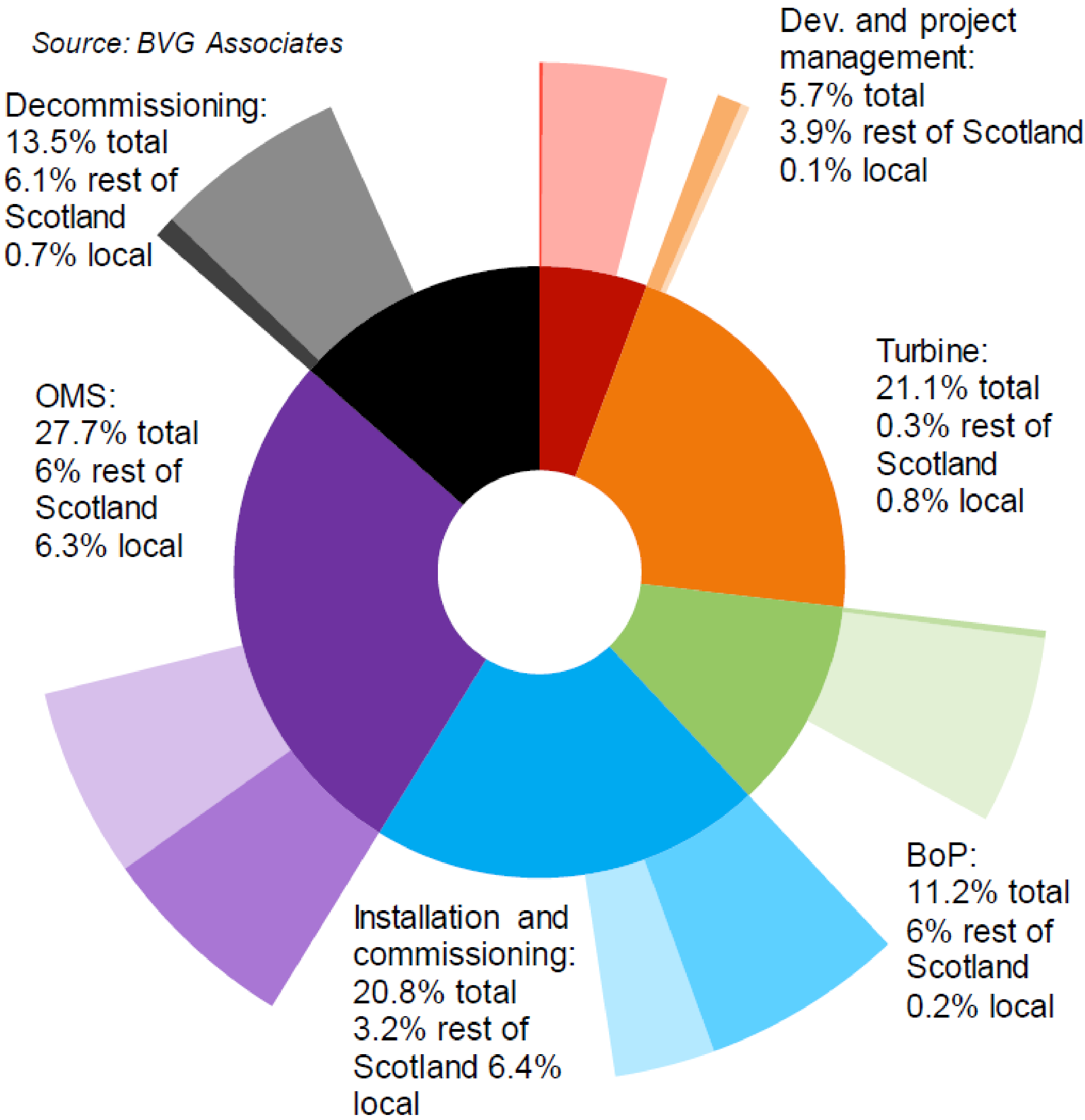


Figure 16 Scottish and local content in MeyGen Phase 1A by supply chain category.

Table 7 Scottish and local content in MeyGen Phase 1A by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	5.7%	Scotland	70.7%	4%	Local	1.7%	0.1%
		Non-Scotland	29.3%	1.7%	Rest of Scotland	69%	3.9%
Turbine supply	21.1%	Scotland	5%	1.1%	Local	3.7%	0.8%
		Non-Scotland	95%	20.1%	Rest of Scotland	1.3%	0.3%
Balance of plant	11.2%	Scotland	55.5%	6.2%	Local	2.1%	0.2%
		Non-Scotland	44.5%	5%	Rest of Scotland	53.4%	6%
Installation and commissioning	20.8%	Scotland	46.2%	9.6%	Local	30.9%	6.4%
		Non-Scotland	53.8%	11.2%	Rest of Scotland	15.3%	3.2%
Operation, maintenance and service	27.7%	Scotland	44.6%	12.4%	Local	22.8%	6.3%
		Non-Scotland	55.4%	15.3%	Rest of Scotland	21.8%	6%
Decommissioning	13.5%	Scotland	50.2%	6.8%	Local	5%	0.7%
		Non-Scotland	49.8%	6.7%	Rest of Scotland	45.2%	6.1%
Total	100%	Scotland	40%	40%	Local	14.5%	14.5%
		Non-Scotland	60%	60%	Rest of Scotland	25.5%	25.5%

GVA, earnings and employment

Table 8 summarises the economic impact of MeyGen Phase 1A locally and in Scotland.

Gross-value added

MeyGen will generate £41 million direct, indirect and induced GVA in Scotland over the lifetime of the project, of which £13.5 million will be generated locally. GVA in Scotland peaked during the construction and installation phase in 2016, at around £11 million (see Figure 17)

Over the lifetime OMS generates the greatest amount of GVA in Scotland at £13 million, comprising of 42% direct, 39% indirect and 19% induced GVA (see Figure 18). OMS would create £4 million locally.

Table 8 Summary of direct, Indirect and induced economic impact generated by MeyGen Phase 1A.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£17	£16	£8	£41	£6	£7	£0.5	£13.5
Earnings (millions)	£5	£9	£2	£16	£2	£4	£0.5	£6.5
FTE years	170	260	90	520	60	110	5	175

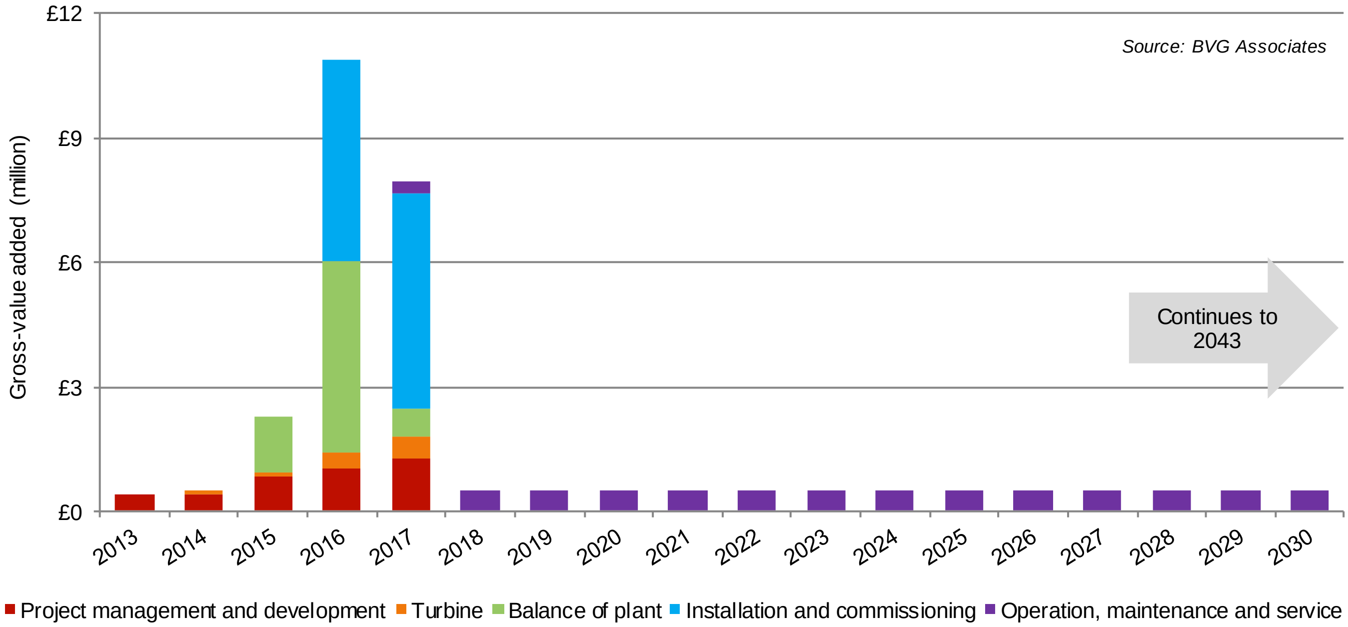


Figure 17 Gross-value added split generated by MeyGen Phase 1A by supply chain area.

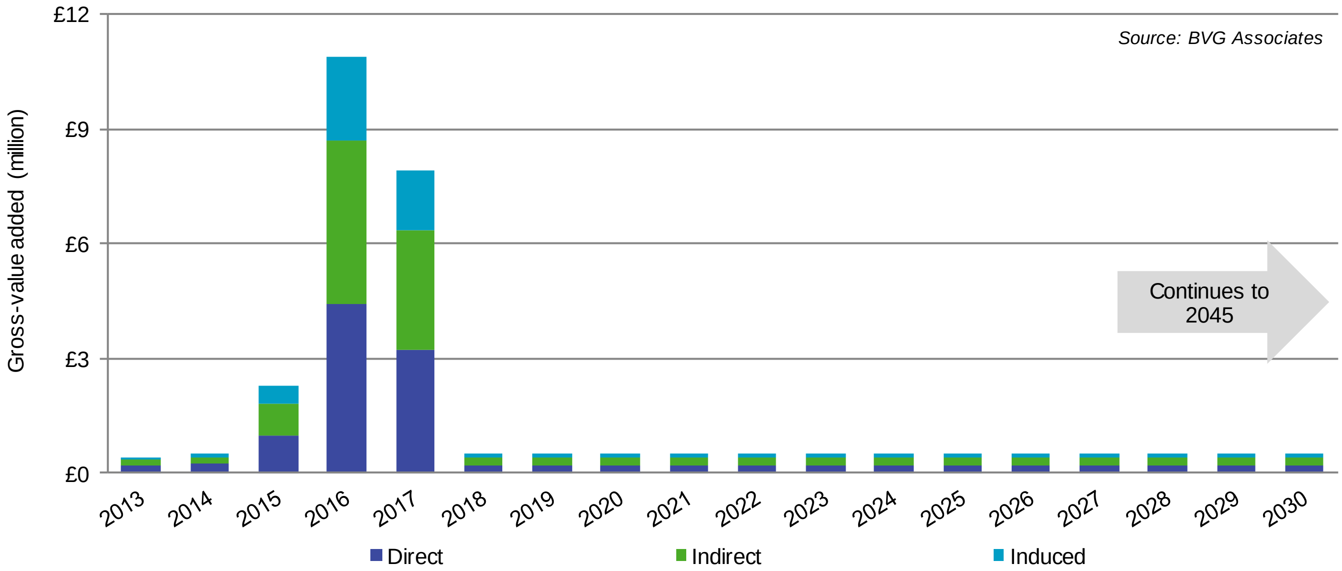


Figure 18 Gross-value added generated in Scotland by MeyGen Phase 1A by direct, indirect and induced impact

Employment

Over the lifetime of the project 520 FTE years will have been created in Scotland, of which 175 are local. The number of FTE years created in Scotland each year between 2013 and 2043, broken down by supply chain, is shown in Figure 19.

FTEs peak in the construction and installation phase in 2016, when 130 FTEs were created. This comprises 27% direct, 56% indirect and 17% induced FTEs (see Figure 20).

OMS will create 180 FTE years over the lifetime of project in Scotland, and this includes the permanent local work force, developer back office functions and periodic work on the project. Of those, 75 FTE years will be local.

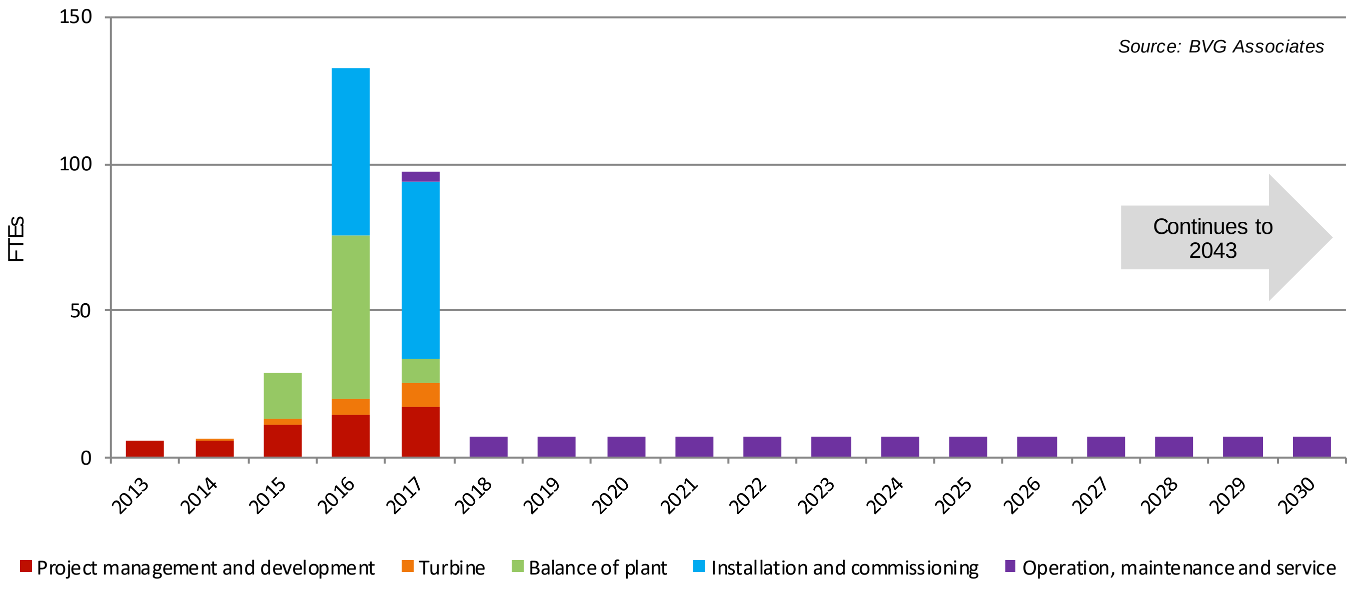


Figure 19 Full-time equivalent years employment created in Scotland by MeyGen Phase 1A by supply chain area.

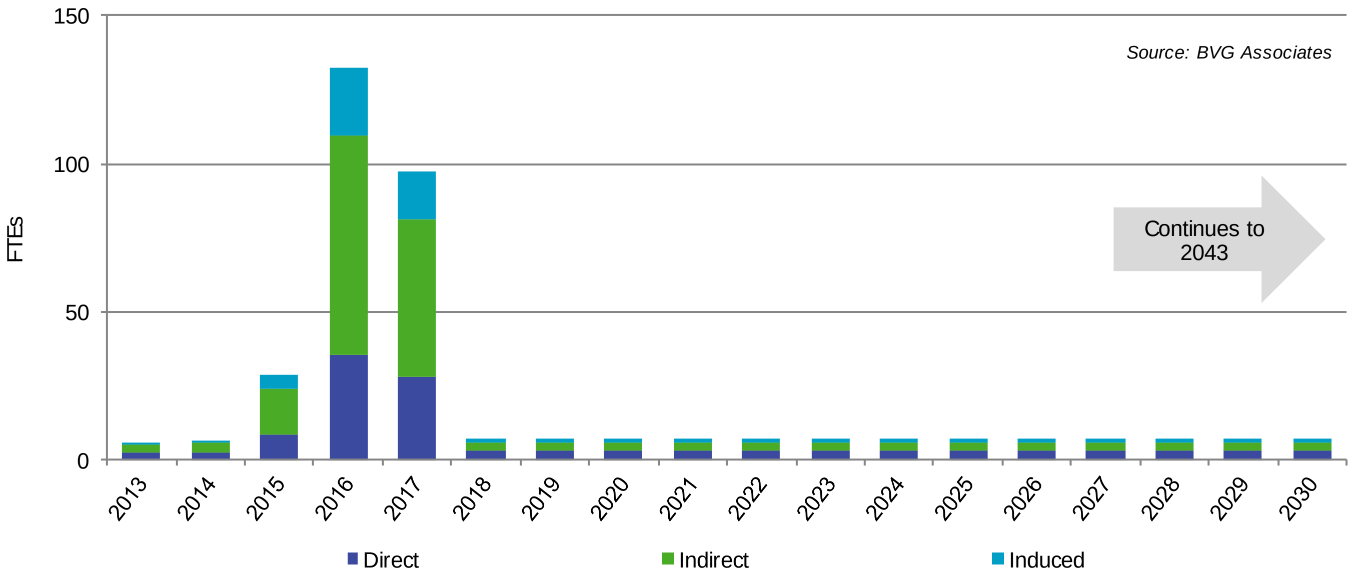


Figure 20 Full-time equivalent years employment created in Scotland by MeyGen Phase 1A by direct, indirect and induced impact.

5. Supply chain assessment[3]

5.1. Development & project management

The charts in this section relate to the fixed offshore wind supply chain, as this is the most mature supply chain of those considered. Where the floating offshore wind or tidal supply chain assessment differs from the fixed offshore wind supply chain, this has been included in the text.

Development

The Scottish supply chain has good capability to offer development services to the offshore renewable energy sector.

Scottish companies have developed commercial scale offshore wind projects already.

Scottish companies have the capability to transition from other sectors (such as onshore wind, maritime, oil and gas) with minimal investment (no new factories or costly equipment required).

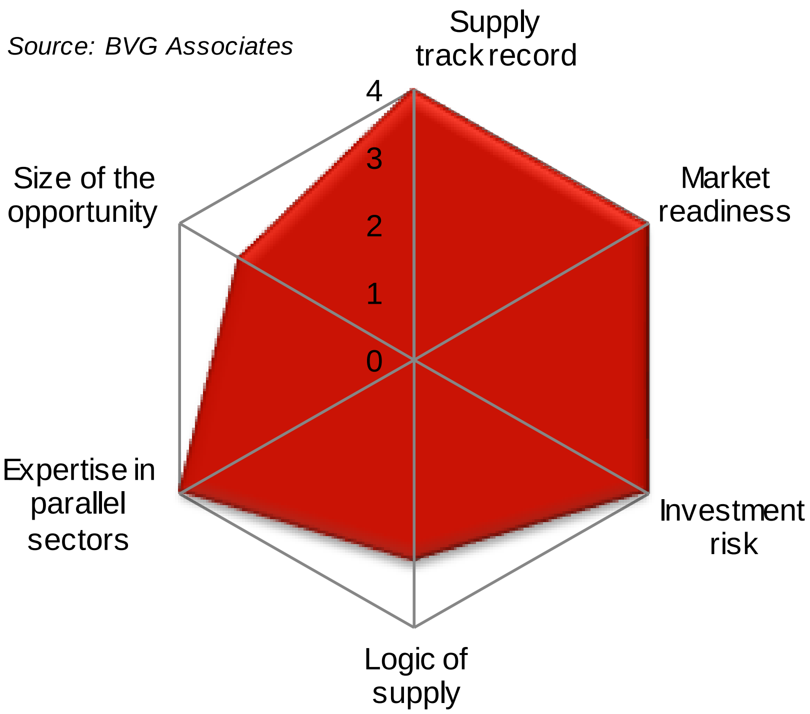


Figure 21 Summary of the assessment for development.

[3] This analysis was undertaken in 2019 and some of the information may have been superseded.

Project management

Scottish supply chain has good capability to offer project management services to the offshore renewables sector.

Scottish offshore wind developers have managed offshore wind projects in the past and Scottish companies have the capability to transition from other sectors (onshore wind, marine, oil and gas) with minimal investment (as no new factories or costly equipment required).

The economic benefit to the project management taking place in Scotland is small, as it represents a minor portion of total project spend.

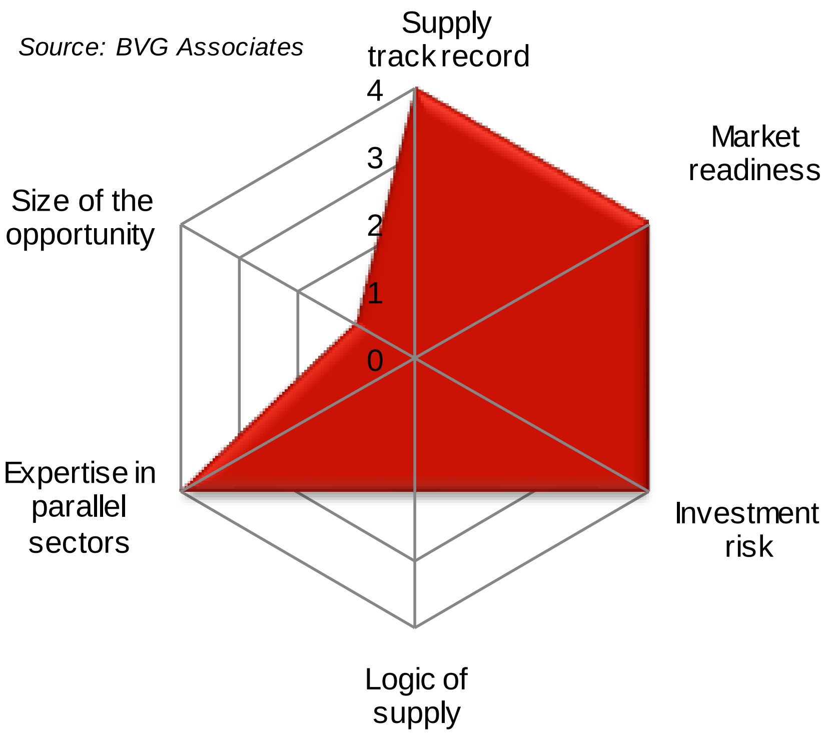


Figure 22 Summary of the assessment for project management.

Surveys

Scottish companies have experience and the capability of providing meteorological and environmental surveys to offshore renewables projects, but more limited experience in geotechnical surveys.

There is good transferability from other offshore industries and onshore renewable industries.

The opportunity is small and so provides little economic benefits to the local area.

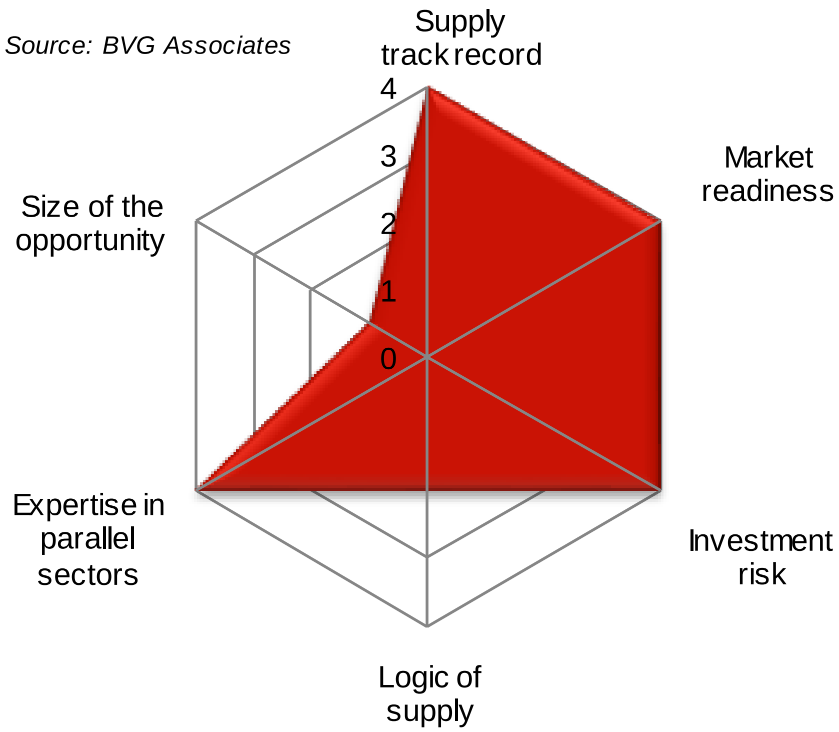


Figure 23 Summary of the assessment for surveys.

Engineering and management

Many large engineering companies have offices in Scotland (Atkins, Ramboll, COWI consulting, DNV-GL). They have worked on many offshore wind projects throughout Europe.

Most engineering services for offshore wind are transferable from other industries such as maritime and oil and gas.

As a proportion of total project spend, engineering and management is small and so does not provide significant economic benefits.

For tidal energy there are a number of leading technology developers that are Scottish. While it is still uncertain which design will be most commonly used for tidal energy, it does offer an opportunity.

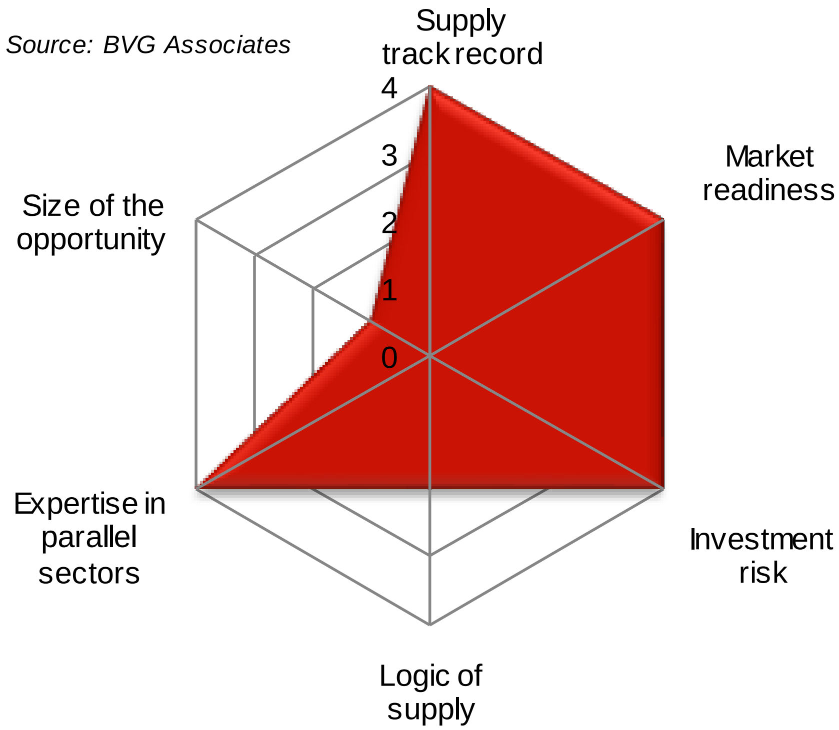


Figure 24 Summary of the assessment for engineering & management.

Key conclusions

- Scotland already has the capability to undertake most of the development and project management work needed for an offshore renewables project.
- Most commercial scale projects have had Scottish project development offices.
- Developers are unlikely to favour Scottish suppliers as such and it seems unlikely that they would secure a higher proportion of contracts than they currently do.
- The ScotWind leasing round may bring new developers to the Scottish market, which may have existing offices elsewhere in the UK. It is possible that Scottish content could fall in the future.

5.2. Turbine

Rotor

No major turbine manufacturers have rotor manufacturing facilities for offshore wind in Scotland.

There is little logic in using Scottish suppliers due to the significant experience of facilities outside of Scotland with more reliable and efficient manufacturing processes.

There is some application from composite manufacturing expertise in Scotland from other industries.

Barriers to market entry are high due to the specialised manufacturing facilities required.

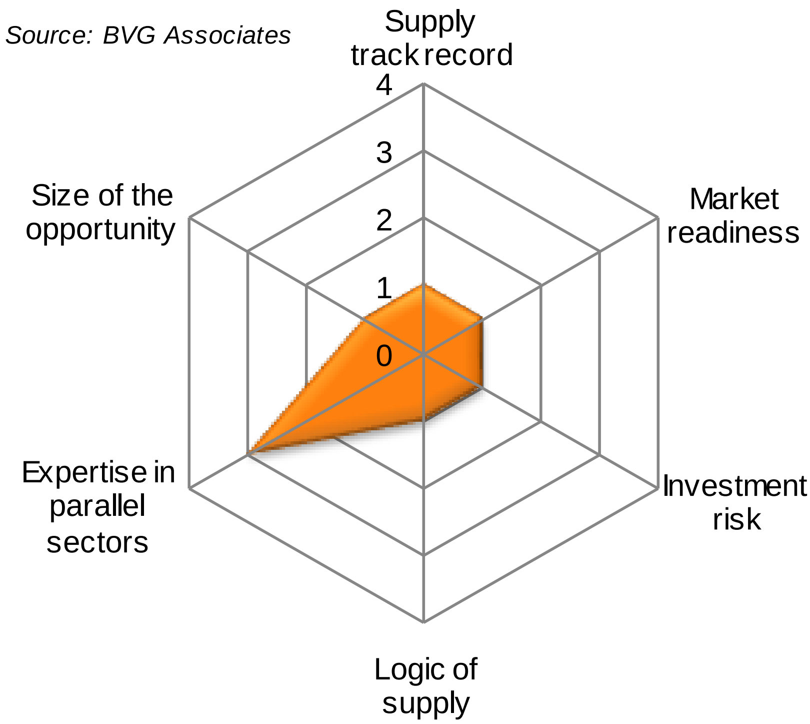


Figure 25 Summary of the assessment for rotors.

Nacelle

As with rotors, no major turbine manufacturers have nacelle manufacturing facilities in Scotland.

There may be some application from composite manufacturing and expertise in Scotland from other industries.

Barriers to market entry are high due to the specialised manufacturing facilities required.

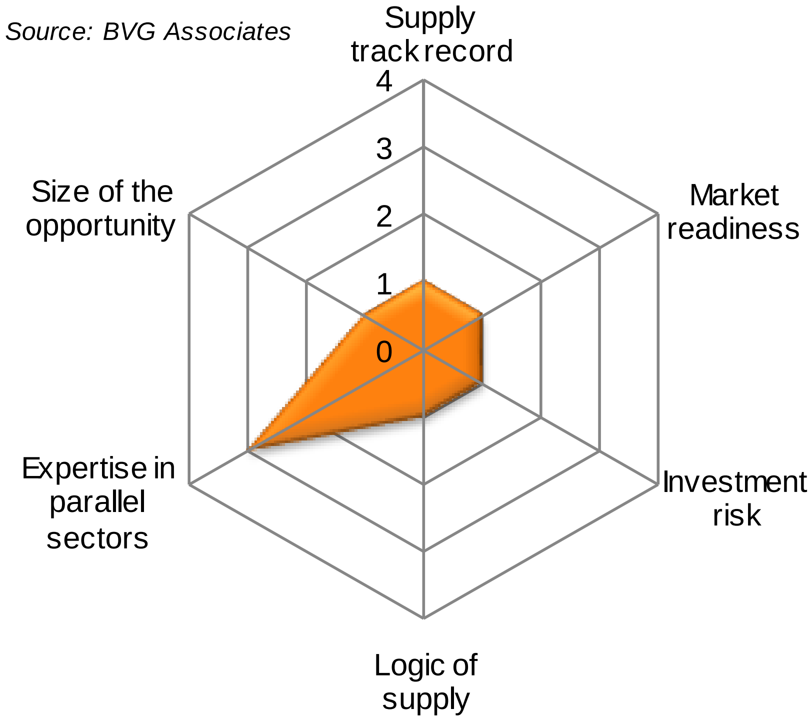


Figure 26 Summary of the assessment for nacelles.

Tower or substructure

There is a good Scottish track record for suppling towers due to tower manufacturer CS Wind.

The investment risk is small as manufacturing facilities do not need to be as specialised as for rotors and nacelles.

Other steelwork industries have applicable facilities and manufacturing techniques.

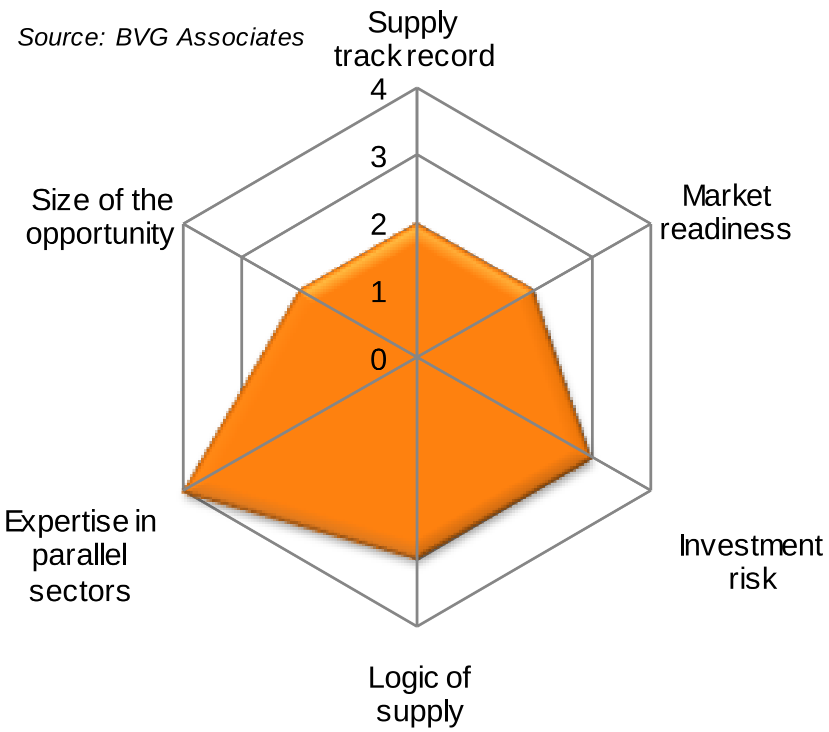


Figure 27 Summary of the assessment for towers.

Turbine – tidal

Tidal energy is an emerging technology and there remains a diversity of designs, including fixed and floating concepts. These provide differing opportunities to supply chain.

As tidal energy is a less mature industry, market entry will be easier. Smaller scale of tidal projects makes investment risk lower.

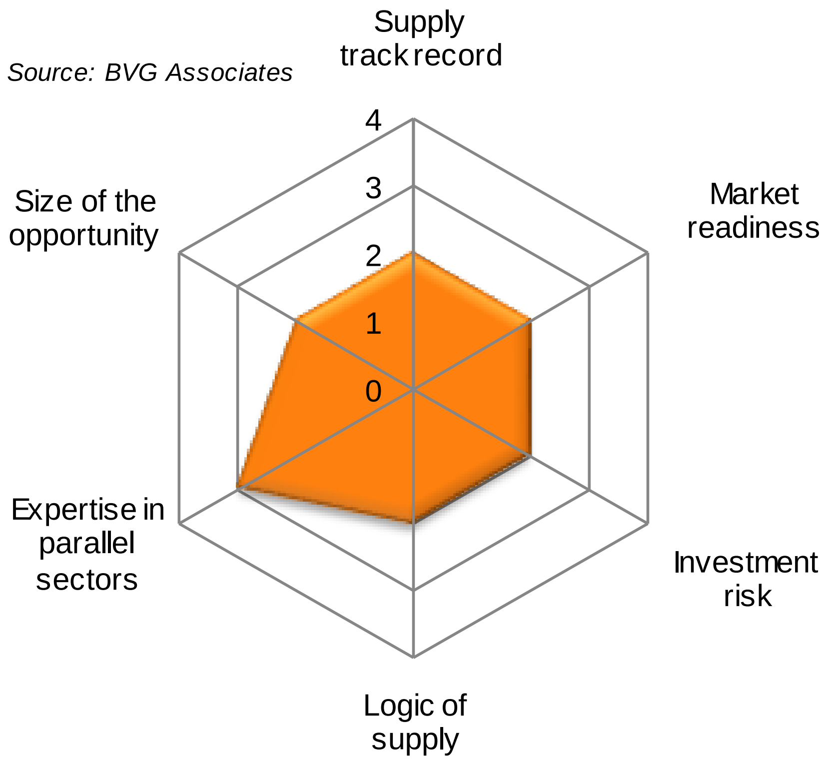


Figure 28 Summary of the assessment for tidal turbines.

Key conclusions

- Scotland has wind turbine tower production capability, but this capacity is under threat from the increased sizes needed for new turbines. New investment in Scotland would be needed to retain its capability.
- For wind turbines, nacelle assembly and blade production is done outside of Scotland and the probability of this changing is low.
- Tidal turbines have been assembled in Scotland and this could continue. Given the small size of the tidal market, this is unlikely to have a significant economic impact for Scotland in the future.

5.3. Balance of plant

Onshore substation

There is some overlap between other industries with electrical infrastructure construction, where Scotland has some experience.

There is economic benefit to Scotland for Scottish companies supplying the onshore substation to commercial offshore wind projects.

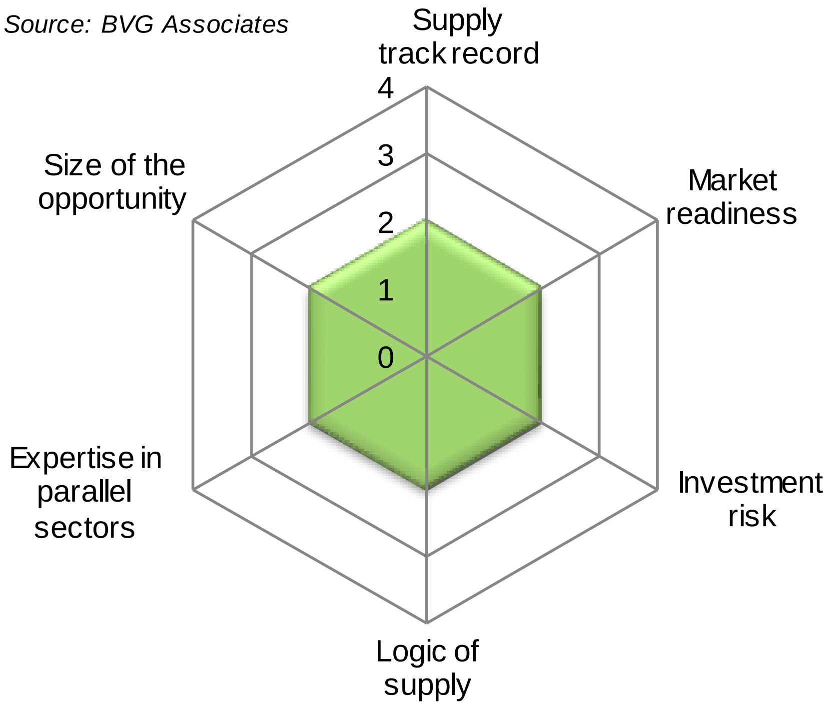


Figure 29 Summary of the assessment for onshore substations

Operations and Maintenance base

The Operations and Maintenance (O&M) base is usually the port with suitable facilities closest to the offshore project. It makes logical sense for Scottish projects to use Scottish O&M bases to minimise O&M travel time.

There are many similarities between the O&M base requirements for the offshore wind and other offshore industries, and Scotland has significant experience in these sectors.

The size of the opportunity is small, due to the minimal cost contribution of the O&M base to the total project cost.

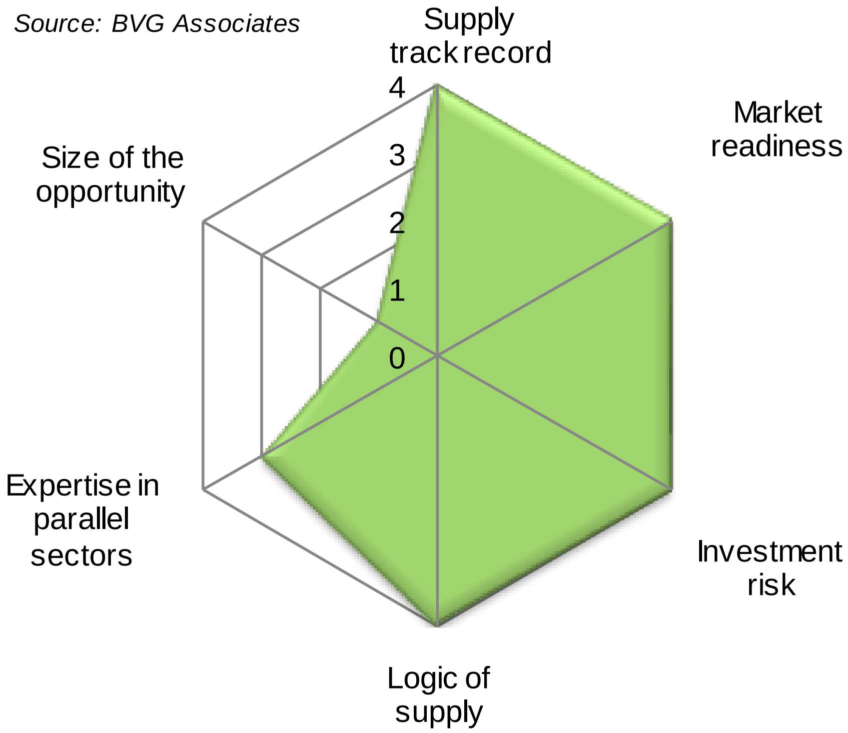


Figure 30 Summary of the assessment for O&M bases

Offshore substation

There is significant overlap between other industries for offshore substations, and Scotland has some experience in these other industries through companies like BiFab.

The logic of using Scottish companies is limited. Other companies in the UK and wider Europe have more experience and so have more efficient manufacturing processes.

The total opportunity for Scottish companies is small.

Source: BVG Associates

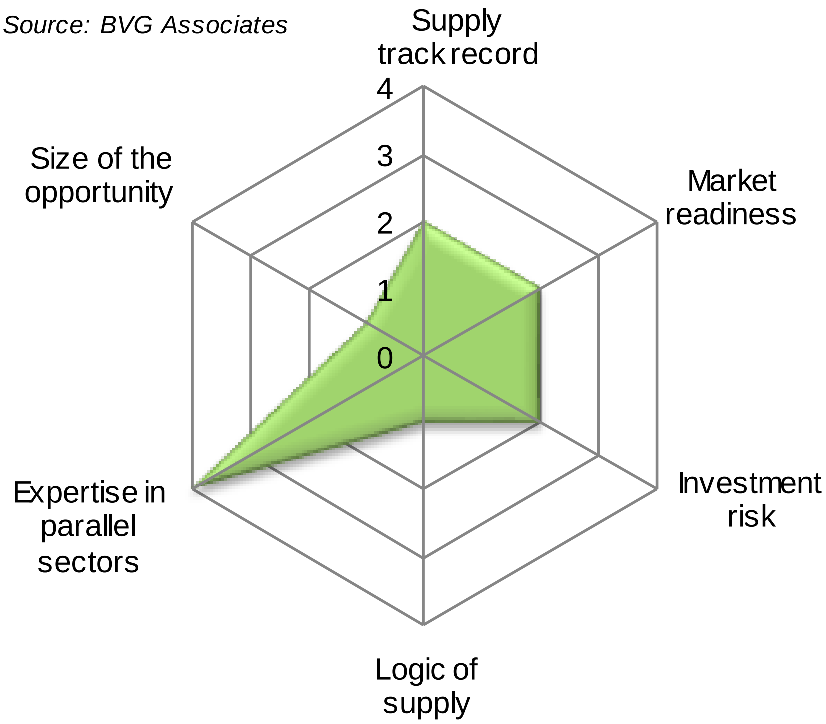


Figure 31 Summary of the assessment for offshore substations.

Foundation – fixed wind

Scotland has some track record of fabricating offshore foundations and has a small number of companies with existing facilities (such as BiFab, Global Energy Group), but would find it difficult to supply the full scope of foundations to a commercial offshore wind farm. Some projects award several foundation contracts however, which might present and opportunity for Scotland.

The investment risk for Scottish companies is high due to the large facilities needed to fabricate foundations and intensity of competition.

The size of the opportunity for Scottish business is high as foundations are significant percentage of total project cost (around 8%).

Source: BVG Associates

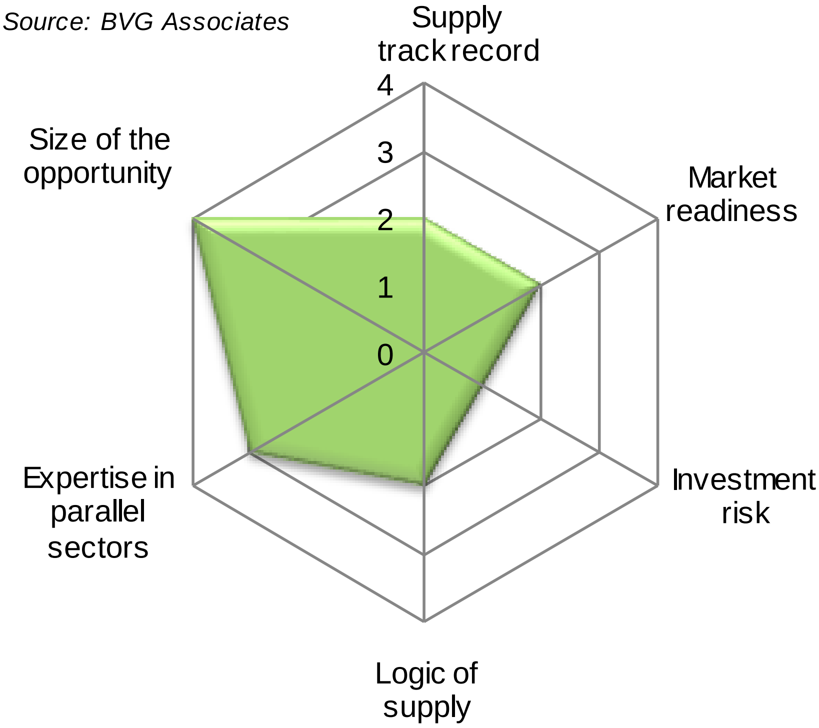


Figure 32 Summary of the assessment for fixed turbine foundations.

Foundation – floating wind

There is no experience of manufacturing floating foundations for offshore wind in Scotland.

There is experience in similar industries that could translate well to manufacturing floating foundations (fixed offshore wind foundations, oil and gas, maritime industries).

As offshore floating wind and floating tidal are newly emerging technologies there is opportunity for Scottish companies to enter the market with innovative technology, for example around quick connection systems for mooring.

There is a good opportunity for Scottish companies in the future given the projected growth of the floating wind industry.

Source: BVG Associates

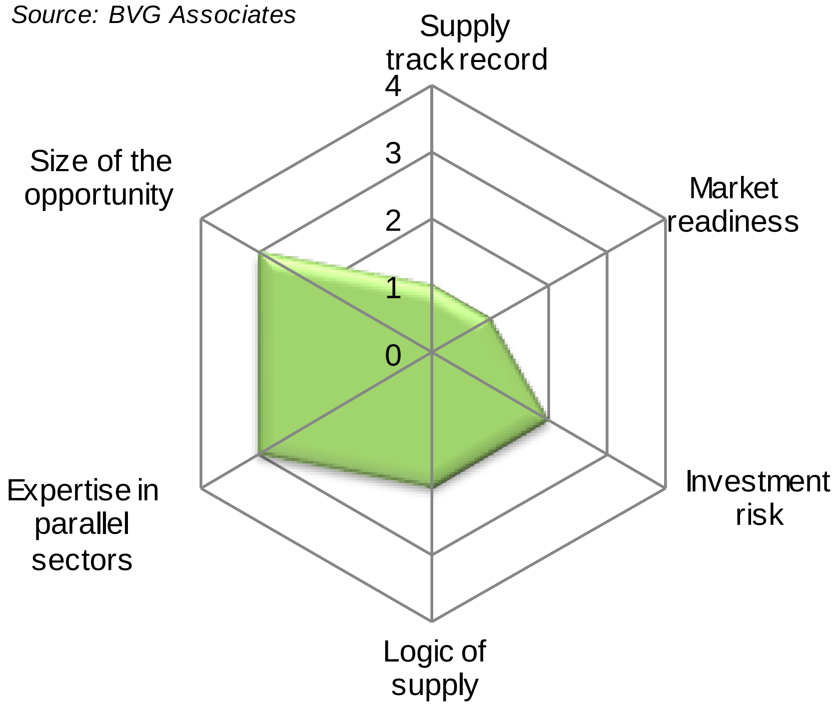


Figure 33 Summary of the assessment for floating foundations.

Foundation – tidal

As with floating foundations, there is no previous experience of manufacturing tidal foundations in Scotland.

There is experience in other similar industries that could translate well to manufacturing tidal foundations (fixed offshore wind foundations, oil and gas, maritime industries).

The connection system between the mooring and electrical subsea cable is a big area of development and an opportunity for tidal.

This is potentially a good opportunity for Scottish companies, but the future of the tidal stream industry is unclear.

Source: BVG Associates

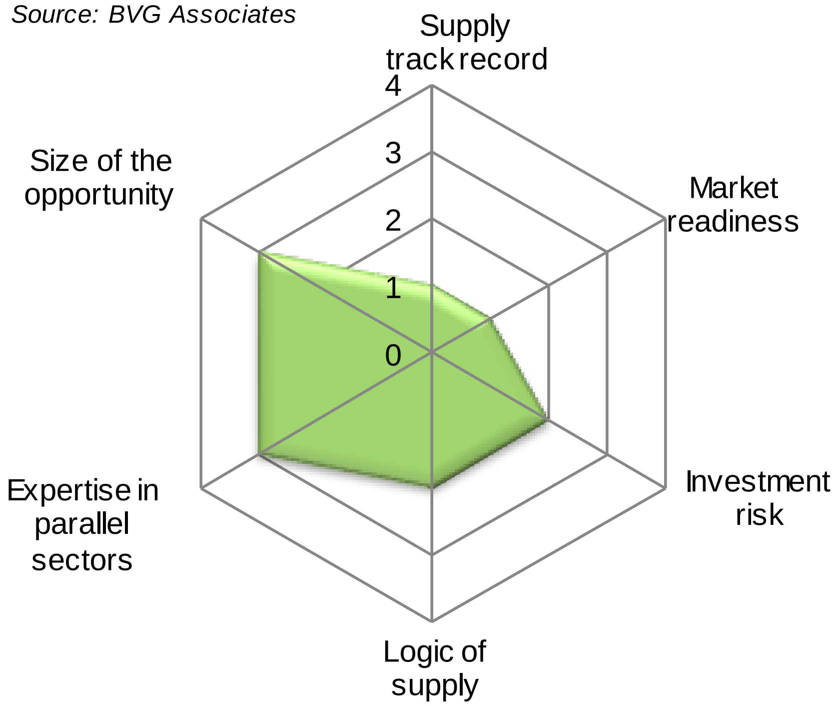


Figure 34 Summary of the assessment for tidal foundations.

Onshore cables

There is no capability of producing high voltage cables for offshore wind in Scotland. There is some limited experience of Scottish medium and low voltage cable manufacturing.

Entering the market would require very large investments and does not represent a good opportunity for Scottish companies.

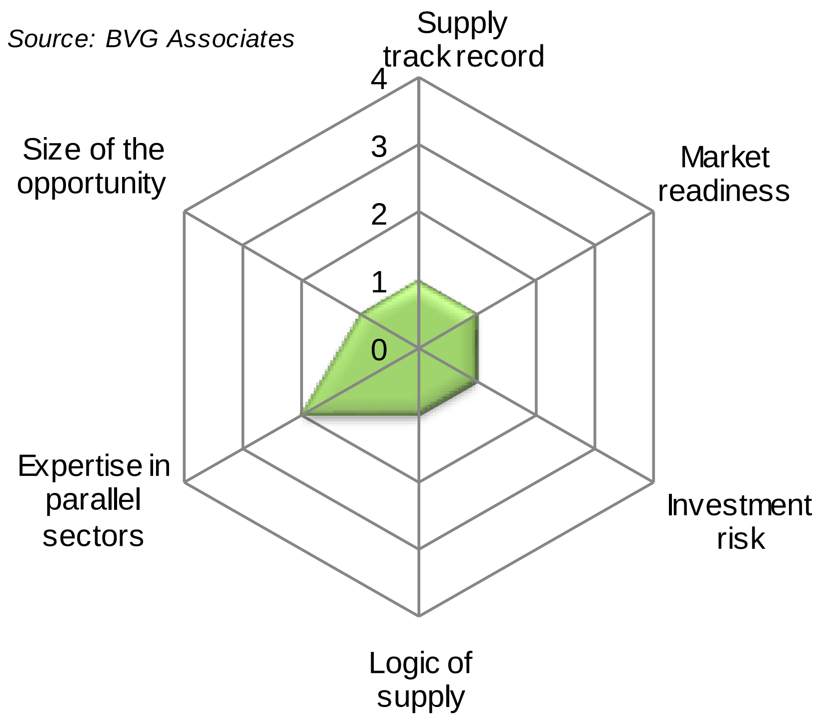


Figure 35 Summary of the assessment for onshore cables.

Subsea export cables

There is no capability for producing high voltage cables for offshore wind in Scotland. There is some limited experience of Scottish medium and low voltage cable production. Entering the market would require very large investments and does not represent a good opportunity for Scottish companies.

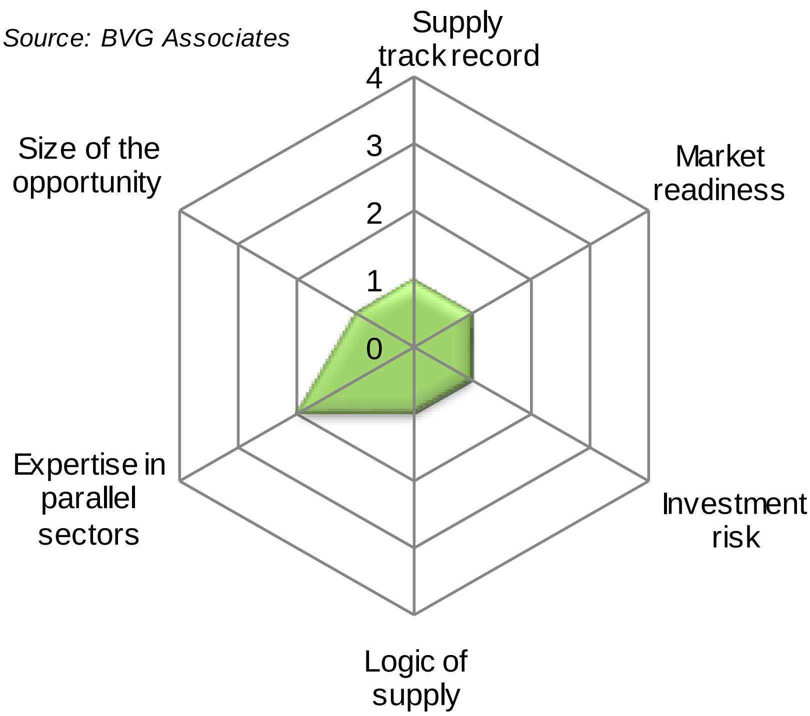


Figure 36 Summary of the assessment for subsea export cables.

Array cables

There is no capability of producing medium voltage cables for offshore wind in Scotland. There is some limited experience of Scottish medium and low voltage cable production for other industries.

There is opportunity for companies to enter the market to produce dynamic cables for floating wind and tidal. This is a new market and has synergy with oil & gas.

As offshore floating wind and floating tidal are newly emerging technologies there is opportunity for Scottish companies to enter the market with innovative technology, for example quick connection systems for array cabling.

Entering the fixed offshore wind market for array cables would require very large investments and does not represent a good opportunity for Scottish companies.

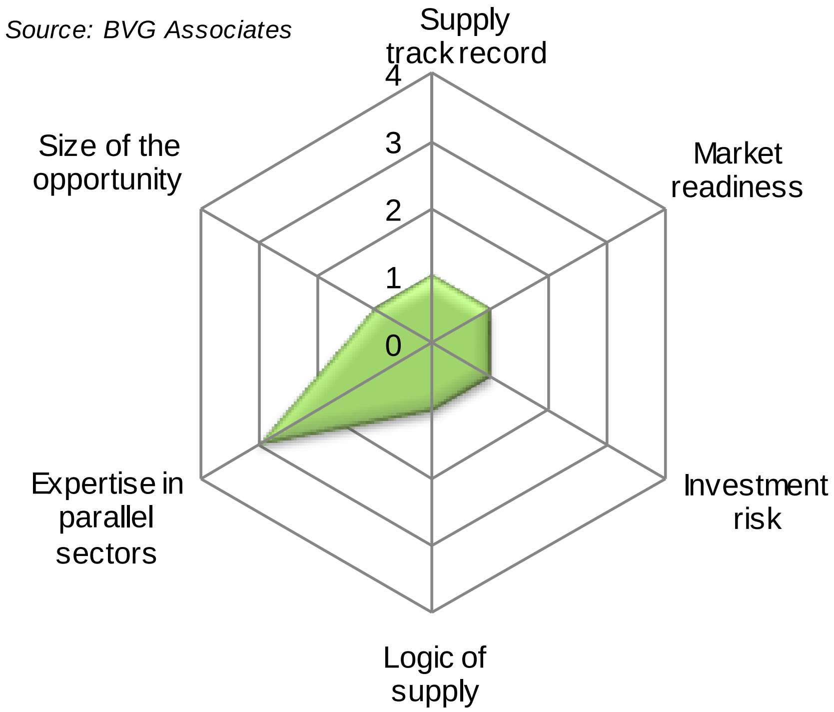


Figure 37 Summary of the assessment for array cables.

Key conclusions

- Scotland has and will continue to provide the structures for the onshore substation and the OMS base.
- Scotland has capability in fabricating large steel structures. Companies have struggled to compete with other overseas suppliers and will continue to do so without investment to enable high volume production. It does provide the single biggest opportunity for economic impact in Scotland from offshore renewables.
- The floating wind and tidal markets in theory create new opportunities for steel fabrication, but the skills and infrastructure needed will be similar to jackets and transition pieces for the fixed wind market. Commercial scale floating and tidal projects in Scotland will attract competition from outside Scotland. Scottish suppliers may therefore need to invest significantly to take advantage.

5.4. Installation

Foundation installation

There is no experience of Scottish companies providing foundation installation for offshore wind projects. Some foundation installers have Scottish offices but the vessels and most of the employees are based elsewhere.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (as jack-up vessels are specialised vessels) and the size of the opportunity for Scottish companies is small.

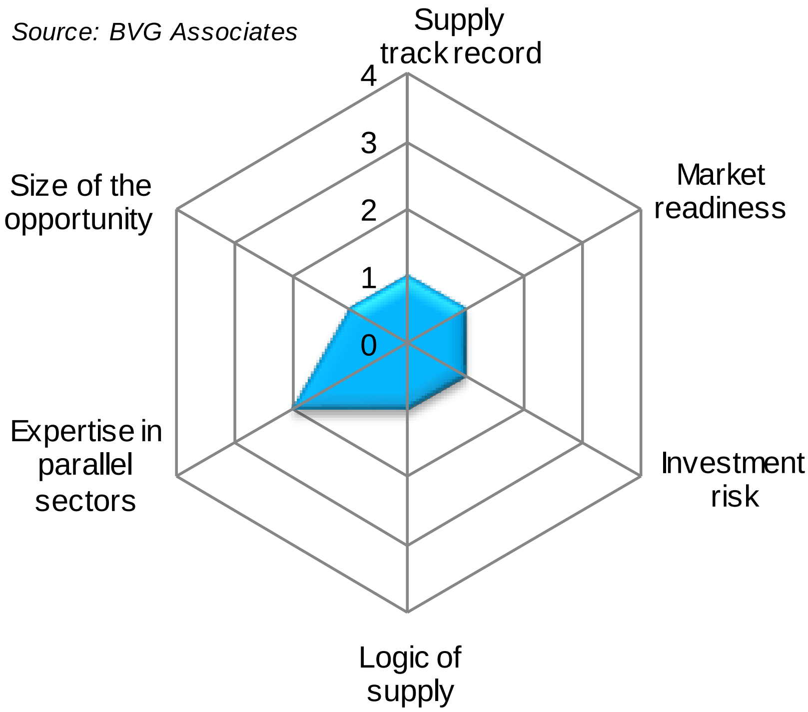


Figure 38 Summary of the assessment for foundation installation.

Turbine installation

There is no experience of Scottish companies providing turbine installation for offshore wind projects. Some turbine installers have Scottish offices but the vessels and most of the employees are based elsewhere.

There is experience of Scottish companies providing installation for tidal projects, but this is at a much earlier and smaller scale than offshore wind.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (as jack-up vessels are specialised vessels) and the size of the opportunity for Scottish companies is small.

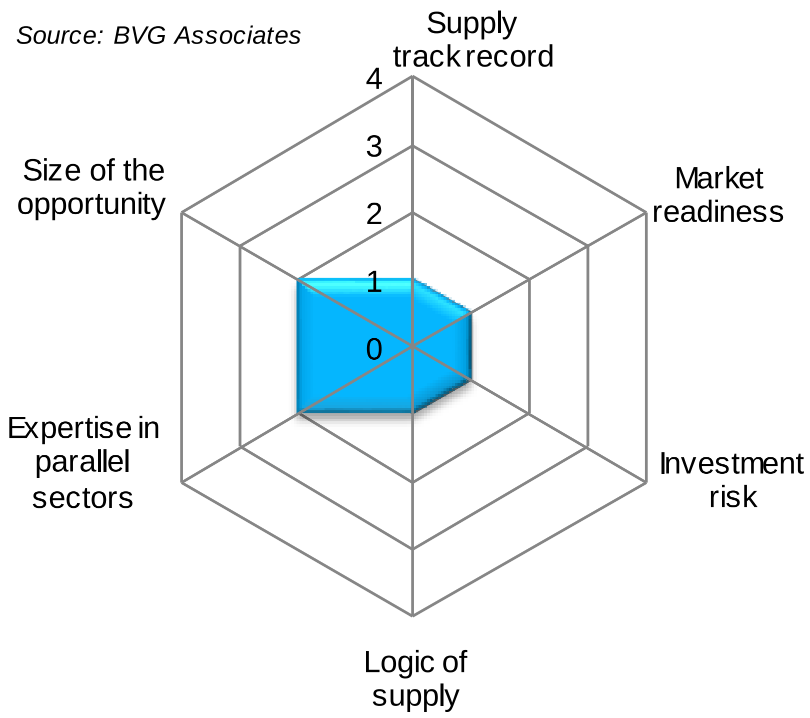


Figure 39 Summary of the assessment for turbine installation.

Floating foundation installation

There is limited experience of Scottish companies providing floating foundation installation for floating offshore wind projects. Some installers have Scottish offices but the vessels and most of the employees are based elsewhere.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (as jack-up vessels are specialised vessels) and the size of the opportunity for Scottish companies is small.

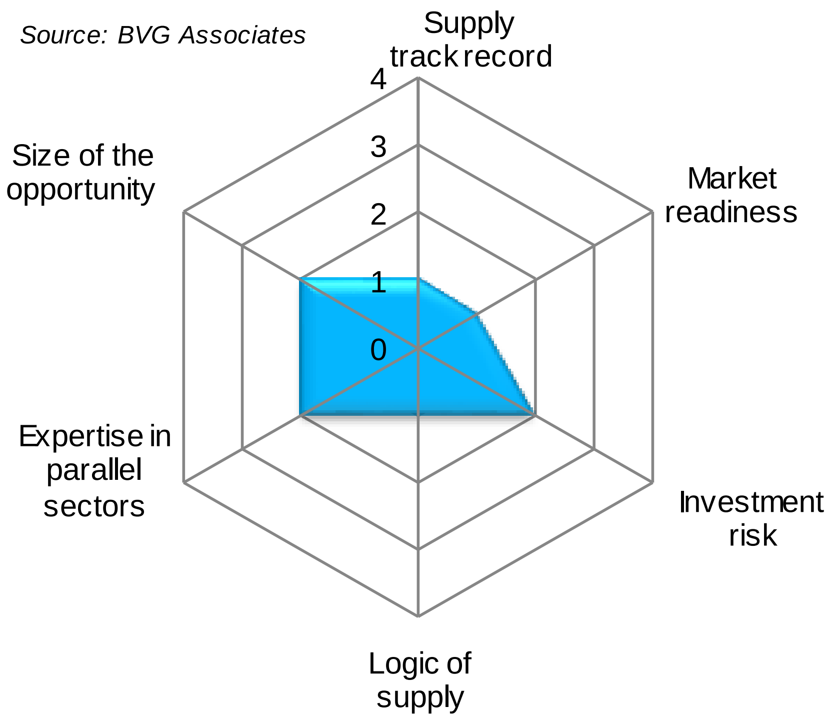


Figure 40 Summary of the assessment for floating foundation installation.

Mooring installation

Limited experience of Scottish companies providing mooring installation for floating projects.

The risk of investment is high but does not require the same specialised vessels as foundation and turbine installation.

There is transferable experience from oil & gas, as well as wave energy. InterMoor in Aberdeen has capability, for example.

Overall opportunity for Scottish companies is small.

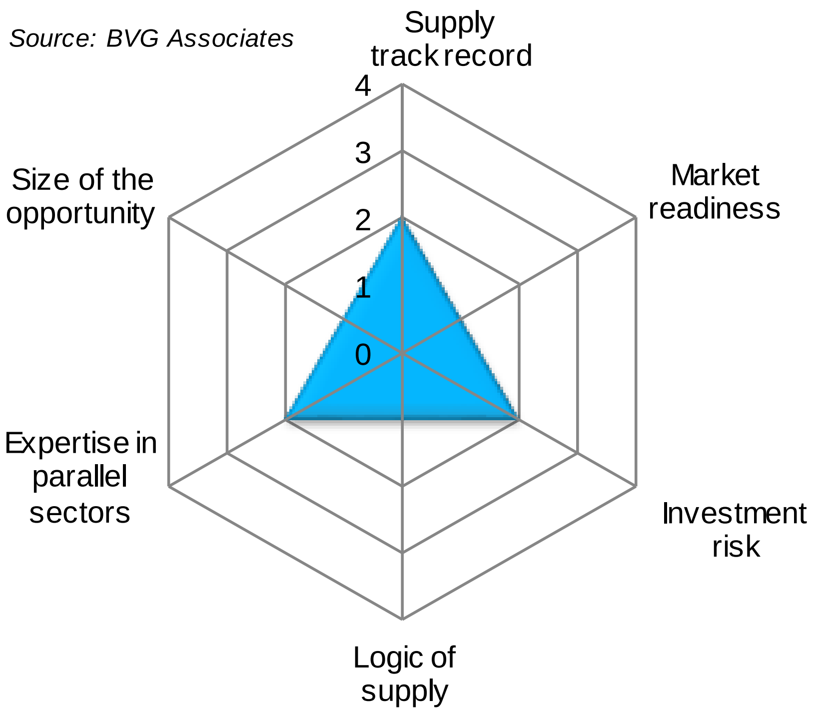


Figure 41 Summary of the assessment for mooring installation.

Offshore export cable installation

There is no experience of Scottish companies providing export cable installation for offshore wind projects. Some cable installers have Scottish offices but the vessels and most of the employees are based elsewhere.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (cable-laying vessels are specialised vessels) and the size of the opportunity for Scottish companies is small.

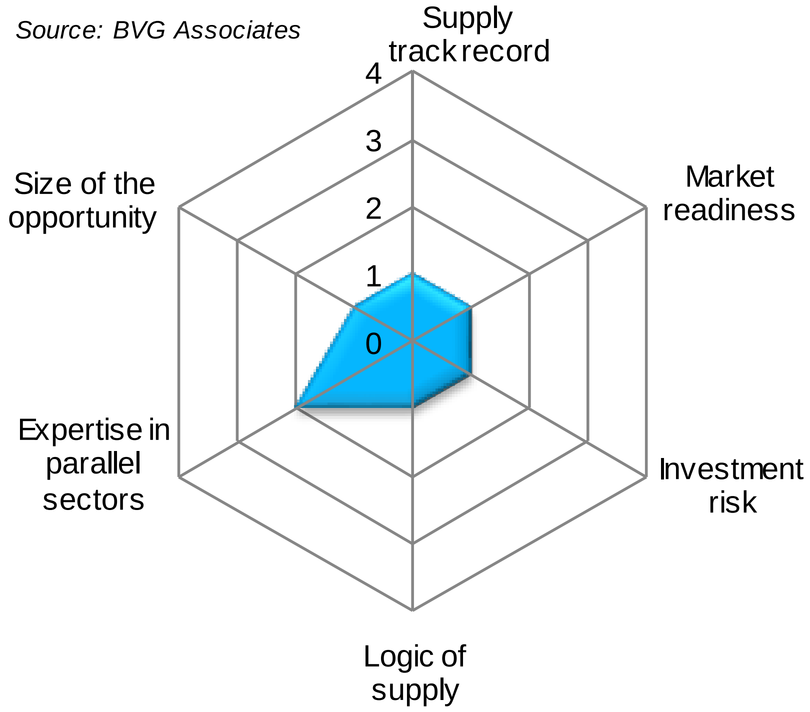


Figure 42 Summary of the assessment for offshore export cable installation.

Array cable installation

There is limited experience of Scottish companies providing array cable installation for offshore wind projects. Some cable installers have Scottish offices but the vessels and most of the employees are based elsewhere.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (cable-laying vessels are specialised vessels) and the size of the opportunity for Scottish companies is small.

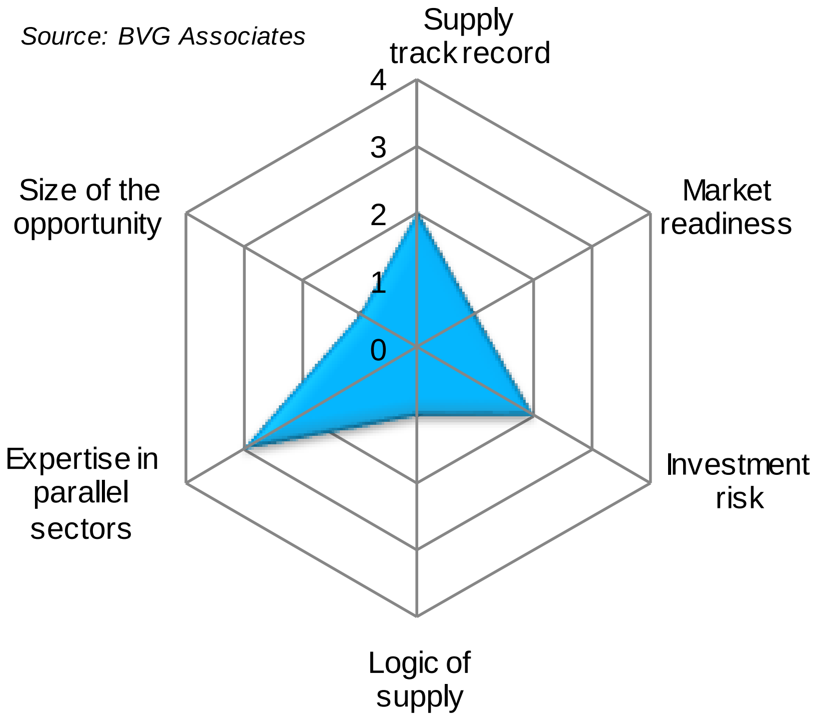


Figure 43 Summary of the assessment for array cable installation

Onshore cable installation

Scottish companies have some experience of installing onshore cables for offshore wind farms. It is one of the few categories of the supply chain that involves onshore construction so the barriers to entry are lower and the logic for using Scottish suppliers is high for Scottish projects.

Onshore cable installation is a small proportion of total project spend so the total opportunity for Scottish companies is low.

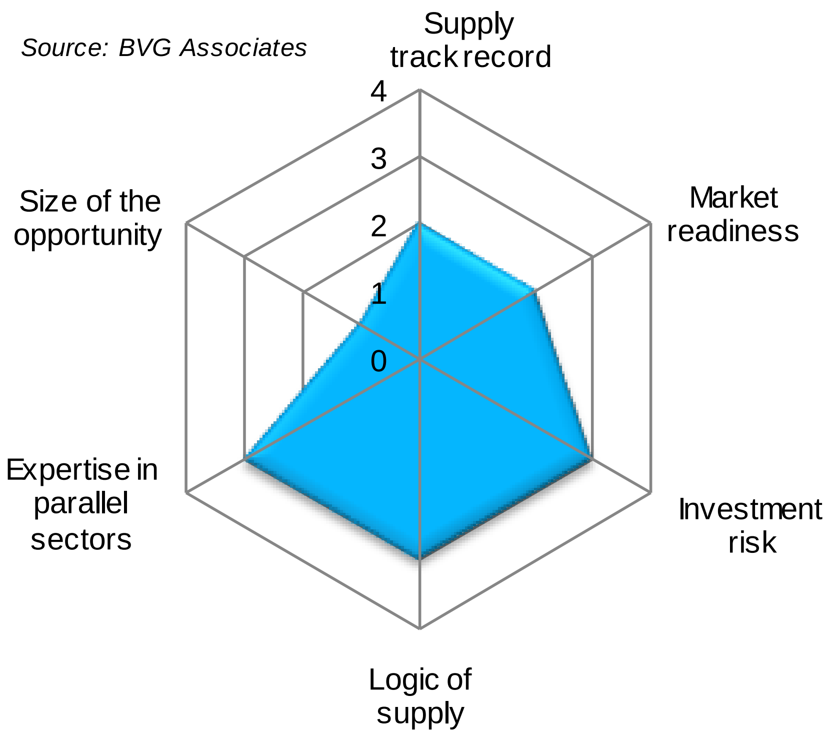


Figure 44 Summary of the assessment for onshore cable installation.

Offshore substation installation

Offshore substation installation requires large vessels. There is no experience of Scottish companies providing offshore substation installation for offshore wind projects. Some vessel operators have Scottish offices, but the vessels and most employees are based elsewhere.

There is transferable experience from other vessel-related industries, but there are high barriers to entry (requiring specialised vessels) and the size of the opportunity for Scottish companies is small.

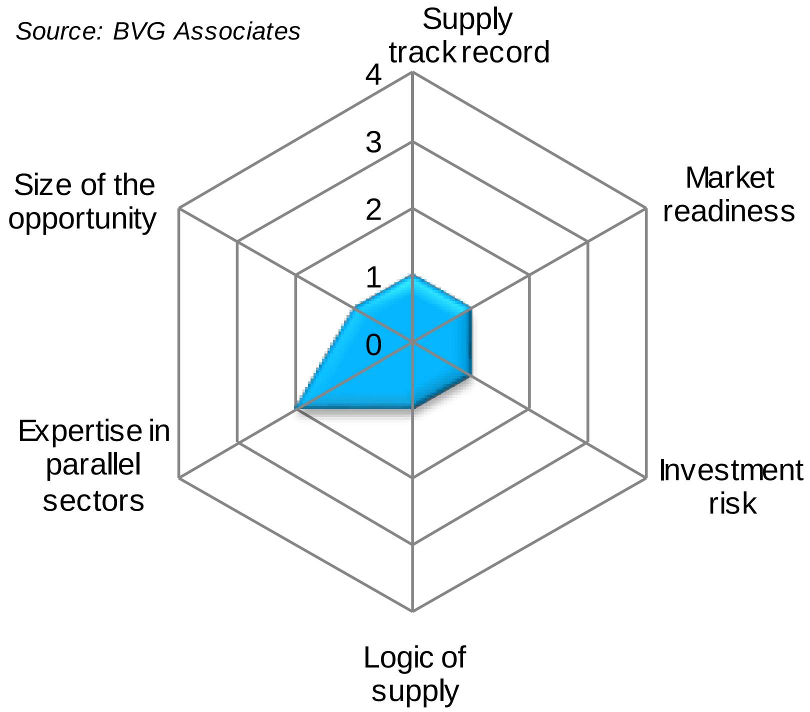


Figure 45 Summary of the assessment for offshore substation installation.

Onshore substation installation

Scotland has experience of installing onshore substations for offshore wind projects. There are multiple Scottish companies that have the capability of installing onshore substations for commercial projects.

There is significant experience from other electrical infrastructure industries, and therefore the barriers to entry for new companies are small.

Onshore substation installation is a small proportion of total spend so, despite the market capability, it does not represent a large opportunity for Scottish suppliers.

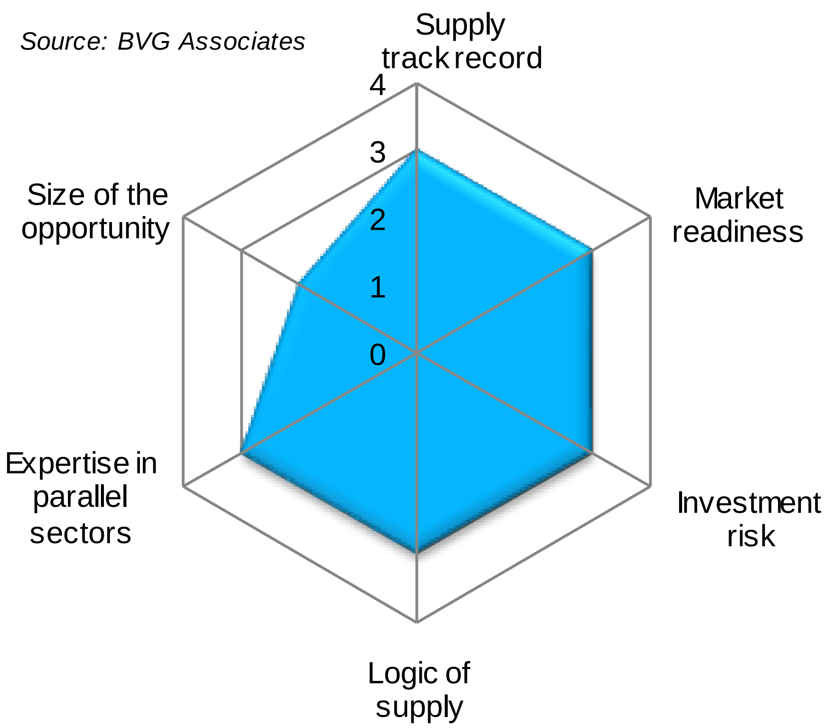


Figure 46 Summary of the assessment for onshore substation installation.

Other

The 'Other' supply chain category consists of categories including CTVs used during installation, installation ports and marine coordination.

There are Scottish suppliers that have supplied these services to offshore wind projects and are capable of supplying to future commercial scale projects.

While the size of the opportunity is fairly low (due to the small financial cost of this category), Scotland has experience in similar industries, there are low barriers to entry and the logic for using Scottish suppliers for Scottish projects is strong.

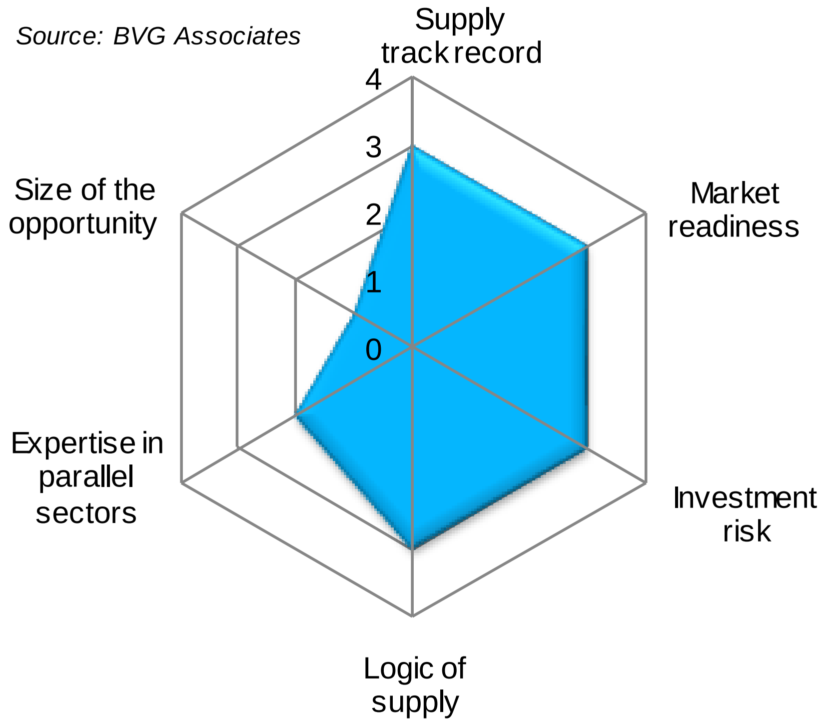


Figure 47 Summary of the assessment for other installation.

Key conclusions

- Onshore works have generated significant economic impacts, and this will continue for Scottish offshore renewable projects, particularly those that need substations.
- For fixed offshore wind the installation market is mature and none of the major contractors have a significant Scottish presence. Subsea7 has a substantial Aberdeen facility but its vessels are operated from Germany and Netherlands.
- The floating and tidal markets have distinct demand for vessels. In theory this creates a new opportunity but there are no significant benefits to local supply and Scottish companies would face competition from across Europe.

5.5. Operations & maintenance

Operations

Scottish companies have limited experience of coordinating the operations of offshore wind farms and only a small number of companies are currently equipped to manage a commercial scale project.

There are few barriers to entry for new companies and there is strong logic for Scottish suppliers coordinating operations for Scottish project.

Operations is one of the best opportunities for Scottish companies to enter the offshore wind supply chain.

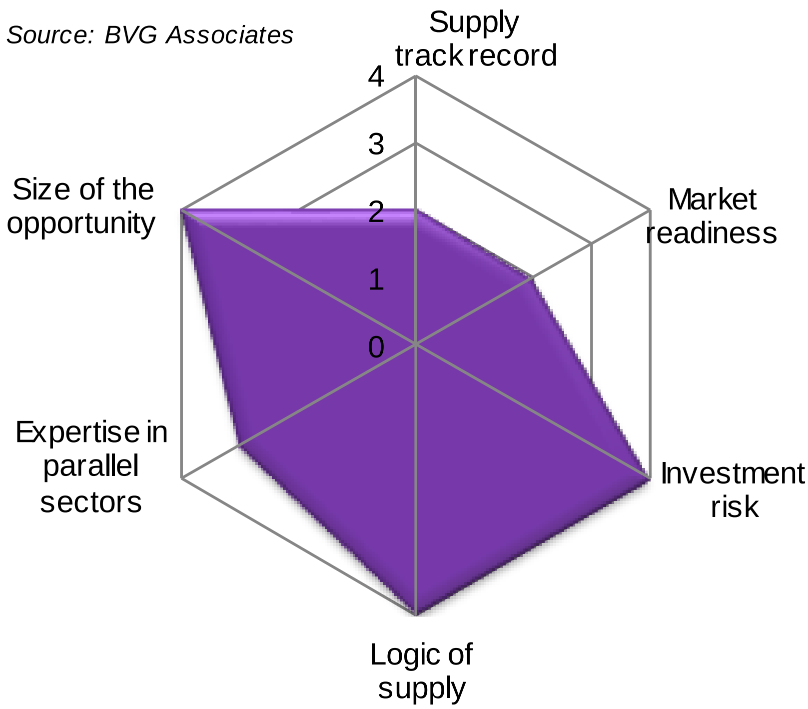


Figure 48 Summary of the assessment for operations.

Grid costs

Maintaining the grid systems during an offshore wind farm's operation presents a significant opportunity as it is a large proportion of total project cost.

To date the Scottish supply chain has no experience of supplying grid maintenance services to offshore wind farms and are currently not able to provide this service to a commercial scale project. Barriers to entry are high and there are no industries that provide similar experience.

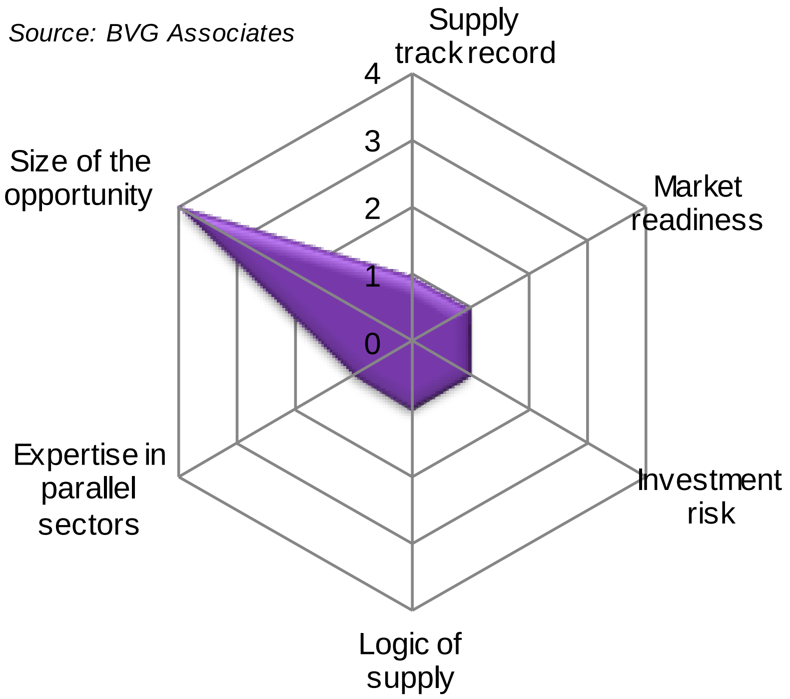


Figure 49 Summary of the assessment for grid costs.

Balance of plant maintenance

Scottish suppliers have limited experience in providing balance of plant maintenance to offshore wind farms and there are not many companies currently able to provide this for commercial scale projects.

There are many similarities in the tasks required between offshore wind and other offshore industries. The vessels and expertise required are not specialised so the barriers to entry are low.

Balance of plant maintenance is a large proportion of total project cost so is a significant opportunity for Scottish companies**.**

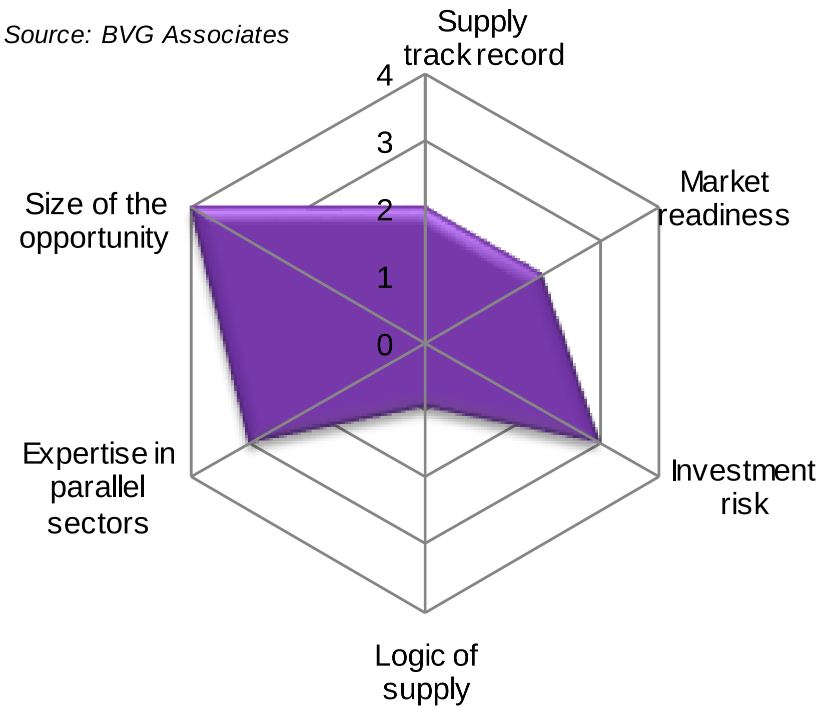


Figure 50 Summary of the assessment for BoP maintenance.

Turbine maintenance

Scottish suppliers have limited experience in providing turbine maintenance to offshore wind farms and there are not many companies currently able to provide this for commercial scale projects.

There are more barriers to entry for new companies, and less transferable experience from other industries, than balance of plant maintenance due to the more specialised nature of turbine maintenance.

Turbine maintenance is a large proportion of total project cost so is a significant opportunity for Scottish companies.

There are less barriers to entry in the tidal sector as technology is at an earlier stage. Technology developers are heavily involved in maintenance with some leaders being Scottish companies.

Floating technology offers a greater potential for nearshore maintenance activity with potential to recover the turbine to shelter. At this stage it is unclear if this approach will be taken for maintenance. However, it is a potential opportunity for Scottish port facilities.

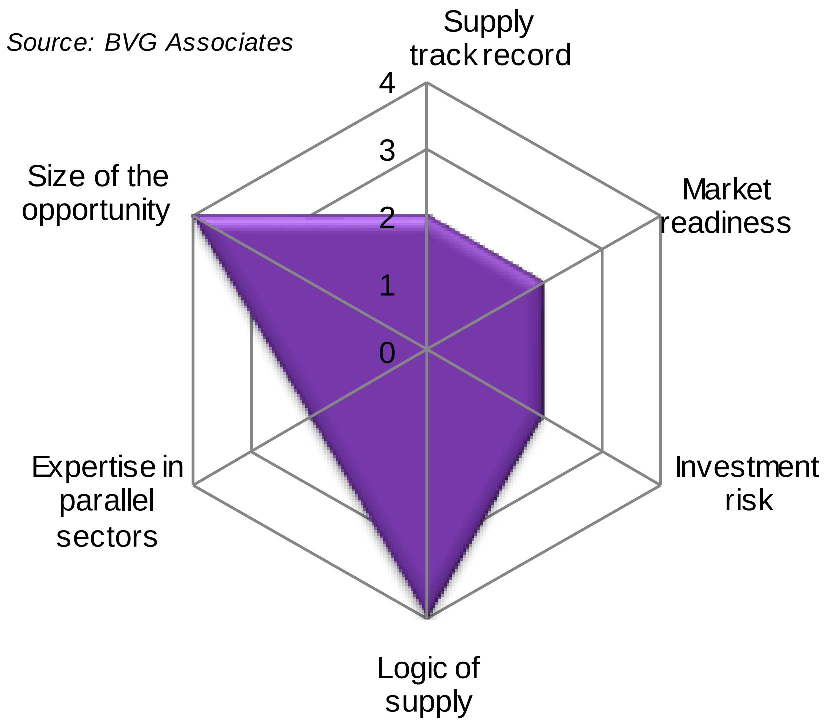


Figure 51 Summary of the assessment for turbine maintenance.

Other

The 'Other' category consists of insurance, environmental studies and compensation payments associated with offshore wind farm maintenance.

Scottish companies have significant experience of providing this for offshore wind farms and many companies can provide these services for commercial projects.

Other maintenance activities represent one of the largest opportunities for Scottish companies in the offshore wind supply chain.

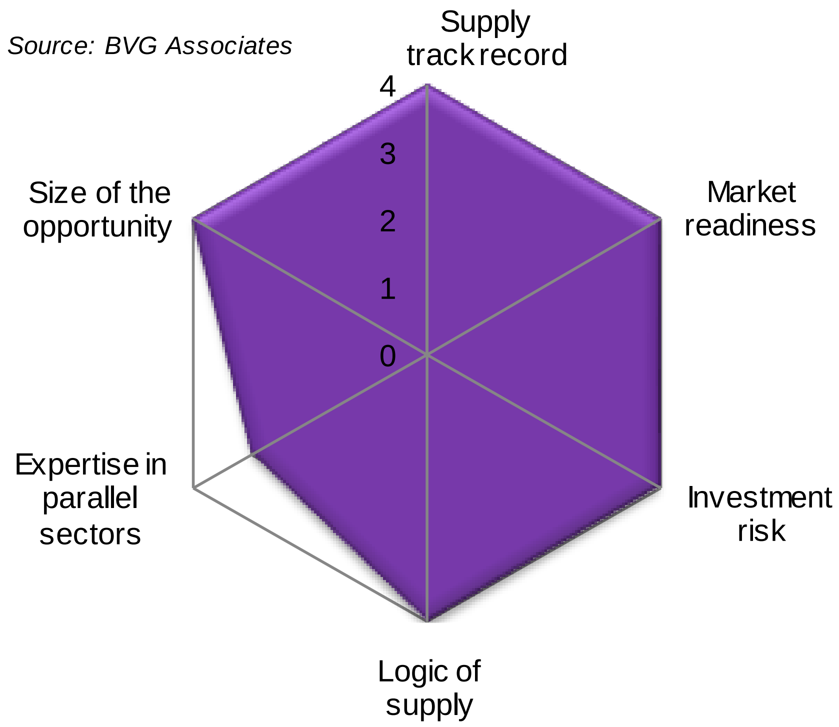


Figure 52 Summary of the assessment for other maintenance.

Key conclusions

- OMS has generated significant economic impacts, and this will continue for Scottish offshore renewable projects.
- The opportunities to increase Scottish content are limited. Turbine suppliers will have UK-wide service centres and spares and consumables will have a global supply chain.
- With the likely high growth of the OMS markets, there is an opportunity for Scottish offshore and subsea engineering companies to invest and grow. These investments will be driven by the demand from across Europe and only to a small degree from the Scottish market. There is a risk that Scottish companies would choose to invest closer to their customers, which could be outside Scotland.

5.6. Decommissioning

Decommissioning

The Scottish supply chain has no experience of providing decommissioning for offshore wind projects, (but very few projects globally have reached this stage).

As with installation, decommissioning requires large vessels. Some vessel operators have Scottish offices but the vessels and most of the employees are based elsewhere. There is transferable experience from other vessel-related industries, but there are high barriers to entry (with jack-up vessels being specialised vessels).

Despite this, the size of the opportunity for Scottish companies is significant given the large cost of decommissioning relative to total project cost.

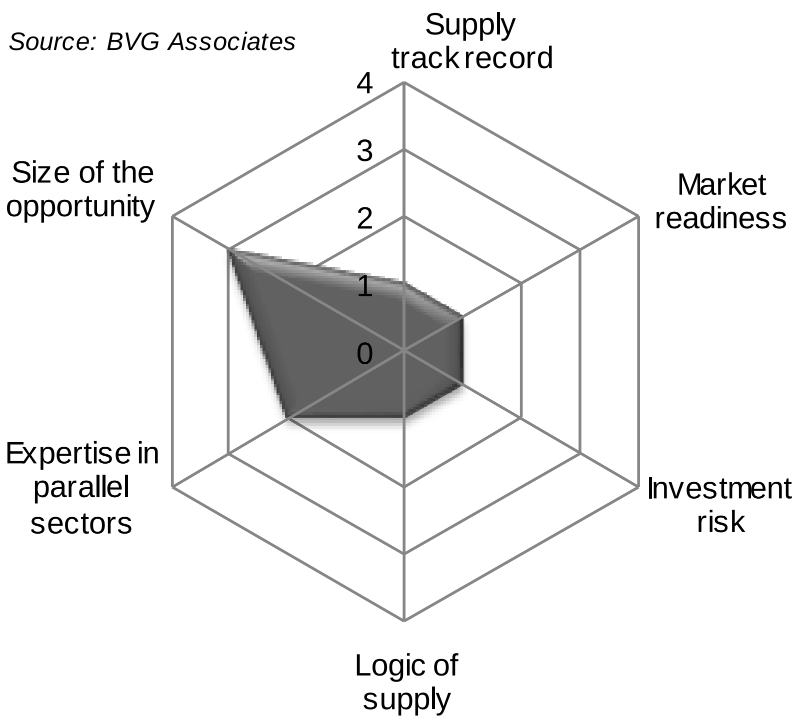


Figure 53 Summary of the assessment for decommissioning.

Key conclusions

- There is significant uncertainty about the specific requirements for decommissioning offshore renewable projects.
- It is likely to become a significant market from 2025 onwards and there is an opportunity for entrepreneurial Scottish companies to invest to meet demand.

6. What-if analysis

For the what-if analysis we modelled what could have been delivered in terms of economic impacts in Scotland from similar projects to the case study projects delivered on the same timescale, if they had used the maximum realistic content from Scottish supply chain. We used the supply chain assessment in section 4 to consider whether the Scottish supply chain had the potential to secure a greater proportion of business from the wind farms, therefore establishing the maximum realistic content.

6.1. Beatrice Offshore Wind Farm

The key differences between the as-is analysis and the what-if analysis includes:

- An increased use of Scottish suppliers for the development and project management phase
- Part of the tower order placed in Scotland, and
- A higher Scottish content in OMS.

Scottish content

We concluded that Beatrice could have achieved 39.2% Scottish content and 12.3% local content (see Table 9 and Figure 54). This compares with 29.6% and 11.7% respectively for the as-is analysis.

The areas with highest percentage Scottish content would be project development and management, where 86.5% of the could come from Scotland. This area is closely followed by OMS which has could have an average Scottish content of 56%, due to its utilisation of Scottish based technicians and operational staff.

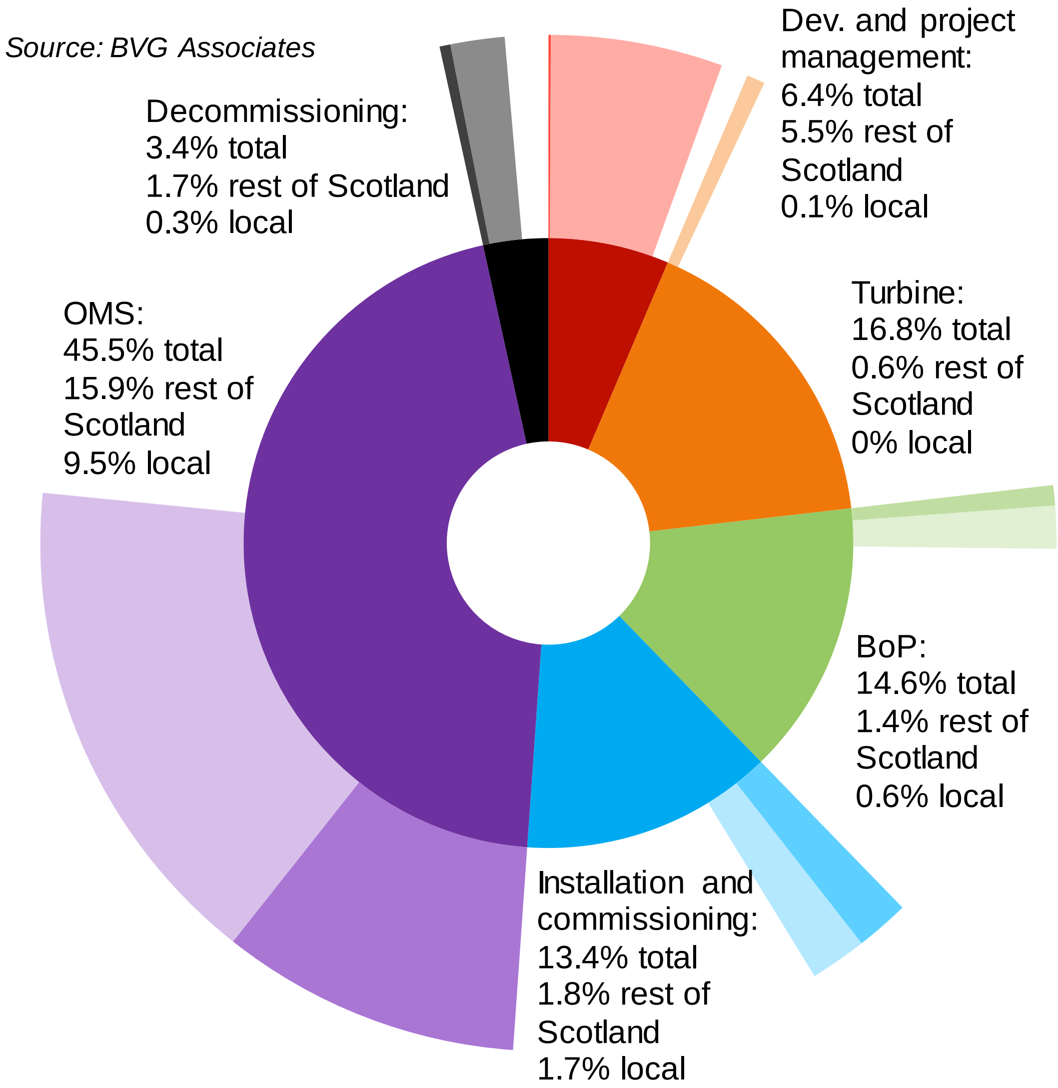


Figure 54 'What-if' Scottish and local content in Beatrice Offshore Wind Farm by supply chain category.

Table 9 'What-if' Scottish and local content in Beatrice Offshore Wind Farm by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	6.4%	Scotland	86.5%	5.5%	Local	1.2%	0.1%
		Non-Scotland	13.5%	0.9%	Rest of Scotland	85.3%	5.5%
Turbine supply	16.8%	Scotland	3.5%	0.6%	Local	0%	0%
		Non-Scotland	96.6%	16.2%	Rest of Scotland	3.5%	0.6%
Balance of plant	14.6%	Scotland	13.8%	2%	Local	4.4%	0.6%
		Non-Scotland	86.2%	12.5%	Rest of Scotland	9.3%	1.4%
Installation and commissioning	13.4%	Scotland	26.2%	3.5%	Local	12.7%	1.7%
		Non-Scotland	73.8%	9.9%	Rest of Scotland	13.4%	1.8%
Operation, maintenance and service	45.5%	Scotland	56%	25.5%	Local	21%	9.5%
		Non-Scotland	44%	20%	Rest of Scotland	35%	15.9%
Decommissioning	3.4%	Scotland	60%	2.1%	Local	10%	0.3%
		Non-Scotland	40%	1.4%	Rest of Scotland	50%	1.7%
Total	100.0%	Scotland	39.2%	39.2%	Local	12.3%	12.3%
		Non-Scotland	60.8%	60.8%	Rest of Scotland	26.8%	26.8%

GVA, earnings and employment

Table 10 summarises the economic impacts that could have been created by Beatrice Offshore Wind Farm.

Gross value-added

Beatrice could have generated £1,716 million direct, indirect and induced GVA in Scotland over the lifetime of the wind farm (£416 million more than as-is analysis), of which £465 million could have been generated locally (£21 million more than as-is analysis). GVA would peak during the construction and installation phase at around £217 million (£42 million more than as-is analysis) in 2018 (see Figure 55).

Over the lifetime OMS could generate the greatest amount of GVA at £1,100 million (£250 million more than as-is analysis), comprising 22% direct, 61% indirect and 17% induced GVA (see Figure 56). OMS could create £360 million locally.

Table 10 Summary of 'what-if' direct, Indirect and induced economic impact generated by Beatrice Offshore Wind Farm.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£546	£861	£309	£1,716	£309	£133	£23	£465
Earnings (millions)	£333	£242	£92	£667	£190	£37	£7	£243
FTE years	6,260	7,130	2,420	15,810	3,970	1,090	230	5,290

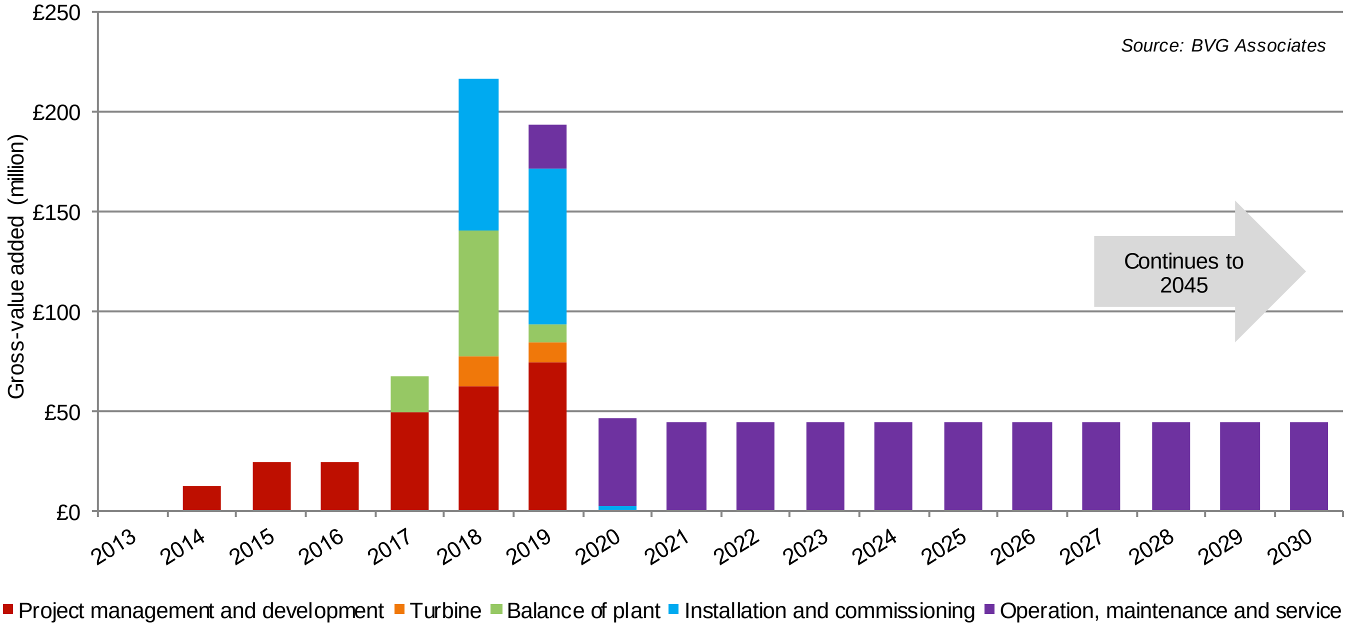


Figure 55 'What-if' gross-value added generated in Scotland by Beatrice Offshore Wind Farm by supply chain category.

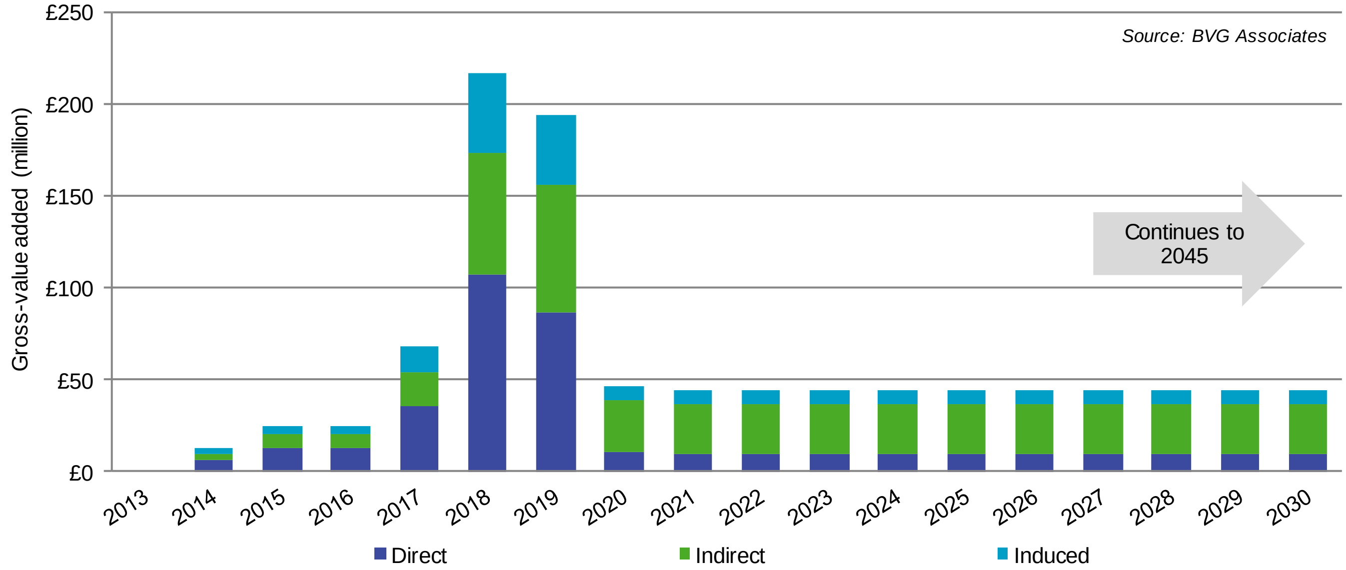


Figure 56 'What-if' gross-value added generated in Scotland by Beatrice Offshore Wind Farm by direct, indirect and induced impact.

Employment

Over the lifetime of the project 15,810 FTEs, could have been created (4,190 more than the as-is analysis), of which 5,290 locally. The number of FTEs created each year between 2013 and 2043, broken down by supply chain, is shown in Figure 57.

FTEs peak in the construction and installation phase in 2017, when 2,270 FTEs could be created (470 more than the as-is analysis). This comprises 57% direct, 25% indirect and 18% induced FTEs (see Figure 58). OMS could create 10,000 FTEs over the lifetime of project (2,600 more than the as-is analysis), and this includes the permanent local work force, developer back office functions and periodic work on the project. 4,090 of these OMS jobs would be local (20 more than the as-is analysis).

Indirect FTE years, FTEs created below tier 1 contracting level, would make the largest contribution to the total.

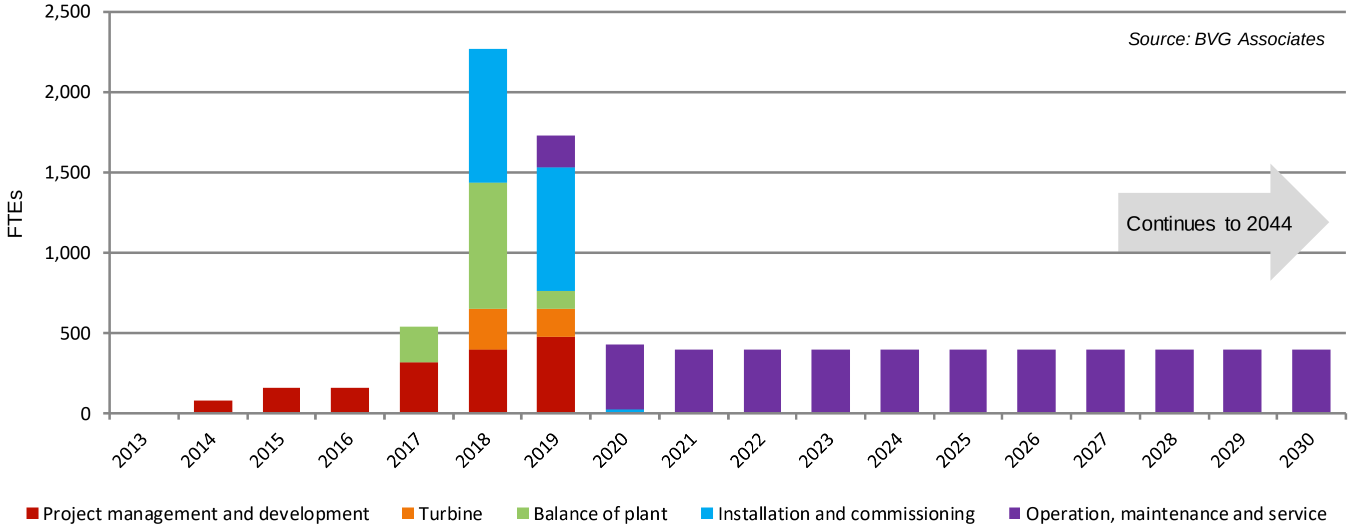


Figure 57 'What-if' employment created in Scotland by Beatrice Offshore Wind Farm by supply chain category.

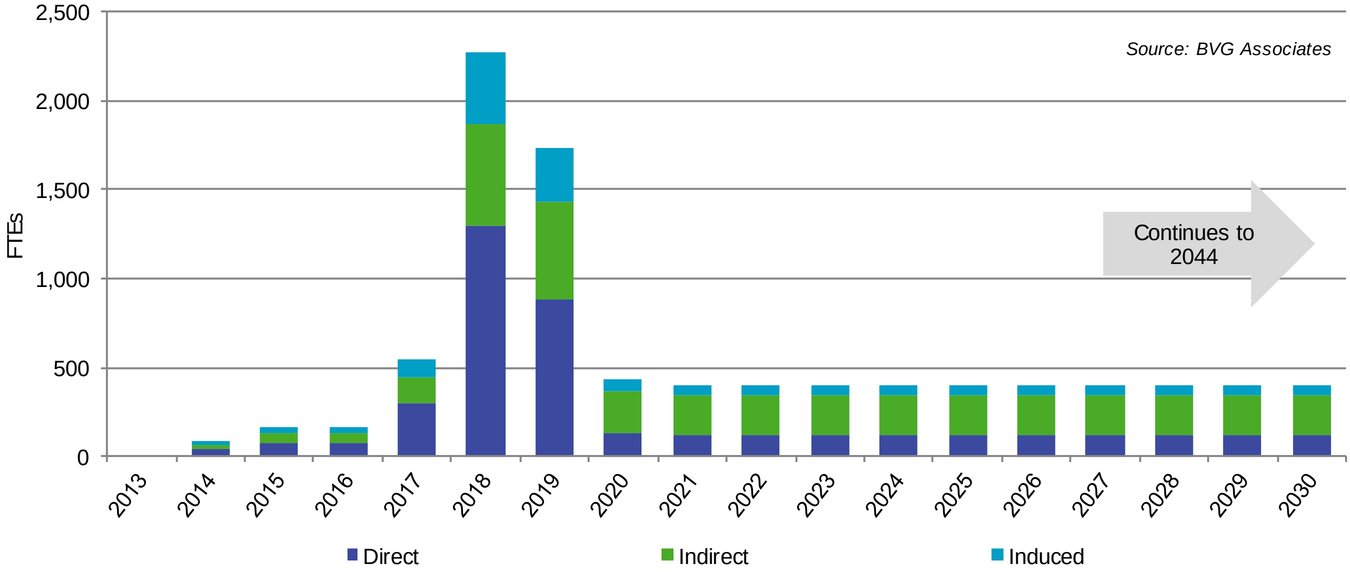


Figure 58 ‘What-if’ employment created in Scotland by Beatrice Offshore Wind Farm by direct, indirect and induced impact.

6.2. Neart Na Gaoithe Offshore Wind farm

The key differences between the as-is analysis and the what-if analysis includes:

- An increased use of Scottish suppliers for the development and project management phase
- Part of the tower work pack being contracted in Scotland
- A small portion of the offshore substation work using Scottish suppliers, and
- A higher Scottish content in OMS.

Scottish content

NNG could have achieved 38.2% Scottish content and 11.9% local content (see Figure 59 and Table 11). This compares with 29.3% and 11.9% respectively for the as-is analysis.

The areas with highest percentage Scottish content would be project development and management with 66.4%. This area would be closely followed by OMS which would have a Scottish content of 54%, due to its use of Scottish based technicians and operational staff. OMS also provide the highest local content, at 21%.

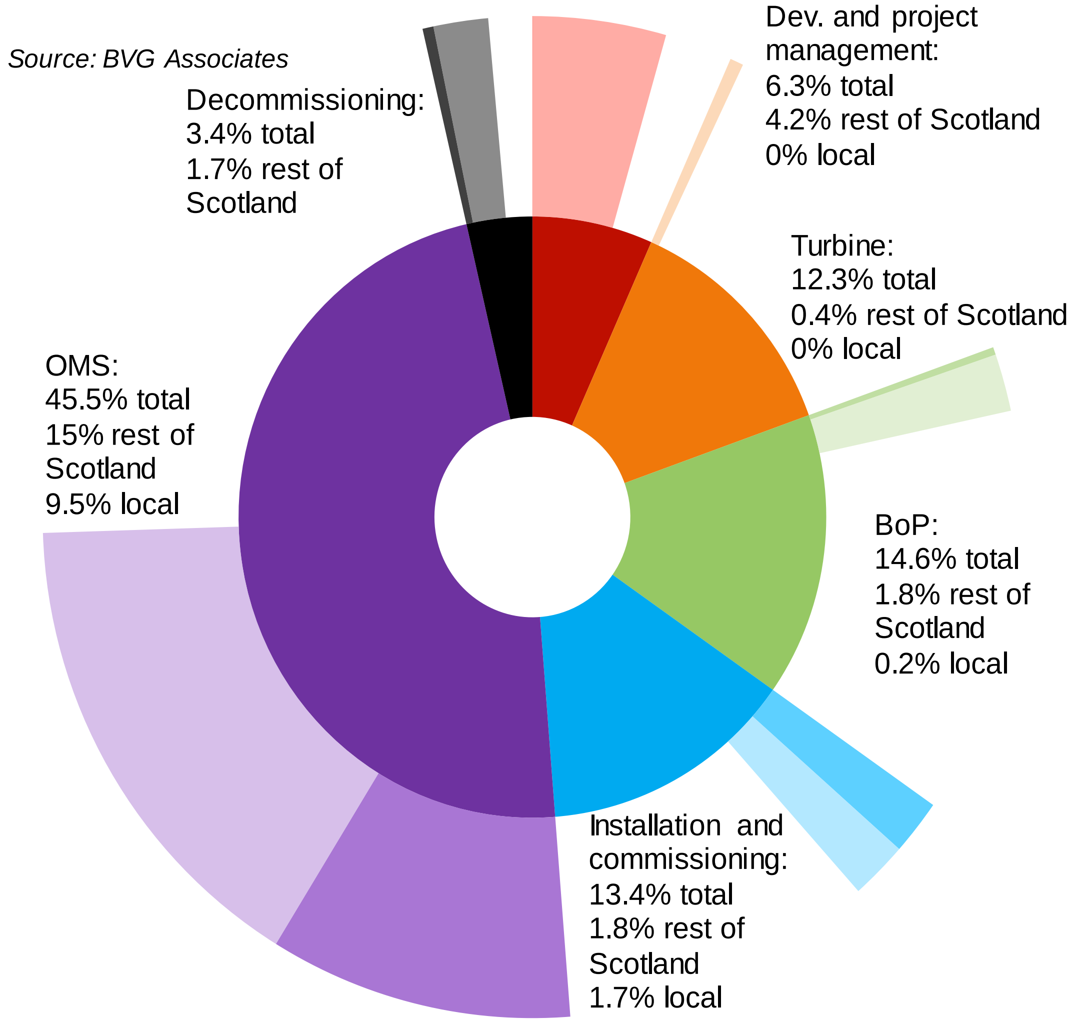


Figure 59 'What-if' Scottish and local content in Neart Na Gaoithe Offshore Wind Farm by supply chain category.

Table 11 'What-if' Scottish content in Neart Na Gaoithe Offshore Wind Farm by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	6.3%	Scotland	66.4%	4.2%	Local	0.2%	0%
		Non-Scotland	33.6%	2.1%	Rest of Scotland	66.2%	4.2%
Turbine supply	12.3%	Scotland	3.5%	0.4%	Local	0%	0%
		Non-Scotland	96.6%	11.9%	Rest of Scotland	3.5%	0.4%
Balance of plant	14.6%	Scotland	13.8%	2%	Local	1.6%	0.2%
		Non-Scotland	86.2%	12.5%	Rest of Scotland	12.1%	1.8%
Installation and commissioning	13.4%	Scotland	26.2%	3.5%	Local	12.7%	1.7%
		Non-Scotland	73.8%	9.9%	Rest of Scotland	13.4%	1.8%
Operation, maintenance and service	45.5%	Scotland	54%	24.6%	Local	21%	9.5%
		Non-Scotland	46%	20.9%	Rest of Scotland	33.0%	15%
Decommissioning	3.4%	Scotland	60%	2.1%	Local	10%	0.3%
		Non-Scotland	40%	1.4%	Rest of Scotland	50%	1.7%
Total	100.0%	Scotland	38.2%	38.2%	Local	11.9%	11.9%
		Non-Scotland	61.8%	61.8%	Rest of Scotland	26.4%	26.4%

GVA, earnings and employment

Table 12 summarises the economic impacts that could have been created by NNG.

Gross value-added

NNG could have generated £1,277 million direct, indirect and induced GVA in Scotland over the lifetime of the wind farm (£297 million more than as-is analysis), of which £342 million would be local. GVA would peak during the construction and installation phase at around £165 million (£45 million more than as-is analysis) in 2021 (see Figure 60).

Over the lifetime OMS could generate the greatest amount of GVA at £810 million (£140 million more than as-is analysis), comprising 22% direct, 61% indirect and 17% induced GVA (see Figure 61). OMS could create £275 million locally.

Table 12 Summary of 'what-if' direct, Indirect and induced economic impact generated by Neart Na Gaoithe Offshore Wind Farm.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£407	£640	£230	£1,277	£236	£89	£17	£342
Earnings (millions)	£248	£180	£69	£497	£145	£24	£5	£174
FTE years	4,660	5,305	1,805	11,770	3,030	710	170	3,910

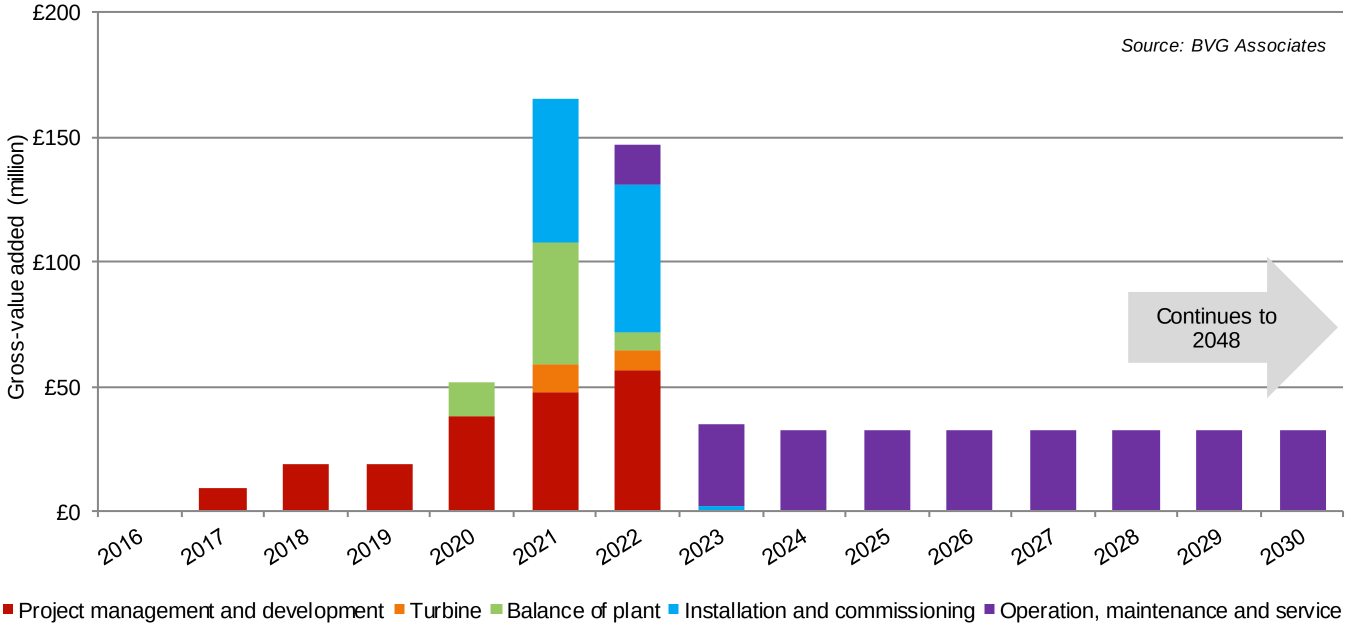


Figure 60 'What-if' gross-value added generated in Scotland by Neart Na Gaoithe Offshore Wind Farm by supply chain category.

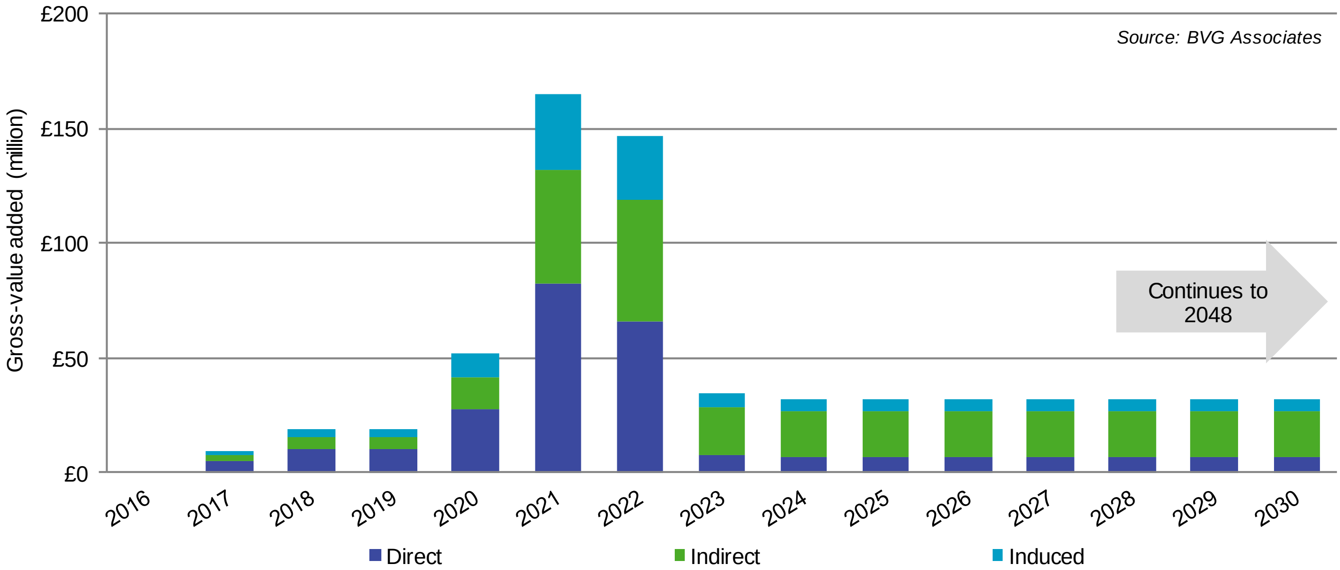


Figure 61 'What-if' gross-value added generated in Scotland by Neart Na Gaoithe Offshore Wind Farm by direct, indirect and induced impact.

Employment

Over the lifetime of the project 11,770 FTEs could have been created (2,730 more than the as-is analysis) of which 3,910 would be local. The number of FTEs created each year between 2016 and 2048, broken down by supply chain, is shown in Figure 62.

FTEs peak in the construction and installation phase in 2021, when 1,730 FTEs could be created (460 more than the as-is analysis). This comprises 57% direct, 25% indirect and 18% induced FTEs (see Figure 63).

OMS could create 7,350 FTEs over the lifetime of project (1,250 more than the as-is analysis), of which 3,110 would be local. This includes the permanent local work force, developer back office functions and periodic work on the project.

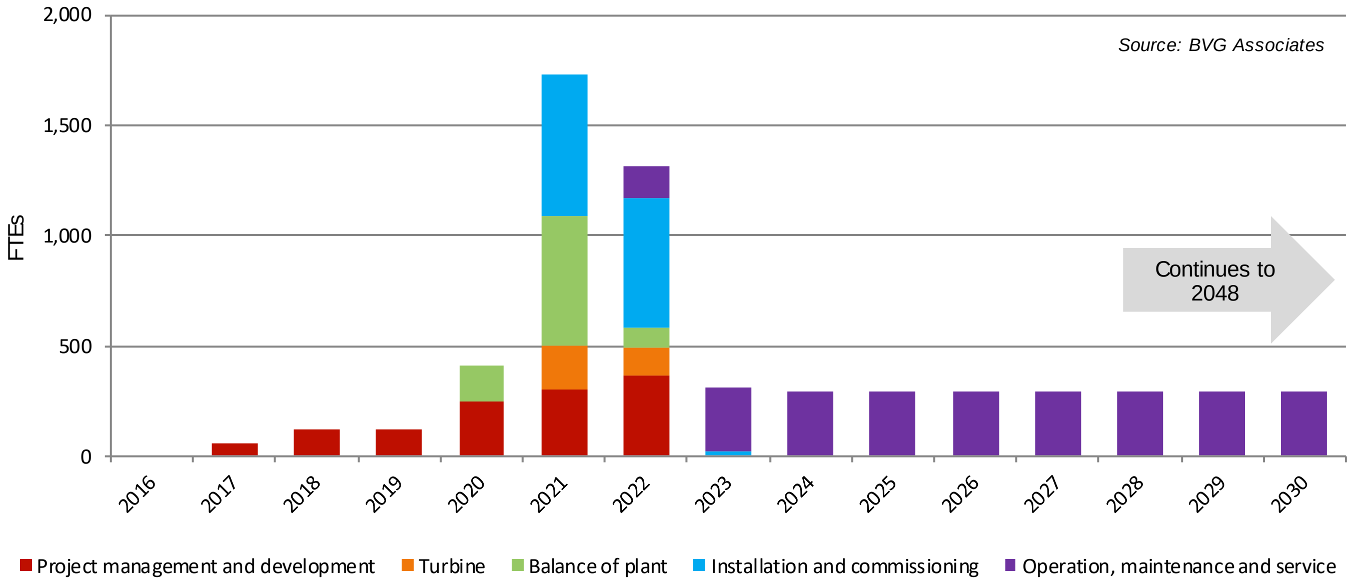


Figure 62 'What-if' employment created in Scotland by Neart Na Gaoithe Offshore Wind Farm by supply chain category.

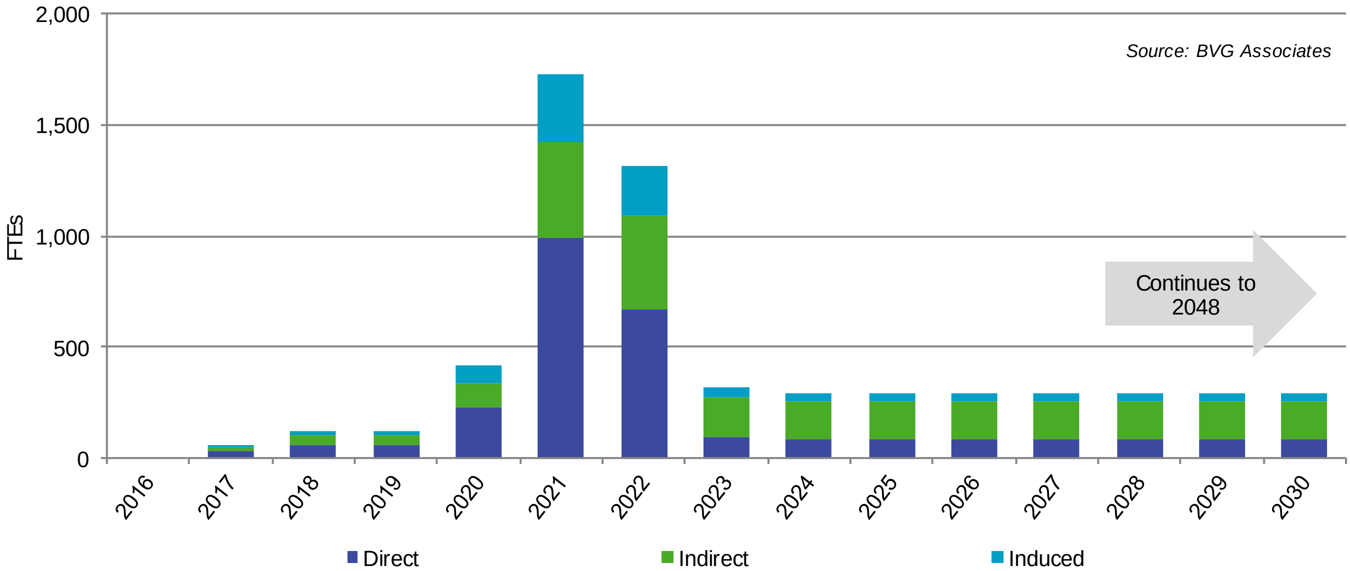


Figure 63 'What-if' employment created in Scotland by Neart Na Gaoithe Offshore Wind Farm by direct, indirect and induced impact.

6.3. Hywind Scotland

The key differences between the as-is analysis and the what-if analysis includes:

- A higher Scottish content in the development and project management phase
- Part of the tower order being placed in Scotland
- Using Scottish supply chain for the installation of foundations and turbines, and
- A higher Scottish content in OMS.

Scottish content

We conclude that Hywind Scotland could have achieved 44.4% Scottish content and 17.3% local content (see Figure 64 and Table 13). This compares with 19.9% and 9% respectively for the as-is analysis.

The areas with highest percentage Scottish content are development and project management with 77.5%.

This area is closely followed by installation and commissioning with 60.5%, due to its utilisation of Scottish based technicians and operational staff.

Source: BVG Associates

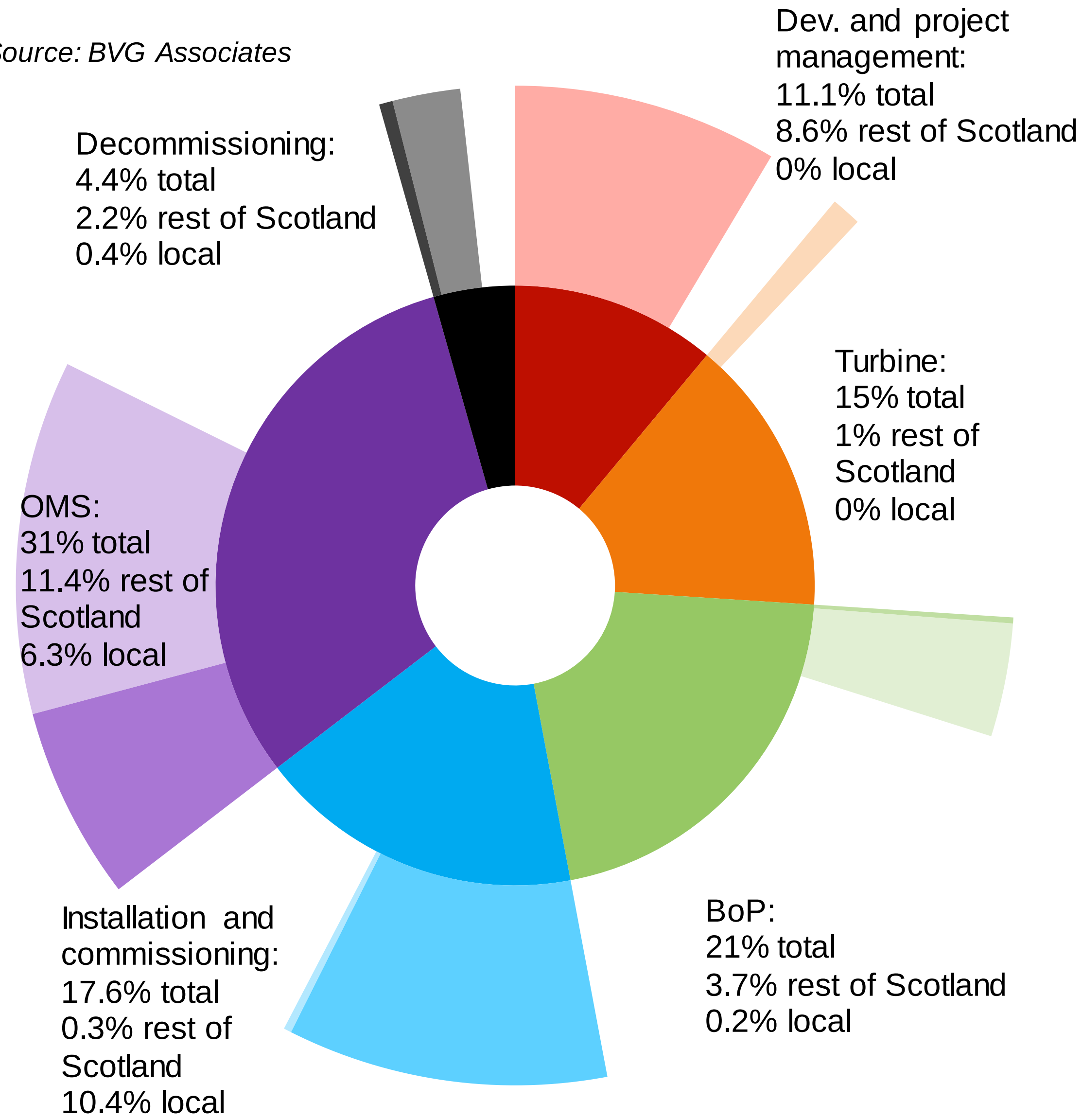


Figure 64 'What-if' Scottish and local content in Hywind Scotland by supply chain category.

Table 13 'What-if' Scottish content in Hywind Scotland by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	11.1%	Scotland	77.5%	8.6%	Local	0%	0%
		Non-Scotland	22.5%	2.5%	Rest of Scotland	77.5%	8.6%
Turbine supply	15%	Scotland	6.5%	1%	Local	0%	0%
		Non-Scotland	93.5%	14%	Rest of Scotland	6.5%	1%
Balance of plant	21%	Scotland	18.3%	3.9%	Local	0.9%	0.2%
		Non-Scotland	81.7%	17.2%	Rest of Scotland	17.4%	3.7%
Installation and commissioning	17.6%	Scotland	60.5%	10.6%	Local	59%	10.4%
		Non-Scotland	39.5%	6.9%	Rest of Scotland	1.4%	0.3%
Operation, maintenance and service	31%	Scotland	57.1%	17.7%	Local	20.2%	6.3%
		Non-Scotland	42.9%	13.3%	Rest of Scotland	36.9%	11.4%
Decommissioning	4.4%	Scotland	60.0%	2.6%	Local	10%	0.4%
		Non-Scotland	40%	1.8%	Rest of Scotland	50%	2.2%
Total	100%	Scotland	44.4%	44.4%	Local	17.3%	17.3%
		Non-Scotland	55.6%	55.6%	Rest of Scotland	27.1%	27.1%

GVA, earnings and employment

Table 14 summarises the economic impacts that could have been created by Hywind Scotland.

Gross value-added

Hywind Scotland could have generated £171 million direct, indirect and induced GVA in Scotland over the lifetime of the wind farm (£103 million more than as-is analysis), of which £59 million would be local. GVA would peak during the construction and installation phase at around £39 million (£26 million more than as-is analysis) (see Figure 65).

Over the lifetime OMS could generate the greatest amount of GVA at £69 million (£28 million more than as-is analysis), comprising 20% direct, 63% indirect and 17% induced GVA (see Figure 66). OMS could create £22 million locally (£5 million more than as-is analysis).

Table 14 Summary of 'what-if' direct, Indirect and induced economic impact generated by Hywind Scotland.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£63	£76	£32	£171	£18	£38	£3	£59
Earnings (millions)	£39	£22	£10	£71	£11	£12	£0.5	£23.5
FTE years	700	660	265	1,625	225	350	25	600

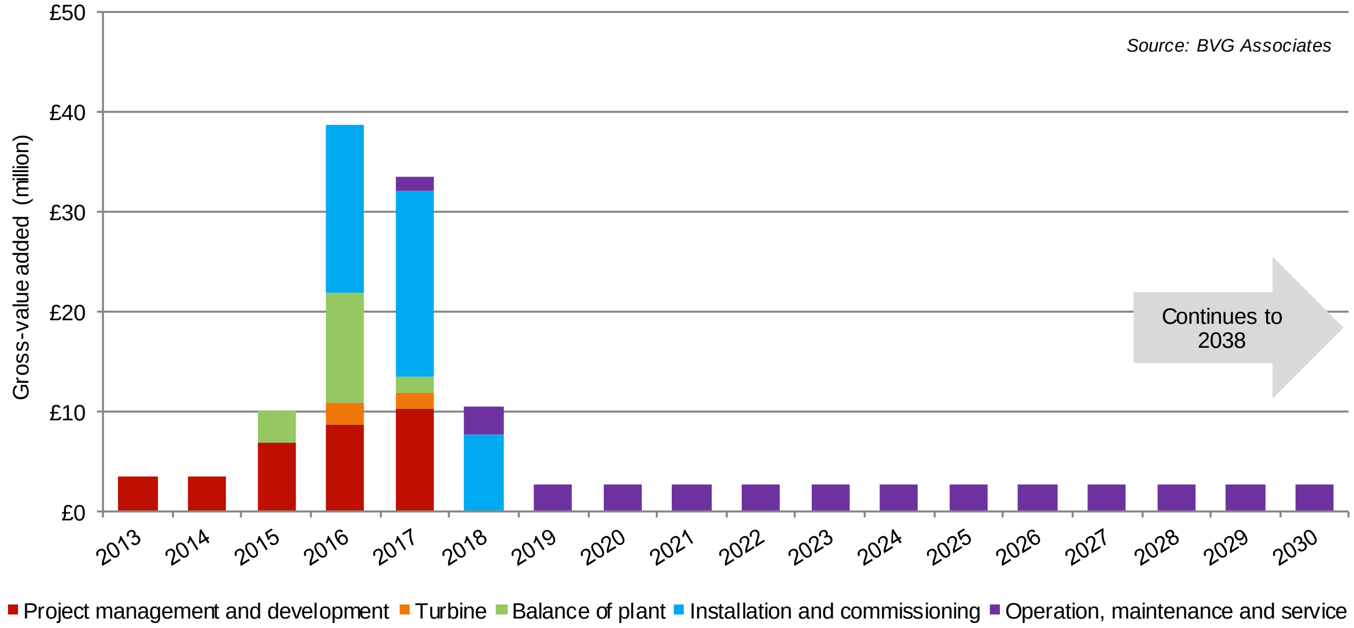


Figure 65 'What-if' gross-value added generated in Scotland by Hywind Scotland by supply chain category.

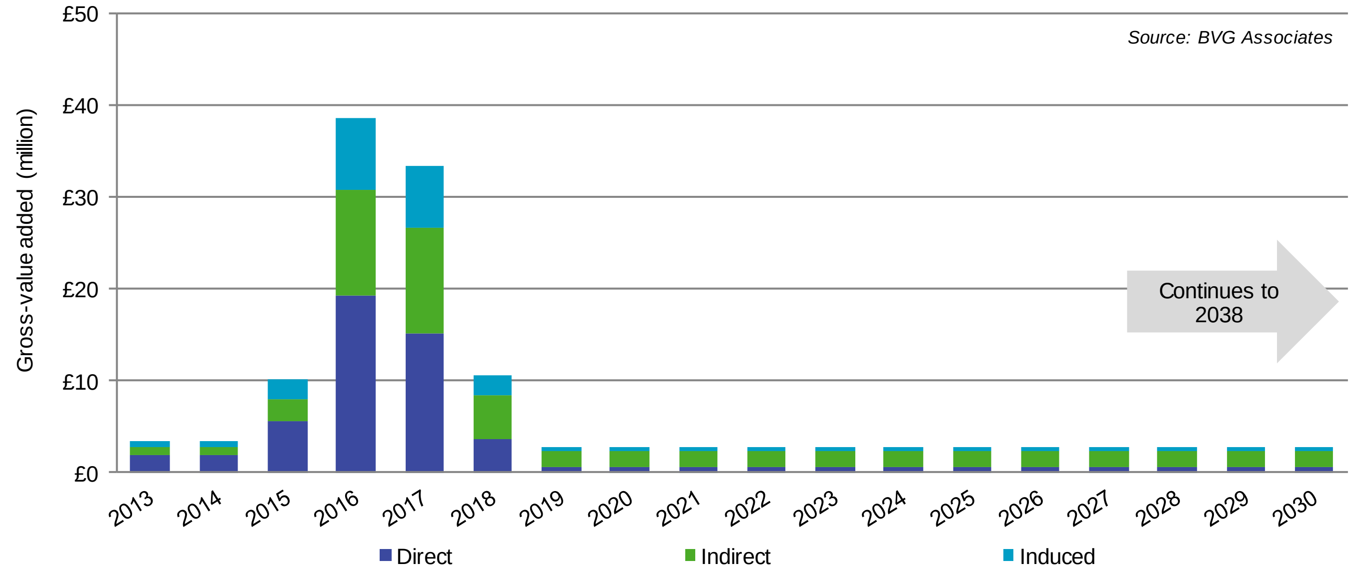


Figure 66 'What-if' gross-value added generated in Scotland by Hywind Scotland by direct, indirect and induced impact.

Employment

Over the lifetime of the project 1,625 FTEs, could have been created in Scotland (935 more than the as-is analysis), of which 600 locally (305 more than the as-is analysis). The number of FTEs created each year between 2013 and 2038, broken down by supply chain, is shown in Figure 67).

FTEs peak in the construction and installation phase in 2016, when 405 FTEs could be created (253 more than the as-is analysis). This comprises 57% direct, 25% indirect and 18% induced FTEs (see Figure 68).

OMS could create 620 FTEs over the lifetime of project (245 more than the as-is analysis), and this includes the permanent local work force, developer back office functions and periodic work on the project. Of these, 240 would be local.

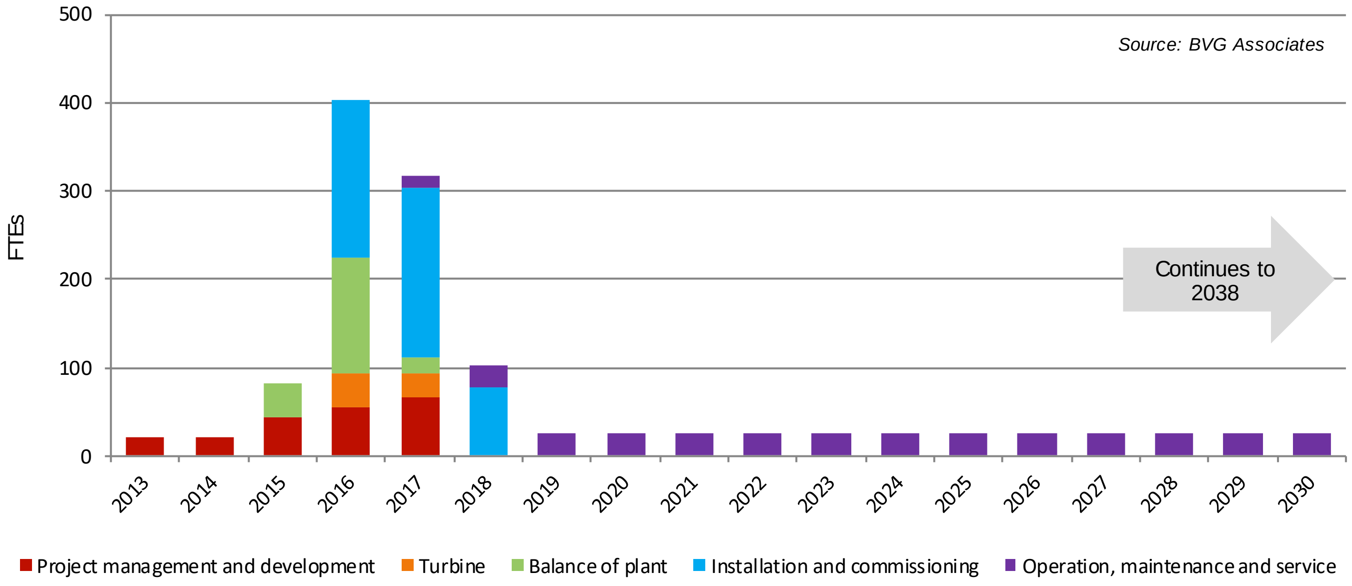


Figure 67 'What-if' employment created in Scotland by Hywind Scotland by supply chain category.

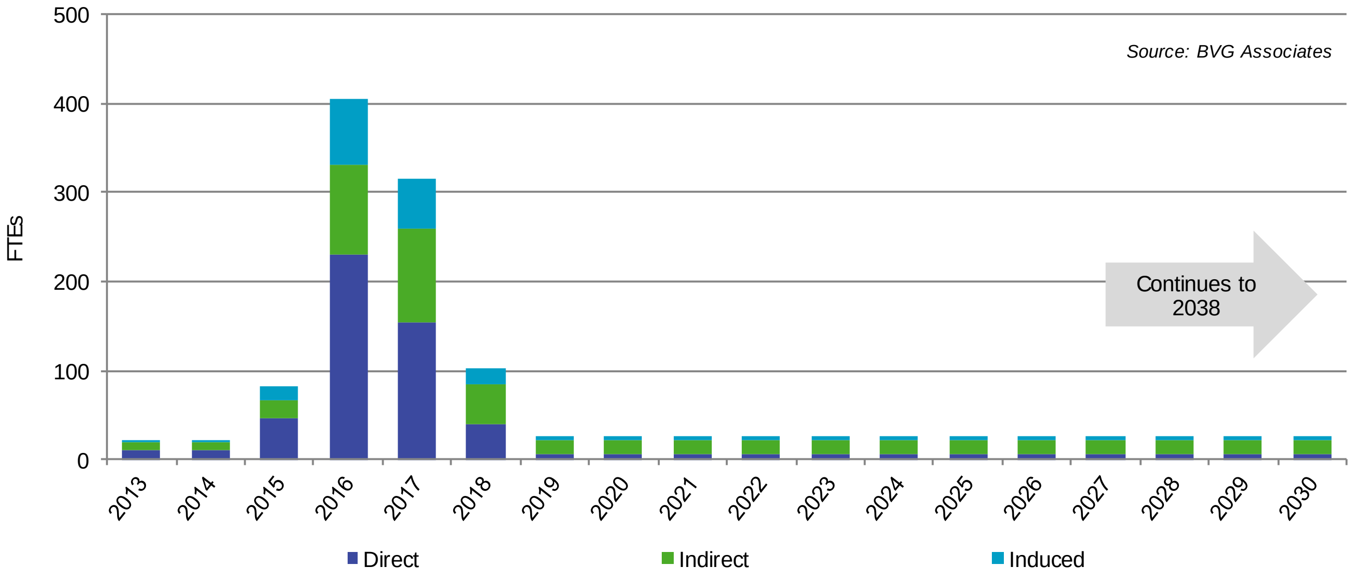


Figure 68 'What-if' employment created in Scotland by Hywind Scotland by direct, indirect and induced impact.

6.4. MeyGen Phase 1A

The key additional Scottish supply for the what-if analysis are:

- Higher Scottish content in the development and project management phase
- A small part of the turbine rotor and nacelle assembly work being contracted in Scotland, and
- A higher Scottish content in OMS.

Scottish content

We conclude that MeyGen could have achieved 51.3% Scottish content and 15.1% local content (see Figure 69 and Table 15Table 13). This compares with 40% and 14.5% respectively for the as-is analysis.

The areas with highest percentage Scottish content are development and project management with 87.7%. This area is followed by installation and commissioning which has an average Scottish content of 60.7%, due to its utilisation of Scottish based technicians and operational staff.

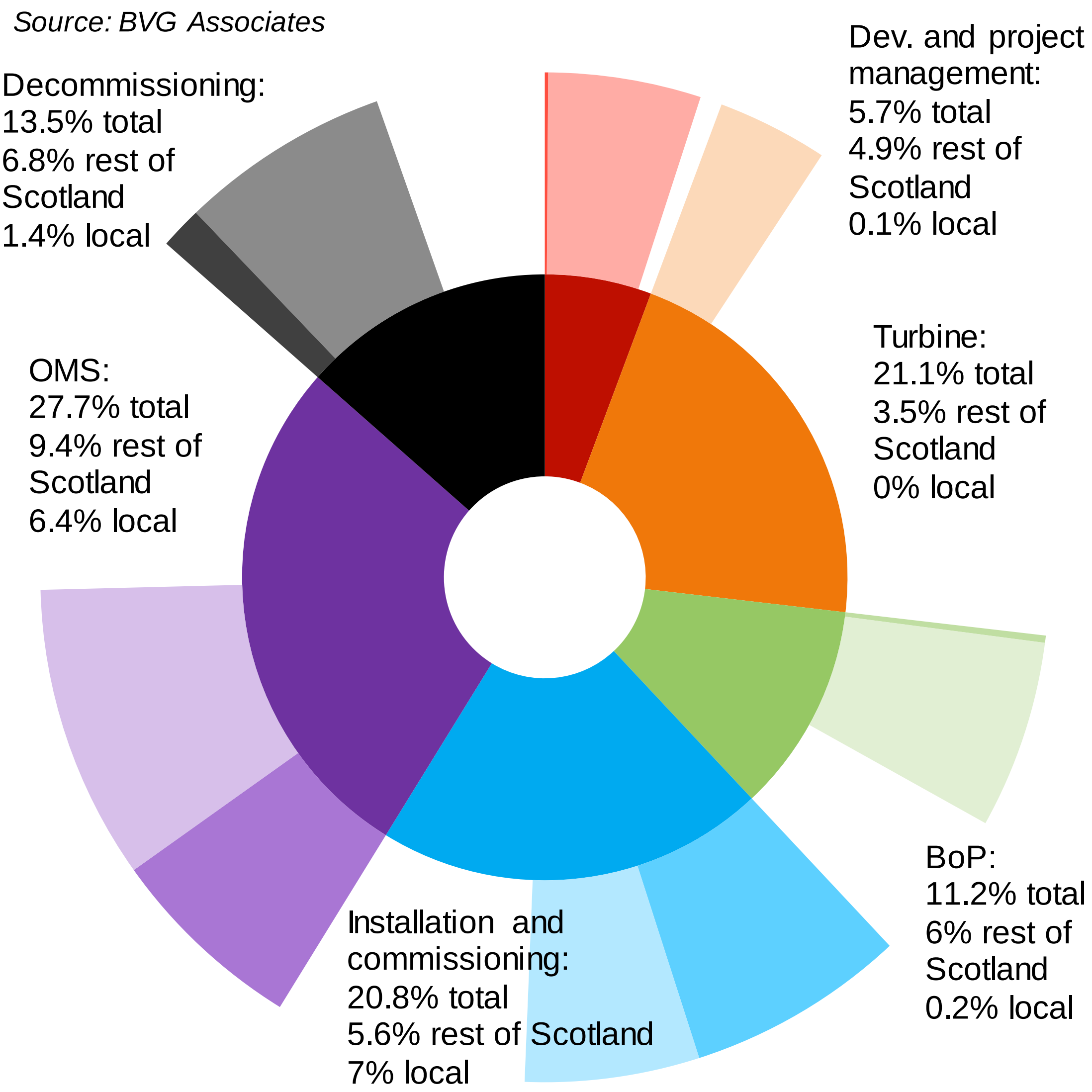


Figure 69 'What-if' Scottish and local content in Meygen Phase 1A by supply chain category.

Table 15 'What-if' Scottish content in Meygen Phase 1A by supply chain category.

Level 1 category	% of total	Territory	% of category	% of total	Territory	% of category	% of total
Development and project management	5.7%	Scotland	87.7%	5%	Local	1.9%	0.1%
		Non-Scotland	12.3%	0.7%	Rest of Scotland	85.8%	4.9%
Turbine supply	21.1%	Scotland	16.8%	3.5%	Local	0%	0%
		Non-Scotland	83.2%	17.6%	Rest of Scotland	16.8%	3.5%
Balance of plant	11.2%	Scotland	55.9%	6.3%	Local	2.1%	0.2%
		Non-Scotland	44.1%	4.9%	Rest of Scotland	53.9%	6%
Installation and commissioning	20.8%	Scotland	60.7%	12.6%	Local	33.8%	7%
		Non-Scotland	39.3%	8.2%	Rest of Scotland	26.9%	5.6%
Operation, maintenance and service	27.7%	Scotland	57.1%	15.8%	Local	23%	6.4%
		Non-Scotland	42.9%	11.9%	Rest of Scotland	34.1%	9.4%
Decommissioning	13.5%	Scotland	60%	8.1%	Local	10%	1.4%
		Non-Scotland	40%	5.4%	Rest of Scotland	50%	6.8%
Total	100.0%	Scotland	51.3%	51.3%	Local	15.1%	15.1%
		Non-Scotland	48.7%	48.7%	Rest of Scotland	36.3%	36.3%

GVA, earnings and employment

Table 16 summarises the economic impacts that could have been created by MeyGen.

Gross value-added

Meygen Phase 1A could have generated £54 million direct, indirect and induced GVA in Scotland over the lifetime of the project (£13 million more than as-is analysis) of which £13.5 million would be local. GVA would peak during the construction and installation phase in 2016, at around £14 million (£3 million more than as-is analysis) (see Figure 70).

Over the lifetime OMS could generate the greatest amount of GVA at £17 million (£4 million more than as-is analysis)., comprising 42% direct, 39% indirect and 19% induced GVA (see Figure 71). OMS could generate £6 million locally.

Table 16 Summary of 'what-if' direct, Indirect and induced economic impact generated by MeyGen Phase 1A.

	Scotland				Local			
Impact	Direct	Indirect	Induced	Total	Direct	Indirect	Induced	Total
Value-added (millions)	£22	£21	£11	£54	£6	£7	£0.5	£13.5
Earnings (millions)	£19	£10	£5	£34	£4	£4	£0.5	£8.5
FTE years	505	295	170	970	140	110	10	260

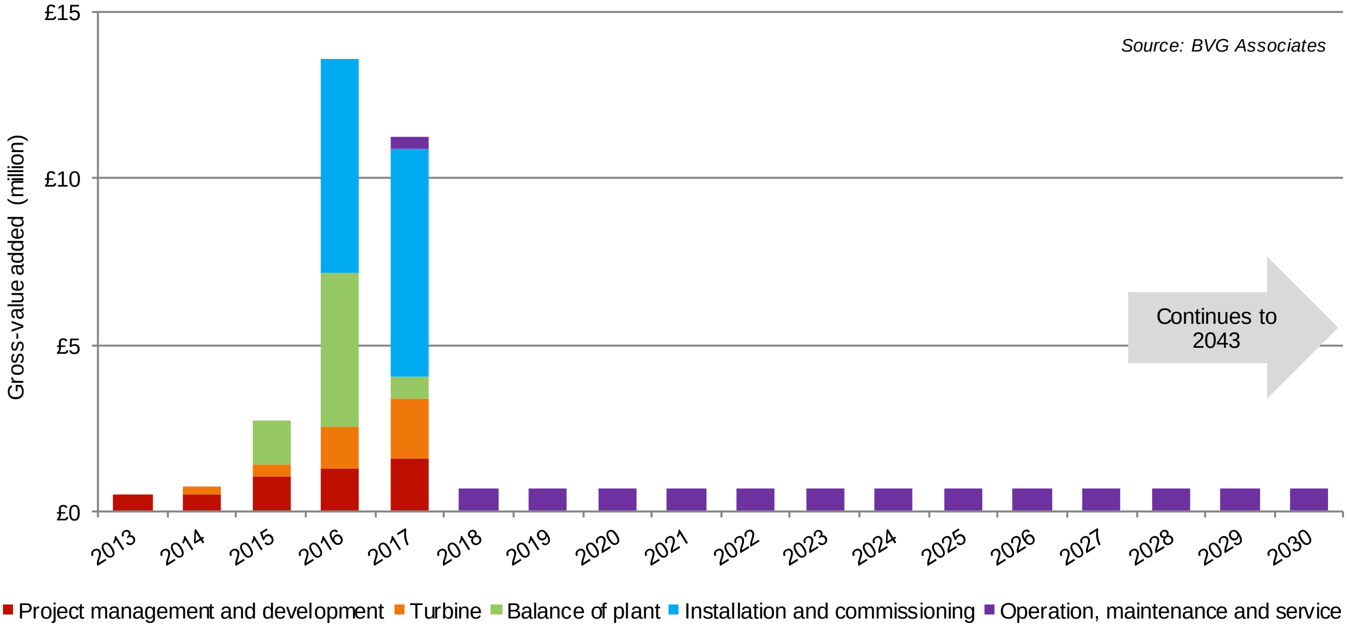


Figure 70 'What-if' gross-value added generated in Scotland by MeyGen Phase 1A by supply chain category.

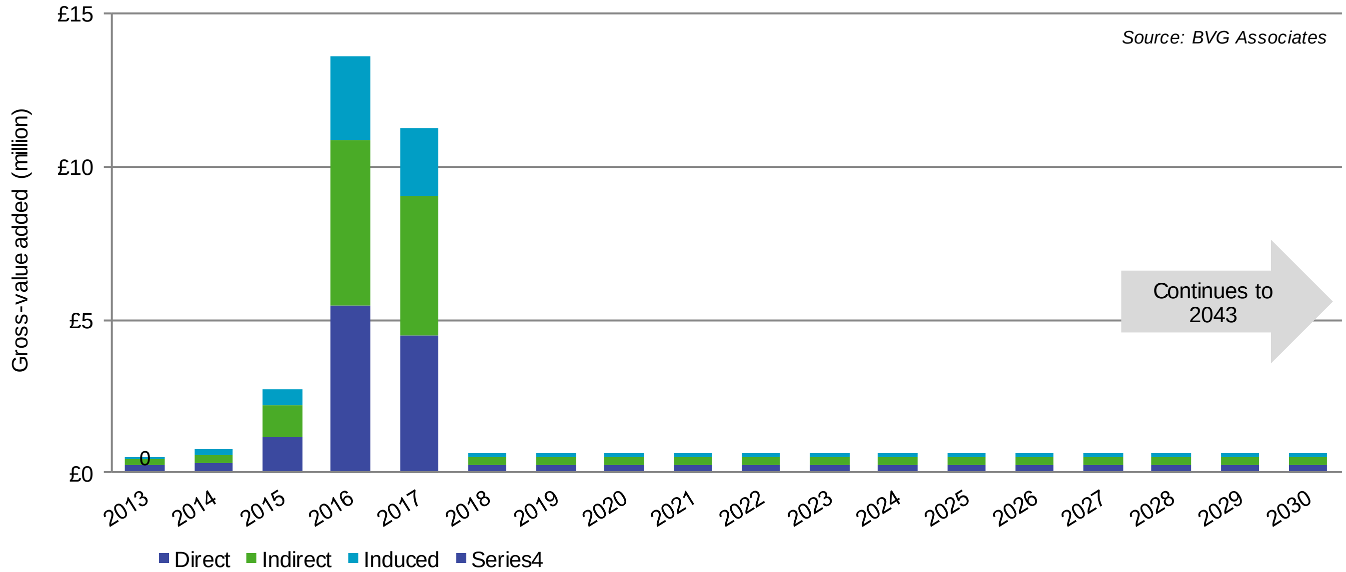


Figure 71 'What-if' gross-value added generated in Scotland by MeyGen Phase 1A by direct, indirect and induced impact

Employment

Over the lifetime of the project 970 FTEs, could have been created (450 more than the as-is analysis) in Scotland. Locally, 260 FTEs would be created (85 more than the as-is analysis). The number of FTEs created each year between 2013 and 2043, broken down by supply chain, is shown in Figure 72).

FTEs peak in the construction and installation phase in 2016, when 250 FTEs could be created (120 more than the as-is analysis). This comprises 50% direct, 32% indirect and 18% induced FTEs (see Figure 73).

OMS could create 320 FTEs over the lifetime of project (140 more than the as-is analysis), and this includes the permanent local work force, developer back office functions and periodic work on the project. 115 of those FTE years would be local.

Indirect FTE years, FTEs created below tier 1 contracting level, would make the largest contribution to the total.

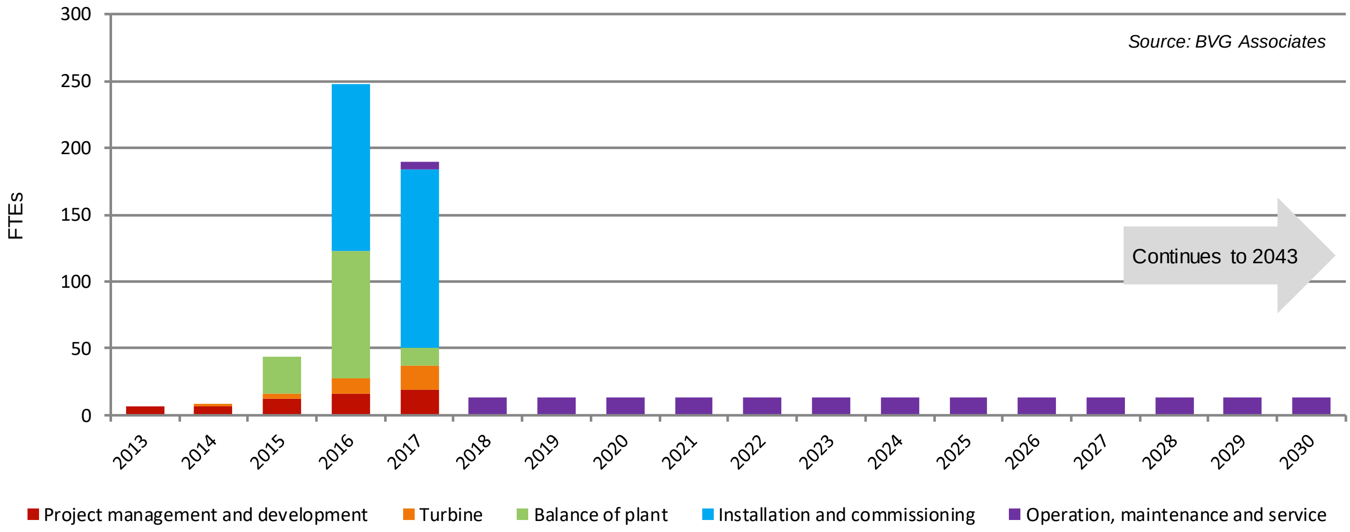


Figure 72 'What-if' employment created in Scotland by MeyGen Phase 1A by supply chain category.

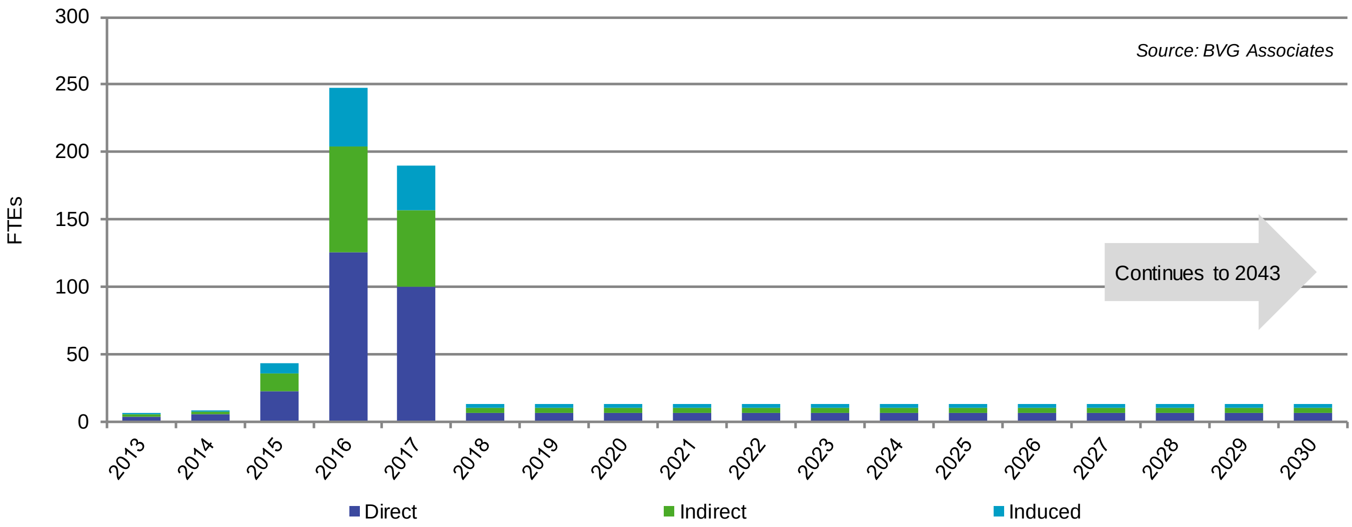


Figure 73 'What-if' employment created in Scotland by MeyGen Phase 1A by direct, indirect and induced impact.

7. Conclusions

The 'as-is' analysis looked at the economic impacts delivered by four different offshore renewable energy projects in Scotland. A 'what-if' analysis was then undertaken to see what could have been delivered by similar projects, had they used the maximum realistic Scottish content from the existing supply chain. A high-level overview and comparison of the outcomes from the two analyses can be seen in Table 17.

Table 17 Summary of 'As-is' and 'What-if' scenarios

		As-is		What-if	
Project	Impact	Scotland	Local	Scotland	Local
Beatrice	% content	29.6%	11.7%	39.2%	12.3%
	Value-added (millions)	£1,300	£444	£1,716	£465
	Earnings (millions)	£506	£227	£667	£243
	FTE years	11,620	5,070	15,810	5,290
NNG	% content	29.3%	11.9%	38.2%	11.9%
	Value-added (millions)	£980	£342	£1,277	£342
	Earnings (millions)	£382	£174	£497	£174
	FTE years	9,040	3,910	11,770	3,910
Hywind	% content	19.9%	9%	44.4%	17.3%
	Value-added (millions)	£68	£26	£171	£59
	Earnings (millions)	£27	£12.5	£71	£23.5
	FTE years	690	295	1,625	600
MeyGen	% content	40%	14.5%	51.3%	15.1%
	Value-added (millions)	£41	£13.5	£54	£13.5
	Earnings (millions)	£16	£6.5	£34	£8.5
	FTE years	520	175	970	260

Recommendations to address opportunities and barriers

In this section we consider the opportunities and barriers in relation to maximising Scottish content in the supply chain for offshore renewable energy projects and make recommendations for increasing the Scottish content of renewable energy development projects.

We considered opportunities and barriers as they relate to the six categories of the supply chain taxonomy used throughout this report.

7.1. Opportunities and barriers

Development and project management

Development and project management represents an opportunity for Scotland to further develop expertise that will both maximise the Scottish content in the supply chain and in turn support the development of offshore renewable projects globally.

Scotland has considerable competence and expertise in development services (such as environmental engineering), subsea engineering and marine operations, building on experience from the oil and gas, and the onshore renewables sectors. These are areas where Scotland should look to transfer this competence to offshore renewables to establish a leading position and reputation for excellence, which can support export to other markets.

The most significant barrier is competition from outside Scotland providing services to Scottish offshore renewable energy projects, and Scottish businesses competing with local expertise in export markets with lower cost bases. The ScotWind leasing rounds could also bring new developers to the Scottish market with established offices elsewhere and non-Scottish supply chains.

Turbine supply

Wind

Wind turbine supply is not considered a significant opportunity for Scotland.

There is no offshore wind nacelle assembly in the UK. This is unlikely to change as almost all components are supplied from mainland Europe and a UK factory would face additional component delivery costs.

There are two blade manufacturing plants in England. Further investment in blade production facilities is possible in the UK, but there are no compelling reasons why it would be in Scotland, rather than elsewhere in the UK.

Scotland has had some tower manufacturing with CS Wind, but it does not have the infrastructure to manufacture all the tower sections for turbine suppliers. Increased Scottish capability is most likely to be achieved with investment at a new site, most likely on the east coast.

While there is potential for new offshore wind turbine production facilities in Europe, there is no compelling reason why these would be in Scotland.

Tidal

Tidal turbine supply does represent an opportunity for Scotland, but this will only have a significant economic impact if there is a substantial pipeline of projects. Current cost projections and government policies seem unlikely to provide that.

For tidal turbines there is intellectual property and capability in Scotland, and Scottish tidal turbines (for example Orbital). As pre-commercial stage businesses, Scottish turbine suppliers face a barrier in meeting the finance and warranty requirements of large commercial tidal projects, should a pipeline of such projects emerge.

Balance of plant

Balance of plant costs are a significant cost of energy for all renewables and if a high proportion of Scottish or local content is to be secured, our supply chain must be able to compete on costs.

Fixed and floating foundations

Generally, Scottish companies have found it difficult to compete with other European and Asian fabricators. Substructure fabrication in Scotland was not deemed to be commercially competitive for Hywind. A small minority of the jackets at Beatrice were manufactured in Scotland. The current Scottish fabrication facilities and methods were developed and optimised to support the offshore oil and gas sector. With a couple of modest exceptions, the cost base of the existing suppliers and facilities is too high, and the track record of volume manufacturing is not there. As it stands, if Scottish content in fabrication is mandated, there is a risk that Scottish projects will be uncompetitive and have a higher investment risk profile.

In Asia, the challenge comes from lower wage economies, while in Europe, many competitors have both lower wage costs and have invested in facilities for high volume production. While Asian labour costs cannot be matched, Scottish companies could become competitive to European competitors for many activities following investment. A prerequisite for this will be a robust pipeline of projects in Scotland.

Government could invest in port and manufacturing facilities to ensure that they meet quality, schedule and HSE requirements for large-scale serial production, as well as enabling high productivity and efficiency to ensure competitive pricing.

Investor risk is one of the biggest barriers to developing greater supply chain content. Reduction in investment risk and return has been the largest factor in the recent rapid reduction in the cost of energy from offshore wind. Large projects now require low investment risk to allow them to construct at the low CfD prices secured. This means that only proven suppliers that have achieved scale in their manufacturing capacity will be used. A Scottish supplier with no track record looking to enter the sector and scale up may be able to compete on price in an attempt to win contracts, but is likely to be seen as unacceptable from an execution risk perspective on all but the smallest projects.

This means that the most effective route to achieving higher local manufacturing content in balance of plant may be to encourage further inward investment from component or subsystem fabricators. However, in the case of fabrication it may be possible and more beneficial to try to broker and support a joint venture approach to attempt to create knowledge transfer and local credibility, and thereby a more persistent economic benefit.

The public and private sectors need to come together to identify strategic fabrication investments and particularly partnerships. Partnerships could be built around reducing the cost of set-up by making use of existing plant and facilities under the ownership or control of Scottish companies. This could attract world-leading fabricators to invest in and establish a presence in Scotland and should effectively tackle the investment risk issue. A prerequisite for this will be a robust pipeline of projects in Scotland.

With the downturn of the oil and gas, and ship building industries, fabricators are reporting that the pool of suitably qualified labour is shrinking. An investment in skills would therefore be required to support any investment in the facilities or suppliers.

The manufacturing of floating offshore wind foundations needs local sites where structures can be assembled and floated to site. The steel fabrication could be done locally or elsewhere, but assembly prior to deployment would need to be completed in Scotland.

For tidal energy projects, both fabrication and assembly offer an opportunity for growth, should a pipeline of commercial projects emerge. Turbines with modular designs mean that the steel can come from elsewhere, but the assembly and testing can happen in Scotland.

Electrical

Electrical systems have a largely European component supply chain with system engineering by the major suppliers from centres of excellence. There are no indications to suggest that any of this will move from current locations.

Substation platforms have been manufactured in Scotland at Rosyth. A challenge for suppliers has been the high risks and low margins that have resulted from a highly competitive market. This potentially could disincline Scottish manufacturers from bidding for offshore wind contracts.

Cable production is distributed across Europe and suppliers typically invest at existing sites. There is opportunity in Scotland for companies that do supply cables and umbilicals to the oil and gas industry, but this has so far not resulted in awards for offshore renewables. Existing Scottish capability is in medium voltage cables (suitable for array cabling) and this tends to offer lower margins than high voltage (export) cables. It is unknown what actions could encourage Scottish companies to diversify into cables for renewables.

The top three barriers to growing content in this area are:

- Lack of track record and scale
- High cost, and
- Availability of skills.

The analysis above is based around Scottish companies competing to supply established solutions. In many areas there remain considerable opportunities for innovation and improved technical solutions. If improved technologies and designs can be created and qualified in Scotland, then this would significantly change the prospects for securing a larger proportion of the value content and would also deliver further value through access to export markets. These aspects are dealt with in the following section.

Installation and commissioning

The development of port facilities represents an opportunity for Scotland, although it is important to note that port expenditure represents about 1% of CAPEX and does not lead to significant local employment.

The major installation contracts are placed with large marine contractors with significant vessel fleets. There is currently only one contractor with a Scottish presence, although it is only the engineering and project management that would be delivered from Scotland. Floating wind and tidal energy have distinct vessels, but with installation methods uncertain for commercial scale projects, it is unclear whether these sectors create a new opportunity for Scotland. It is notable than many oil and gas vessels in Aberdeen are in foreign ownership.

The greatest opportunity in installation is likely to come from offshore and subsea engineering companies, providing either services or equipment. Scotland has significant strengths here in the oil and gas industry. Many have taken the strategic step into renewables, but the full potential has not yet been realised.

The major barrier has been the perceived credibility of offshore renewables, but this is rapidly changing. The construction of major projects such as Beatrice, NNG and Seagreen is likely to be a catalyst for change.

OMS

OMS represent a significant opportunity to grow Scottish content in offshore renewable energy projects. Capturing benefits in the operations and maintenance phase alone would deliver significant long-term benefits to coastal communities.

Scotland has considerable competence and expertise in OMS, largely building on experience from the oil and gas, and onshore renewables sectors.

This is an area where Scotland should look to transfer this competence to offshore wind to establish a leading position and reputation for excellence, which can support export to other markets.

In tidal operations and maintenance is the biggest opportunity for Scottish suppliers.

Barriers

- Proven track record vs established players
- Cost base, and
- Current vessel portfolio.

Summary of opportunities and barriers

It is apparent that there are opportunities to increase the Scottish content of offshore renewable energy projects.

The barriers are two-fold. First, investment in facilities and capability is required for Scotland to deliver at the scale and cost required to be competitive with facilities elsewhere. This is particularly true with regards to fabrication and assembly. Secondly, there is the issue of cost. If higher Scottish content is required, Government might need to accept that Levelised Cost of Energy (LCOE) from Scottish renewable energy projects will increase, at least for earlier projects.

Ultimately, it is important to ensure that Scottish suppliers are competitive, which will enable them to capture a greater market share outside of Scotland, as well as support continued cost reduction.

Efforts to assist the local supply chain to secure contracts should be focused on ensuring that suppliers can win projects under competitive procurement processes, rather than imposing strict local content requirements.

Ensuring that domestic suppliers are competitive is the best way to ensure that a sustainable supply chain develops to deliver long-lasting benefits to Scotland. Competitive suppliers will also be able to capitalize on the considerable export opportunities.

7.2. Recommendations

Based on our analysis, we make recommendations across three themes:

- Encouraging pipeline volume through policy
- Floating wind and tidal, and
- Opportunities in innovation.

There are three core areas where industry, Government and enablers should focus to maximise the potential for Scottish content in offshore renewable energy projects.

Build offshore wind pipeline volume

Building a pipeline of offshore wind projects ready to enter construction in the near to medium-term will enable Scottish suppliers to capitalise on the benefits offered by multi-billion-pound energy infrastructure investments around Scotland’s coastline.

A pipeline of projects could unlock investment from the supply chain. This includes existing domestic suppliers, but also inward investment from major tier one and two suppliers, which could deliver a step-change in local job creation.

Projects in Scotland will need to be competitive in the wider UK portfolio to provide confidence to supply chain investors and ensure that the economic opportunities can be realised. This has proved challenging with Scottish projects typically having higher capital costs (due to water depth and sea bed conditions) and high transmission costs, which penalise Scottish generators that are far from demand centres.

Regarding tidal energy projects, the cost of energy from tidal energy projects needs to be demonstrated to be competitive with other forms of generation before a pipeline of project is likely to materialise.

Floating wind and tidal

Scottish suppliers have the potential to become leading providers to the emerging floating offshore wind market, due to the evident synergies with the oil and gas sector.

To realise this opportunity it is vital to have a framework in place that encourages developers to pursue a significant volume of commercial floating projects in ScotWind.

This framework needs to include regulatory policies that give investors sight of a significant volume of projects to be delivered over the next decade or more. This regulatory framework needs to work hand in hand with an industrial strategy that delivers investment in floating wind fabrication infrastructure.

After having led technology development and early deployment for many years Scotland is now falling behind the rest of the world. In order to secure long term and persistent value in this sector we must re-establish a well-designed deployment programme.

Innovation

A valuable approach would be to use Scottish projects to qualify improved methods or technology for the wider industry. Scottish Government support could be directed at supporting the inclusion of new technology in commercial projects through grants and risk sharing.

New improved technology, methods or operating practices offers not only reduced cost and increased local value in domestic projects but creates the platform for exports to the entire global market. Scotland created a global lead in subsea technology for aggressive sites and with the North Sea now in decline has turned to exporting this to the global market creating GVA long after the domestic opportunity is over.

Innovation needs to be targeted at key issues in the existing technical solutions and be in areas where the existing leading Scottish expertise lies.

A successful strategy would use Scottish projects to prove Scottish innovation – at low cost and risk to the developer, who still get their cheap product from a proven low risk supply chain overseas. The return would be not only higher local content on Scottish projects, but long-term Scottish competitive advantage in the global market. Value share of existing projects may remain modest, but the ultimate prize is much bigger.

Barriers are:

- Clear understanding and framing of opportunities for innovation
- Lack of domestic pipeline to engage and motivate the supply chain and research base to focus and invest, and
- Risk appetite in fully commercial projects.

Scotland has a clear opportunity to pursue a specialisation focus in technology innovation areas where there are existing strengths and potential to exploit competitive advantages, as opposed to spreading focus across too many areas and risk failing to deliver on potential in key areas.

Areas where Scotland has the opportunity to establish a world-leading position in fixed and floating wind and tidal systems, by way of example, include:

- Fixed and floating foundation solutions for deeper and rougher waters
- Offshore construction and installation technologies and processes suited to deeper, rougher locations
- Specific technologies and processes to improve the installation and grouting of fixed foundations
- Mooring system engineering, including fibre rope moorings for floating systems
- Mooring connectors
- Dynamic cable engineering
- Cable accessories and protection systems
- Cable connectors, and
- O&M subsea monitoring and inspection technologies.

These are areas where Scottish suppliers could be well-placed to serve both domestic and overseas markets, provided innovations can be commercialised.

Establishing manufacturing facilities for innovative products could represent an opportunity to capture a higher economic value from future projects in Scotland.

Despite being a more mature technology, there remains considerable scope for innovation in fixed offshore wind, particularly during the installation and OMS phases. Wind farm operators will be driven to reduce costs, improve health and safety, and better understand the performance of a growing fleet of assets. Developing new products and services in the OMS space will also offer export opportunities to the growing global offshore wind market.

Innovation in areas such as digitalisation, robotics, and subsea engineering could represent high value opportunities for Scottish suppliers, leveraging experience from the oil and gas and other marine sectors.

Perceived investor risk could be a barrier for innovation, but with right approach and qualification this could be offset by the higher expected returns.

The approach requires insight from developers and contractors as to current costs and risks at each stage in the process, to show where innovation is valuable or essential. Several such processes have been carried out by the industry such as the Offshore Wind Accelerator and Carbon Trust floating wind studies. However, there has not yet been a clear targeted study as to where the Scottish technology and manufacturing base could best focus its efforts. We recommend such a study is carried out as a priority, and that a tailored innovation programme is designed around its outcomes.

Appendix A: Supply Chain scoring system

Criterion	Score	Definition		
Scottish supply track record	1	No Scottish capability		
	2	Scottish capability but only for a pilot project		
	3	One Scottish-based supplier with capability to fulfil a commercial scale project		
	4	Two or more Scottish-based suppliers with capability to fulfil a commercial scale project		
Market readiness for commercial scale projects	1	Existing capacity or investment plans are not in existence or are at an early stage		
	2	Companies have investment plans that are pending final investment decision that would enable them to supply a commercial scale project		
	3	One company has either existing capacity or has made the final investment decision on an investment in new capacity that will enable it to supply a commercial scale project		
	4	Two or more companies have existing capacity or have made the final investment decision on an investment in capacity that will enable them to supply a commercial scale project		
Availability of Scottish expertise in parallel sectors	1	Scotland has no significant industrial expertise		
	2	Scotland has relevant industrial expertise but is unlikely to be competitive in the offshore renewable energy sector		
	3	Scotland has strong expertise in relevant parallel sectors but would require a shift in relevant company strategies to enter the offshore renewable energy market		
	4	Scotland has world class expertise in sectors analogous to offshore renewable energy that can be readily exploited or is already applying significant expertise to the market		
Logic of Scottish supply	Scottish projects		Overseas projects	
	1	There is no significant logic for Scottish supply to Scottish projects	1	There is strong logic for local supply to overseas projects, leaving little room for Scottish suppliers to compete
	2	There is a limited logic for Scottish supply to Scottish projects	2	There is good logic for local supply to overseas projects

	3	There is a good logic for Scottish supply to Scottish projects	3	There is limited logic for local supply to overseas projects
	4	There is strong logic for Scottish supply to Scottish projects	4	There is no logic for local supply to overseas projects, leaving significant room for Scottish suppliers to compete
Scottish investment risk	1	Investments in Scotland can only be made with long-term confidence in the market and with public sector financial support		
	2	Investments in Scotland need long-term confidence in the market		
	3	Investment in Scotland can be triggered by framework contracts or two or more commercial scale orders		
	4	Investment in Scotland is not needed or can be made with a single commercial scale order in the market		
Size of the opportunity	1	Likely Scottish opportunity is <0.1% of lifetime expenditure at current prices		
	2	Likely Scottish opportunity is 0.1% to <0.5% of lifetime expenditure at current prices		
	3	Likely Scottish opportunity is 0.5% to <1% of lifetime expenditure at current prices		
	4	Likely Scottish opportunity is ≥1% of lifetime expenditure at current prices		

Appendix B: Economic impact assessment methodology

Conventional modeling of economic impacts for most industrial sectors relies on government statistics, for example those based on Standard Industry Classification (SIC) codes and use input-output tables and other production and employment ratios, for example those produced by the Office of National Statistics or the Scottish Government.

SIC code data can be appropriate for traditional industries at a national level. The development of new codes for a maturing sector, however, takes time. This means that conventional SIC analyses of offshore wind need to map existing North American Industry Classification System (NAICS) data onto offshore wind activities, which is not easy and a source of error. Analyses using SIC codes also have to rely on generalised data.

Offshore wind is ideally suited to a more robust approach that considers current and future capability of local supply chains because:

- Projects tend be large and have distinct procurement processes from one another, and
- Projects tend to use comparable technologies and share supply chains.

It therefore enables a realistic analysis of the local, regional and national content of projects even where there are gaps in the data.

The methodology used here was developed by BVGA and has been used for a series of major clients.

The methodology's first input is the cost per MW of each of the supply chain categories at the time of wind farm completion.

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

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

Where:

FTE_a = Annual FTE employment

GVA = Gross value added (£)

M = Total operating margin (£)

Y_a = Average annual wage (£), and

W_a = Non-wage average annual cost of employment (£).

To make robust assessments, therefore, we consider each major component in the offshore wind supply chain and estimate typical salary levels, costs of employment and profit margins, bringing together BVGA's specific sector knowledge and research into typical labor costs for the work undertaken in each supply chain level 2 category.

The impacts in this report relate to Scotland as a whole or to local areas within Scotland. Employment, earnings and GVA all relate to places of work within Scotland.

FTEs relate to full time equivalent job years, with part-time or part-year work taken into account as appropriate. A full-time job would normally be at least 7 hours per day over c230 working days of the year. If an individual works significantly more than this over a year, FTE attribution would be more than 1 FTE (e.g. 1.5 FTEs if working long hours over 7 days per week).

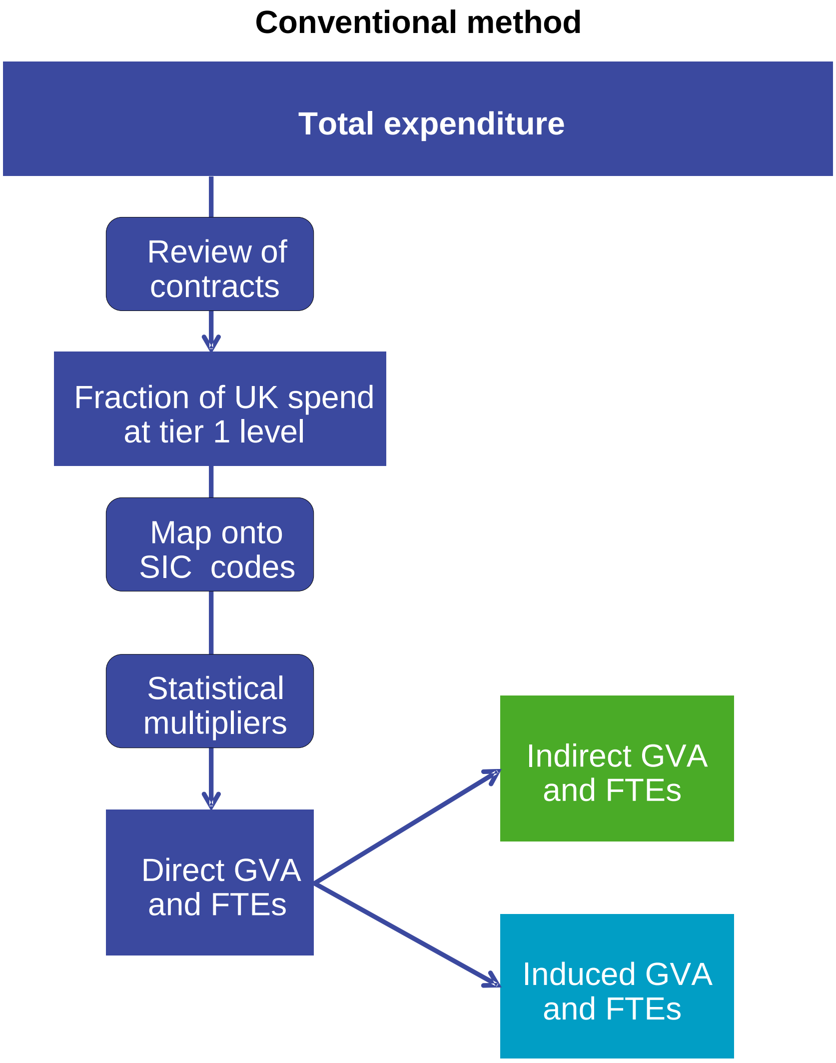
FTEs in the report are by workplace rather than by residence and will include migrant/temporarily resident workers.

Where work in a local area (e.g. on an assembly site) is carried out by people who have been brought there from elsewhere in the UK or overseas and live in temporary accommodation while working on site, their daily expenditures on accommodation, food & drink, leisure, etc create employment impacts locally and within Scotland more widely. These impacts have been taken into account in the indirect impacts because these payments are likely to be covered through subsistence expenses rather than personal expenditure.

The GVA to gross earnings ratio for a business can be relatively high where it is charging for use of expensive plant, equipment, boats, etc. Where a specialist vessel, for example, has been built in Scotland for offshore renewables work, the prior employment and earnings impacts from this could be additional to what it has been possible to capture in the analysis carried out for this report

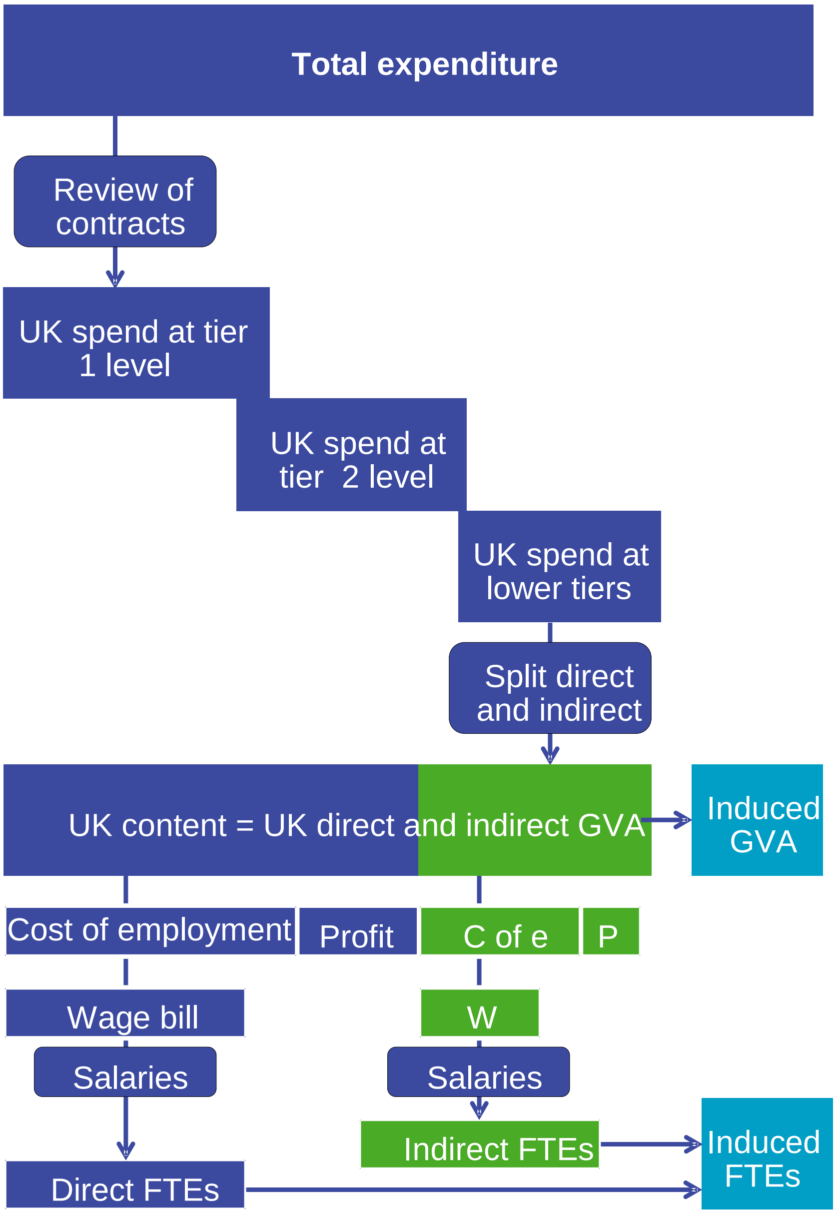
In this report, GVA and earnings impacts have not been discounted.

Comparison with conventional economic impact methodologies



In a conventional analysis, multipliers are used that are based on statistics of expenditure flows in different sectors. Once the analysis has established what contracts have been awarded to companies in the UK, the contractors are associated with one of more sectors used in the Standard Industry Classification. Input-output tables created, for example, by the Scottish Government are used to develop multipliers. These multipliers are used to calculate how demand in each of the SIC sectors leads to direct, indirect and induced impacts.

BVG Associates method



The multipliers used in conventional analysis in effect ignore the supply chain in detail, assuming that sector statistics are valid. The BVGA method is based on the offshore wind UK content methodology that seeks to understand the supply chain in the lower tiers and produces a figure that is equivalent to direct and indirect GVA. Calculating a UK content figure, and having an understanding of profit margins, costs of employment and salaries enables direct and indirect FTEs to be calculated. Induced impacts are calculated using conventional multipliers. The same methodology is followed for Scottish and local content.

Appendix C: Supply chain taxonomy

Level 1	Level 2	Level 3
Development and project management	Development	Development expenditure
		Financing costs
		Legals
	Project Management	Internal advisor costs
		External advisor costs
	Surveys	Meteorological monitoring
		Environmental surveys
		Sea bed surveys
	Engineering & Management	FEED
		Construction management
Turbine	Rotor	Rotor components
		Rotor assembly
		Rotor transport
	Nacelle	Nacelle components
		Nacelle assembly
		Nacelle transport
	Electrical and auxiliary systems	Electrical systems
		Auxiliary systems
	Tower (Offshore Wind (OSW) only)	Tower main structure
		Tower flanges
		Tower internals
		Tower coatings
		Tower transport
		Tower base section assembly
Substations and foundations	Onshore substation	Onshore substation electrical systems
		Onshore substation structure
		Onshore substation facilities
		Grid connection (TSO)
	O&M base	O&M base
	Offshore substation (Fixed OSW only)	Offshore substation electrical systems
		Offshore substation foundations
		Offshore substation topside structure
		Offshore substation engineering
		Offshore substation facilities
		Offshore substation helideck
		Offshore substation crane
	Foundations (fixed OSW)	Foundation lattice
		Foundation platform/primary structure
		Foundation secondary steel
		Foundation pin piles
		Foundation coatings
		Foundation crane (OSW only
		Foundation transport
	Foundation - floating and	Floating foundation primary structure
		Floating foundation secondary structure
		Mooring lines

Level 1	Level 2	Level 3
	moorings (Floating OSW)	Anchoring
		Foundation coatings
		Foundation crane
		Foundation transport
	Foundations (Tidal)	Foundation primary structure
		Foundation secondary steel
		Foundation pin piles
		Foundation coatings
		Foundation transport
Cables	Onshore cables	Onshore cable core
		Onshore cable insulation and armouring
		Onshore cable fibre optics and communication
		Onshore cable accessories
		Onshore cable jointing and testing
		Onshore cable transport
	Subsea export cables	Subsea export cable core
		Subsea export cable insulation and armouring
		Subsea export cable fibre optics and communication
		Subsea export cable accessories
		Subsea export cable jointing and testing
		Subsea export cable transport
	Array cables (OSW only)	Array cable core
		Array cable insulation and armouring
		Array cable fibre optics and communication
		Array cable accessories
		Array export cable jointing and testing
		Array cable transport
Turbine and foundation installation	Foundation installation	Foundation installation vessel
		Foundation installation vessel fuel
		Foundation installation vessel mob and demob
		Foundation sea fastenings
		Foundation installation vessel crew
		Foundation installation equipment
		Foundation installation vessel maintenance and administration
	Turbine installation	Turbine installation vessel
		Turbine installation vessel fuel
		Turbine installation mob and demob
		Turbine sea fastenings
		Turbine vessel crew
		Turbine OEM personnel
		Turbine installation equipment
		Turbine installation vessel maintenance and administration
		Floating foundation installation vessels

Level 1	Level 2	Level 3
	Floating foundation installation (Floating OSW)	Floating foundation installation vessels fuel
		Floating foundation installation vessels mob and demob
		Floating foundation installation vessels vessel crew
		Floating foundation installation equipment
		Floating foundation installation vessels maintenance and administration
	Mooring installation (Floating OSW)	Mooring installation vessel
		Mooring installation vessel fuel
		Mooring installation vessel mob and demob
		Mooring sea fastenings
		Mooring installation vessel crew
		Mooring installation equipment
		Mooring installation vessel maintenance and administration
Cable installation	Offshore export cables installation	Export cable vessels
		Export cable vessels fuel
		Export cable vessel mob and demob
		Export cable vessel crew
		Export cable vessel maintenance and administration
		Export cable ROVs
		Export cable route survey and clearance (Unexploded Ordinances (UXO), Pre-Lay Grapnel Run (PLGR))
		Export cable pull-in, termination and testing
		Export cable protection
	Array cables installation (OSW only)	Array cable vessels
		Array cable vessels fuel
		Array cable vessel mob and demob
		Array cable vessel crew
		Array cable vessel maintenance and administration
		Array cable ROVs
		Array cable route survey and clearance (UXO, PLGR)
		Array cable pull-in, termination and testing
		Array cable protection
	Onshore cables installation	Onshore cable civil works
		Onshore cable electrical works
		Onshore cable horizontal directional drilling
Installation other	Offshore substation installation (electrical and topside) (Fixed OSW)	Offshore substation installation vessel
		Offshore substation installation vessel fuel
		Offshore substation installation vessel mob and demob
		Offshore substation sea fastenings
		Offshore substation installation vessel crew
		Offshore substation installation vessel maintenance and administration

Level 1	Level 2	Level 3
		Offshore substation commissioning
	Onshore substation installation	Onshore substation civil works
		Onshore substation electrical works
		Onshore substation commissioning
	Other	Marine warranty surveyor
		Marine coordination
		Ports
		Guard vessels, CTVs
		MetOcean forecast and measurements
		Compensation payments
		Navigation aids
		Insurance
OMS	Operations	Operational management
		O&M base maintenance
		O&M vessels
		Wind farm rent / sea bed rent
	Grid costs	Transmission Network Use of System (TNUoS) wide
		Balancing Services of System (BSUoS)
	Maintenance - BoP	Onshore substation maintenance
		Onshore cables maintenance
		Offshore export cable maintenance
		Offshore array cables maintenance (OSW only)
		Foundation above water maintenance (Fixed OSW only)
		Foundation below water maintenance (Fixed OSW only)
		Offshore substation maintenance (non-OFTO) (Fixed OSW only)
		Foundation maintenance (Tidal only)
		Onshore substation maintenance (non-OFTO) (Tidal only)
	Maintenance - WTG	Blades maintenance
		Pitch system maintenance
		Main gearbox maintenance
		Generator maintenance
		Electrical maintenance
		Control and auxiliary maintenance
		Support structure maintenance (incl. tower) (OSW only)
		Other WTG maintenance
	Other	Insurance
		Environmental studies
		Compensation payments
Decommissioning	Decommissioning	Preparation for disassembly
		Turbine and foundation removal

Level 1	Level 2	Level 3
[redacted]		Onshore and offshore substation decommissioning (OFTO)
		Rock dumping and inspection
		Port, transport and logistics
		Decommissioning engineering
		Decommissioning project management
		Decommissioning insurance
[redacted]		

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