Bellrock Offshore Wind Farm

Wind Farm Development Area

Environmental Impact Assessment Report - Volume IV

Appendix 17.1: Greenhouse Gas Assessment Methodology

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Glossary of Terminology

Term	Definition
Applicant	Bellrock Offshore Wind Farm Limited, the legal entity submitting Section 36 Consent and Marine Licence applications for the Bellrock Offshore Wind Farm Development Area.
Bellrock Offshore Wind Farm (or the Bellrock Project)	An offshore wind farm capable of exporting up to 1.8 GW of renewable energy to the National Electricity Transmission System. The Wind Farm Development Area is located 120 km east of Stonehaven, and will connect to the National Electricity Transmission System at the proposed SSEN Transmission Hurlie substation, west of Stonehaven in Aberdeenshire. The Bellrock Offshore Wind Farm comprises of the following Development Areas: ▪ Wind Farm Development Area; ▪ Offshore Transmission Development Area; and ▪ Onshore Transmission Development Area.
Carbon Dioxide Equivalent (CO_2e)	Carbon dioxide equivalent is a term for describing different greenhouse gases in a common unit. The unit takes the different global warming potentials of greenhouses gases into account. CO_2e is signifies the amount of CO_2 which would have the equivalent global warming impact.
Cradle to (factory) gate	The extraction, manufacture, and production of materials to the point at which they leave the factory gate of the final processing location.
Greenhouse gas (GHG)	A greenhouse gas is a gaseous constituent of the atmosphere, both natural and anthropogenic that absorbs and re-emits infrared radiation causing the greenhouse effect.
Offshore Development Area	The area comprising: ▪ The Wind Farm Development Area; and ▪ The Offshore Transmission Development Area.
Offshore Transmission Development Area	The boundary within which the Offshore Transmission Infrastructure will be constructed, operated and maintained, and decommissioned (and includes the whole of the Wind Farm Development Area).
Onshore Transmission Development Area	The boundary within which the Onshore Transmission Infrastructure will be constructed, operated and maintained, and decommissioned.
Operational life	The expected operational life of the Wind Farm Infrastructure from the Commercial Operation Date to the first floating offshore unit being decommissioned.
Site preparation works	Preparatory activities undertaken within the Wind Farm Development Area prior to the commencement of construction of the Wind Farm Infrastructure, which may comprise (and which may require separate consents): ▪ Geophysical surveys, geotechnical surveys, and non-archaeological/archaeological diver/remotely operated vehicle surveys; ▪ Seabed preparation including sand wave levelling, slope levelling for gravity based anchors (if selected), boulder clearance, and pre-lay grapnel runs;

Term	Definition
	▪ Unexploded ordnance survey and/or clearance; ▪ Debris clearance; and ▪ Out of service cable/pipeline removal.
Wind Farm Development Area	The boundary within which the Wind Farm Infrastructure will be constructed, operated and maintained, and decommissioned.
Wind Farm Infrastructure	Infrastructure located within the Wind Farm Development Area including wind turbine generators; floating substructures, station keeping systems and associated scour protection; inter-array cables and associated cable protection; subsea cable hubs; and ancillary infrastructure including buoys (including activities associated with the Wind Farm Infrastructure construction, operation and maintenance, and decommissioning).

Glossary of Abbreviations

Term	Definition
AHTS	Anchor handling tug supply vessel
AHV	Anchor handling vessel
BEIS	Department for Business, Energy and Industrial Strategy (now the Department for Energy Security and Net Zero)
BoP	Blowout Preventer
CAHV	Construction anchor handling vessel
CLV	Cable laying vessel
CSV	Construction support vessel
CTV	Crew transfer vessel
DESNZ	Department for Energy Security and Net Zero *(formally BEIS/DECC)*
GHG	Greenhouse gas
GloMEEP	Global Maritime Energy Efficiency Partnerships Project
IAC	Inter-array cables
ICE	Inventory of Carbon and Energy
IEMA	Institute of Environmental Management and Assessment
IPCC	Intergovernmental Panel on Climate Change
MGO	Marine gas oil
MVA	Megavolt-ampere
OfTDA	Offshore Transmission Development Area
OnTDA	Onshore Transmission Development Area
O&M	Operation and maintenance
ROV	Remotely operated vehicle
SF_6	Sulphur hexafluoride
SOV	Service operation vessel
UXO	Unexploded ordnance
WFDA	Wind Farm Development Area
WTG	Wind turbine generator

1 Introduction

1. This methodology Appendix presents the methodology for the greenhouse gas (GHG) assessment adopted for **Chapter 17: Greenhouse Gas Assessment (Volume II)** of the Bellrock Wind Farm Development Area (WFDA) Environmental Impact Assessment (EIA) Report. This Appendix contains an overview of the data, emission factors and assumptions used to calculate GHG emissions from the Bellrock WFDA. The GHG assessment has been undertaken in accordance with the Institute of Environmental Management and Assessment (IEMA) Guide: Assessing Greenhouse Gas Emission and Evaluating their Significance (IEMA, 2022). The principles of The Carbon Trust: Offshore Wind Industry Product Carbon Footprinting Guidance (Carbon Trust, 2024a) has also been considered for the GHG assessment.

2. Emissions from electricity generation in the United Kingdom (UK) have reduced by 50.4% since 1990, the majority of which has occurred within the last decade (Climate Change Committee, 2025). This reflects the transition from coal to gas and low-carbon electricity generation, of which the renewables and the offshore wind sector have been a key player. To enable further reductions in emissions from electricity generation, an increase in the role of renewables, along with other supply and demand-side responses are required.

3. The UK Government has also set out its intention to decarbonise all sectors of the UK economy, including the power sector, within the Clean Growth Strategy (Department for Business, Energy & Industrial Strategy (BEIS), 2017). Reaffirmation of this ambition was provided as a commitment within the Offshore Wind Sector Deal (BEIS, 2019), which reinforces the UK Government's aims to advance offshore wind generation as an integral part of a future low-cost, low-carbon and flexible grid system.

4. The update to the 2020 Offshore Wind Policy Statement (Scottish Government, 2026) includes a target to deliver up to 40 GW of new offshore wind capacity by 2040 to support Scotland's commitment to net zero by 2045. This marks a substantial increase compared to earlier objectives outlined in the Offshore Wind Policy Statement (Scottish Government 2020a) and the Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020b), which included a target to deliver up to 11 GW of offshore wind capacity by 2030. The Sectoral Marine Plan is currently undergoing review to reflect the ScotWind and Innovation and Targeted Oil and Gas (INTOG) leasing rounds and is expected to be published in summer 2026.

2 Greenhouse Gas Emission Sources

5. The construction, generation, operation and maintenance (O&M), and decommissioning of the following components of Bellrock Project will generate GHG emissions:

- Wind farm infrastructure within the WFDA;
- Offshore transmission infrastructure within the Bellrock Offshore Transmission Development Area (OfTDA); and
- Onshore transmission infrastructure within the Bellrock Onshore Transmission Development Area (OnTDA).

6. The emission sources arising from activities associated with the Bellrock Project include:

- Embedded carbon and GHG emissions from components used within the Bellrock Project. These are the emissions caused by the extraction and refinement of raw materials and their manufacture into the commodities and products that make up the components of the WFDA infrastructure, OfTDA infrastructure and OnTDA infrastructure;
- Carbon and other GHG emissions arising from the combustion of fuel and energy used over the project's lifetime; and
- Fugitive GHG emissions arising from the use of the wind farm infrastructure, OfTDA infrastructure and OnTDA infrastructure.

7. Further details of GHG emissions generated by the Bellrock WFDA are discussed in **Section 3**.

8. The release of emissions from these sources are small in comparison to emissions from fossil fuel generation of energy, therefore the emissions avoided as a result of offshore wind generation (when compared to fossil fuel sources) significantly outweigh those released from the activities listed above.

9. To ensure a complete assessment of all Development Areas is undertaken, a whole-project GHG assessment for the Bellrock Project (i.e. the WFDA, OfTDA and OnTDA) is presented in **Chapter 17: Greenhouse Gas Assessment (Volume II)**. This whole-project GHG assessment estimates the net contribution of the Bellrock Project as a whole to climate change, through consideration of GHG emissions arising from infrastructure associated with all component parts (e.g. the WFDA, OfTDA and OnTDA). The whole-project GHG assessment is iterative, and will be updated for the Bellrock OfTDA EIA Report and the Bellrock OnTDA EIA Report to utilise the most up to date information available at the time of preparing each EIA Report.

10. There are inherent uncertainties associated with carrying out GHG assessments for offshore wind farm projects, such as the embodied emissions from materials being dependent on the specific manufacturer/supplier, and emissions from operating plant and equipment can be difficult to predict and may vary over time. However, the approach to determine emissions from individual source groups is well defined in The Carbon Trust: Offshore Wind Industry Product Carbon Footprinting Guidance (Carbon Trust, 2024a), and are adopted in this assessment. In addition, the assumption and limitations of the approach to calculating GHG emissions in the assessment are detailed in **Section 17.5.1.2** of **Chapter 17: Greenhouse Gas Assessment (Volume II).**

11. A report published by the University of Edinburgh in 2015 (Thomson and Harrison, 2015) examined the lifecycle costs and GHG emissions associated with offshore wind farm projects, comparing data gleaned from the analysis of some 18 studies carried out over the period 2009 to 2013. This report is considered relevant to, and provides useful context for the Bellrock Project's GHG assessment and benchmark figures used to verify the assessment outcomes. It is acknowledged that advancements and efficiencies have been gained in the offshore wind sector since this study was undertaken, however, the figures and details assessed within this study are considered to be applicable and provide useful context for the GHG assessment.

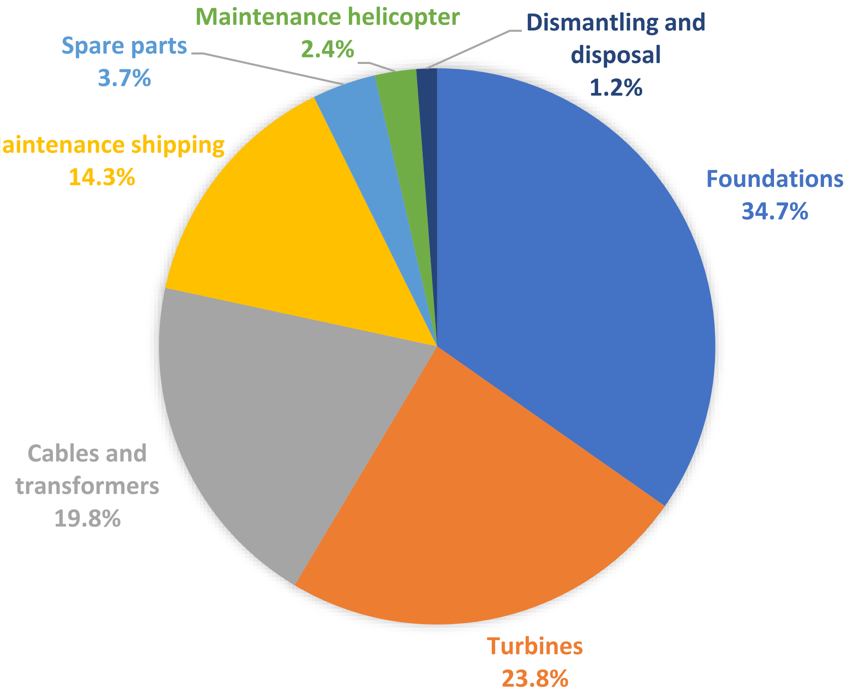
12. **Table 2.1**: provides a summary of the percentage of the total GHG emissions associated with the different phases of an offshore wind farm development as provided within Thomson and Harrison (2015).

Table 2.1: Summary of Offshore Wind Farm Greenhouse Gas Emissions (GHG)

Phase	% of Total GHG Emissions
Construction	78.4
Operation and Maintenance	20.4
Decommissioning	1.2
Notes: The Thompson and Harrison (2015) study is considered the best available data to quantify emissions resulting from decommissioning at the time of drafting the Chapter.	

13. The report highlights that the greatest proportion of emissions are associated with the manufacture and installation of the wind farm components. Decommissioning accounts for the smallest proportion, approximately 1.2%, of total life cycle GHG emissions. A more detailed breakdown of emissions is given in Thomson and Harrison (2015) for an offshore wind farm with steel substructures. This is reproduced in **Plate 2.1** (source: Thomson and Harrison, 2015) for indicative purposes.

Plate 2.1: Summary of Offshore Wind Farm Greenhouse Gas Emissions (GHG)



14. Of the phases shown in **Plate 2.1**, GHG emissions associated with construction accounts for the largest proportion of emissions (78.4%), which consists of foundations fabrication and installation (34.7%), manufacture and installation of the turbines (23.8%) and the cables and transformers (19.8%). The O&M phase accounts for the second largest proportion of emissions (20.4%), which consists of maintenance shipping (14.3%), spare parts (3.7%) and maintenance helicopter use (2.4%).

3 Wind Farm Development Area GHG Assessment Methodology

15. The GHG assessment is based on the maximum design scenario for the Bellrock WFDA detailed in **Section 17.7.2** of **Chapter 17: Greenhouse Gas Assessment (Volume II).** This document details the methodology used to calculate the emission sources, in line with the lifecycle modules established in the Carbon Trust's Guidance, which are detailed in **Table 3.1**.

16. Emissions from decommissioning are derived from previous studies (Thomson and Harrison, 2015), where it is established that the decommissioning phase would contribute approximately 1.2% of the carbon footprint of an offshore wind farm.

Table 3.1: Greenhouse Gas Assessment (GHG) Emission Sources and Lifecycle Modules

Lifecycle Module	Emissions Sources
A1-A3 (Embodied Carbon)	Embodied carbon in materials
A0 (Site preparation works) A4 (Transportation) A5 (Construction)	Marine vessels and helicopters
B1 (Use)	Sulphur hexafluoride (SF_6)
B2-B4 (O&M)	Marine vessels and helicopters Embodied carbon in materials in spare parts
C1-C4 (Decommissioning)	Undefined, figure obtained from literature

17. The approach to calculating emissions from each of the sources listed in **Table 3.1** is provided below.

3.1 Embodied Emissions in Materials

18. The GHG assessment includes a calculation of embodied carbon in materials used for the Bellrock WFDA. This includes the quantification of emissions from 'Cradle-to-(factory) gate', a term which includes the extraction, manufacture and production of materials to the point at which they leave the site of the final processing location. Emissions associated with the delivery of materials to the WFDA are quantified separately through the use of marine vessels, as detailed in **Section 3.2** Emissions from the movement of road vehicles associated with the delivery of materials to the port are excluded from the scope of this assessment, due to lack of available data.

19. GHG emissions were calculated from quantities or volumes of known materials that would be used in construction of the Bellrock WFDA:

- Wind turbine generators (WTGs) with floating substructures ('floating offshore unit' (FOU);
- Station-keeping systems (SKSs) for each floating substructure (comprising mooring lines, anchors and ancillary elements);
- Inter-array cables (IACs);
- Subsea cable hubs; and
- Cable/scour protection.

20. Full details on the wind farm infrastructure of the Bellrock WFDA are provided in **Chapter 4: Project Description (Volume II)**.

21. To provide a precautionary assessment, it is assumed that there will be no reduction in the emission intensity during the abstraction and manufacturing of materials up until and during the construction phase of the Bellrock WFDA. This is considered to be a conservative approach as the earliest year of construction of the WFDA is anticipated to be 2031 (with site preparation works commencing in 2030), where the emissions intensity of some sectors such as transport and industry are likely to have reduced.

22. The maximum quantities of each type of construction material to be used on site were provided by the Applicant in the Project Design Envelope, and the relevant emission factors sources from the Inventory of Carbon and Energy (ICE) database (Jones & Hammond, 2024), where possible. The ICE database provides a comprehensive database of emission factors for embodied carbon in materials that are commonly used in the UK. Alternative sources for emission factors are used for more specific components of offshore wind farms and are detailed in **Table 3.2**.

Table 3.2: Emission Factors for Embodied Greenhouse Gass (GHGs) in Materials

Material	Emission Factor (kg CO_2e/kg, unless otherwise stated)	Source	Notes
Aluminium	6.67	ICE Database, v4.0 December 2024 (Jones & Hammond, 2024)	N/A
Copper	2.71		N/A
Concrete	0.103		N/A
Nylon	9. 14		N/A
Polyurethane	4.84		N/A
Rock or gravel	0.079		Stone (general)
Steel (average)	2.34		Average of embodied CO_2e steel values provided in ICE database.

Material	Emission Factor (kg CO_2e/kg, unless otherwise stated)	Source	Notes
Lead (cable)	1.67	Cableizer (n.d.)	General type.
Semi-conductor (proxy)	1.49		N/A
Aluminium conductor	137.27 tonnes CO_2e/km cable	Provided by the Applicant	Values provided for a static IAC (800 mm^2) rated at 66kV.
Sheath	5.73 tonnes CO_2e/km cable		
Steel Armor	109.33 tonnes CO_2e/km cable		
XLPE (Cross Linked Polyethylene) insulation	10.93 tonnes CO_2e/km cable		
Siemens Gamesa 14 MW Wind Turbine Generator full asset production	7,272,570 (as kgCO_2e/unit)	Proxy Emission Factor Database extracted from the Carbon Trust OSW-Footprinting-Tool (Carbon Trust, 2024b)	Emission factor considers CO_2e per unit WTG which includes nacelle and internals, blades, hub, and rotor system. This was used in the absence of data for a larger WTG. To account for the smaller turbine size, the proxy emission factor was scaled by the number of units that would be required for the wind farm size (1.8 GW).

23. Details surrounding embodied emissions in spare parts are not yet known at this stage. Therefore, an assumption of 3.7% of total whole lifecycle GHG emissions has been applied to quantify emissions from spare parts, a figure obtained from literature (Thompson and Harrison, 2015).

3.2 Marine Vessels

3.2.1 Activity Data

24. Marine vessels will be used to bring materials and components to the Bellrock WFDA, install the wind farm infrastructure (see **Chapter 4: Project Description (Volume II)**), and provide crew accommodation and support during construction and operation and maintenance.

25. Activity data for vessels, including movements and days on site during both the construction phase (including site preparation works) and the O&M phase[1] are outlined in **Table 3.3** and **Table 3.4** respectively. To ensure a worst-case scenario is adopted, the assessment considers a maximum number of vessels and movements to/from the Bellrock WFDA. As the Origin Port has not yet been confirmed, it was assumed that the majority of components will first be transported to final assembly yards on the east coast of Scotland or England. The fabrication of components may also occur outside of the UK and subsequently transported directly to the Bellrock WFDA, which has been reflected in the assessment where information is known at the time of assessment.

Table 3.3: Indicative Number of Vessel Movements During Construction

Package	Activity	Origin Port	Vessel	Total Days on Site per Vessel Type	Maximum Number of Return Trips*
Lifecycle Module: A0 (Site Preparation Works)					
Seabed preparation	Unexploded ordnance (UXO) geophysical survey	East Coast Scotland and England	Towed survey	504	18
	UXO and archaeology ID campaign	East Coast Scotland and England	Remotely operated vehicle (ROV) survey	336	12
	UXO disposal campaign	East Coast Scotland and England	ROV intervention	168	6
	Sand wave levelling campaign	East Coast Scotland and England	Large anchor handling vessel (AHV)	196	7
	Pre-boulder clearance survey campaign	East Coast Scotland and England	ROV survey	336	12
	Boulder clearance works	East Coast Scotland and England	Large AHV	672	24
	Post-boulder clearance survey campaign	East Coast Scotland and England	ROV survey	392	14
Lifecycle Modules: A4 (Transport to Site) and A5 (Construction)					
Pre-installation surveys	Pre-installation surveys	East Coast Scotland and England	ROV survey	392	28

[1] Specific activity data has not been estimated for vessels during decommissioning, as details surrounding decommissioning activities are not known at this stage.

Package	Activity	Origin Port	Vessel	Total Days on Site per Vessel Type	Maximum Number of Return Trips*
Pre-lay grapnel run	Pre-lay grapnel run	East Coast Scotland and England	AHV	392	14
Anchor, mooring line and scour protection installation	Anchor installation	East Coast Scotland	Construction anchor handling vessel (CAHV) or Construction support vessel (CSV)	792	240
	Mooring line installation	East Coast Scotland	AHV	462	140
	Anchor scour protection installation	Europe	Fallpipe vessel	1008	36
FOU	FOU tow	Cromarty Firth region	AHV	528	264
	FOU hook-up	Cromarty Firth region	AHV	896	64
IACs	Subsea cable hub installation and testing	Europe	CLV or AHV	168	42
	IAC installation	East Coast Scotland	Cable laying vessel (CLV) or AHV	264	132
	IAC burial (inc post burial survey)	East Coast Scotland	Construction support vessel (CSV)	966	69
	IAC termination and testing		Service operation vessel (SOV)	966	69
WTG electrical completion	WTG electrical completion	East Coast Scotland	SOV	966	69
			Crew transfer vessel (CTV) (daughter craft)	966	69
Guard vessel	Guard vessel	East Coast Scotland	Guard vessel	4732	286
Notes: * One return trip comprises two movements (i.e. to and from the Bellrock WFDA).					

Table 3.4: Indicative Number of Vessel Movements During Operation and Maintenance

Package	Activity	Origin Port	Vessel	Total Days on Site Per Vessel Type	Maximum Number of Return Trips*
Lifecycle Module(s): B2-B4 (O&M)					
O&M	WTG scheduled and minor corrective maintenance	East Coast Scotland	SOV	329	23
			CTV (daughter craft)	329	23
	WTG major corrective maintenance	Europe	Anchor handling tug supply vessel (AHTS)	180	15
		East Coast Scotland	Tug	30	15
		Europe	Jack-up vessel	38	8
	Minor corrective maintenance	East Coast Scotland	SOV	329	23
			CTV (daughter craft)	329	23
	Subsea infrastructure inspections	East Coast Scotland	ROV	56	4
			ROV support vessel	56	4
	IAC repairs	Europe	Cable repair vessel	10	2
		To be confirmed post-consent, assumed East Coast Scotland	ROV	10	2
		To be confirmed post-consent, assumed East Coast Scotland	ROV support vessel	10	2
	Mooring line repairs	Europe	AHV	288	32
		East Coast Scotland	Tug	64	32
	Cable burial	To be confirmed post-consent, assumed East Coast Scotland	CLV	3	1
		East Coast Scotland	Guard vessel	3	1
	Cable burial assessments	To be confirmed post-consent, assumed East Coast Scotland	Survey vessel	14	1
Notes: * One return trip comprises two movements (i.e. to and from the Bellrock WFDA).					

3.2.2 Vessel Emissions Calculations

26. The methodology to calculate emissions from vessels is based on best practice guidance documents, including the United States Environmental Protection Agency's (US EPA) 'Port Emissions Inventory Guidance: Methodologies for Estimating Port-Related and Goods Movement Mobile Source Emissions' (2022), and the Global Maritime Energy Efficiency Partnerships Project's (GloMEEP) 'Port Emissions Toolkit' (GloMEEP, 2018).

27. Emissions from marine vessels associated with the Bellrock WFDA were quantified based upon an estimation of fuel consumption, estimated from the activity data presented in **Section 3.2.1**. Emission factors for marine gas oil (MGO), in kg CO_2e per kWh are obtained from Department for Energy Security and Net Zero (DESNZ) (DESNZ, 2025), which is assumed to be the most common fuel used during the construction, and operational and maintenance phases. The shipping sector is expected to decarbonise over the lifespan of the Bellrock WFDA, although projections for the speed and the extent to which this will take place are difficult to predict. It is therefore assumed for the purposes of this assessment that marine vessels will continue to use MGO during the construction and O&M phases of the Bellrock WFDA. This approach is precautionary and likely to result in an overestimation of emissions.

28. Vessel emissions were calculated in accordance with the following formula:

$$E_{transit} = \left((A * PE * LF_{prop}) + (A * AE * LF_{aux}) \right) * EF$$

Where:

$E_{transit}$ – Emissions during transit (tonnes CO_2e)

A – Activity (approximate hours engine in use)

PE – Propulsion engine size (kW)

AE – Auxiliary engine (kW)

LF_{prop} – Load Factors for propulsion engines

LF_{aux} – Load Factors, for auxiliary engines

EF – Emission Factor (tonnes CO_2e/kWh)

29. Vessel engine sizes were obtained from public vessel specification sheets, where available. Propulsion engine sizes were assumed to include the main engine and thrusters. However, auxiliary engine sizes tend to be undisclosed. Therefore, they were estimated based on the total installed power, less the propulsion engine size, or calculated using a ratio provided in US EPA's report on vessel emissions (US EPA, 2009). The majority of vessels included in the GHG assessment could be categorised as bulk carriers, whose auxiliary to propulsion ratio is estimated at 0.222. For vessels without total installed power specified and whose type falls outside of the US

EPA's ratio table, an indicative estimate of 10% of the propulsion engine size was assumed for the auxiliary engine (US EPA, 2009).

30. Emissions were calculated separately for two different modes of activity, in transit and whilst situated within the WFDA for offshore construction purposes, due to different engine loads factors for vessels during these periods. The activity hours for each transit were calculated by dividing the total distance covered by the average transit speed. The estimated number of days each vessel will spend on site was provided by the Applicant in the Project Design Envelope.

31. Vessels have various operating modes such as cruising, manoeuvring and hotelling, which affect how much work is being undertaken by the propulsion and auxiliary engines. In emission calculations, this is captured by the load factor, which represents the percentage of a vessel's maximum engine load while undertaking a specific activity. A vessel's engines are rarely operated at 100% or more of its maximum load due to fuel consumption costs, efficiency and engine maintenance requirements, therefore most vessel operators limit their engine load to around 83% or less (GloMEEP, 2018).

32. During transit, load factors will be higher for propulsion than auxiliary engines, and vice versa for offshore construction activities. Load factors for propulsion engines for vessels in transit were derived from previous project experience, and the GloMEEP guidance for those undertaking offshore construction activities. Load factors for auxiliary engines were obtained from US EPA guidance. Load factors used in the vessel emission calculations are detailed in **Table 3.5**.

Table 3.5: Assumed Engine Load Factors

Engine Type	Activity	Load Factor	Data Source	Assumptions
Propulsion engine	In transit	0.75	Assumed based on typical load factors	Vessels assumed to be in cruising mode.
	Offshore construction	0.31 (tugs) 0.38 (work boats and miscellaneous)	GloMEEP (2018)	Vessels assumed to be in manoeuvring mode as worst-case scenario.
Auxiliary ene	In transit	0.17	US EPA (2009)	Vessels assumed to be in cruising mode.
	Offshore construction	0.26		All vessels assumed to be bulk carriers, tugs or miscellaneous vessels.

3.3 Helicopters

33. Helicopter movements during the construction, and O&M phases of the Bellrock WFDA will result in the release of GHG emissions. Helicopters may transfer technicians to turbines during commissioning of the WDA, and to carry out maintenance tasks during the O&M phase.The volume of GHG emissions from helicopter use during the construction, O&M phases are calculated by determining the expected fuel consumption using trip data.

34. The anticipated number of helicopter journeys during the construction and O&M phase are outlined in **Table 3.6**.

Table 3.6: Indicative Construction and Operation and Maintenance Phase Helicopter Movements

Lifecycle Module	Phase	Assumed Helicopter Base	Total Number of Return Trips*
A5 (construction)	Construction	Aberdeen	816
B2-B4 (O&M)	O&M	East Coast Scotland	34,510
Notes: * One return trip comprises two movements (i.e. to and from the Bellrock WFDA).			

35. The total distance travelled by helicopter is determined by multiplying the number of trips by the maximum trip distance. The maximum helicopter trip distance is approximately 145 km, an assumption based on the approximate distance from Aberdeen airport (being the assumed helicopter base, and will be confirmed post-consent) to the centre of the Bellrock WFDA.

36. The type of helicopter assumed for the assessment is the Leonardo AW139, which has an average fuel consumption rate of 430 kg/h, and a maximum cruise speed of 306 km/h. Emission factors for aviation turbine fuel (or jet fuel), in CO_2e/tonnes fuel, are obtained from the DESNZ (DESNZ, 2024).

3.4 Fugitive Emissions

37. Sulphur hexafluoride (SF_6) is commonly used as an insulating and circuit-breaking gas in the operation of high-voltage switchgears and other electrical equipment, which are required as part of both the Project's offshore and onshore infrastructure. SF_6 is an extremely potent GHG, with a global warming potential of 24,300, as reported by the Intergovernmental Panel on Climate Change (IPCC) in the Sixth Assessment Report (AR6). This means that every kg of SF_6 leaked to atmosphere has the equivalent effect on global warming as the emission of 24.3 tonnes of CO_2e.

38. The methodology to calculate GHG emissions from sulphur hexafluoride (SF_6) is based on an assumed annual leakage rate applied against the stock contained in electrical equipment. The worst-case leakage rate is assumed to be 0.5% per year.

39. Resulting total emissions over the life of the Bellrock WFDA were calculated in accordance with the following formula:

$$E_{SF6} = S * LR * GWP * L$$

Where:

E_{SF6} – Emissions over the lifetime of the Bellrock WFDA (tonnes CO_2e)

S – Stock of SF_6 contained in electrical equipment (kg)

LR – Assumed annual leakage rate (% per year)

GWP – Global Warming Potential of SF_6 (24.3 (tonnes CO_2e/kg))

L – Lifetime of the Bellrock WFDA (years)

40. While SF_6 has historically been widely used in switchgear equipment, there is a growing industry trend and regulatory drive towards adopting SF_6-free alternatives. For the purposes of the EIA a worst-case scenario has been assumed based on the use of SF_6-containing equipment to ensure a precautionary approach. This allows for a comprehensive assessment of potential environmental impacts, while maintaining flexibility for future design improvements aligned with best environmental practices.

3.5 Decommissioning

41. Details surrounding decommissioning activities and downstream end-of-life processes are not yet known at this stage. Therefore, an assumption of 1.2% of total whole lifecycle GHG emissions has been applied, as obtained from literature (Thompson and Harrison, 2015).

4 Whole Project Assessment Methodology

42. To fully consider the impact on net GHG emissions as a result of the implementation of the Bellrock Project, consideration of the combined emissions from the offshore and onshore infrastructure ("whole project") is also required. The transmission infrastructure is subject to separate EIA applications, therefore the whole project assessment is undertaken using indicative information and estimates of the emission sources associated with the transmission infrastructure that were available at the time of writing the GHG chapter. A whole project assessment is undertaken using the calculated GHG emissions for the WFDA infrastructure combined with the indicative emissions associated with the transmission infrastructure (i.e. the OfTDA and the OnTDA), and the overall effect significance is evaluated. It is noted that at the time of this assessment, a Scoping Report is not available for either the OfTDA or the OnTDA, therefore the information available to inform this whole project assessment is limited. As the EIA applications for the OfTDA and OnTDA progress and additional information becomes available, this whole project assessment will be updated with more recent and accurate information in the applications for the OfTDA and the OnTDA. Please see **Chapter 1: Introduction (Volume II)** for an overview of the three Development Areas (WFDA, OfTDA and OnTDA).

43. In considering the whole project assessment, it is acknowledged that the WFDA is expected to form the most GHG intensive element of the Bellrock Project. This is further supported by Thomson and Harrison (2015), which indicates that the foundations and turbines together account for over 50% of offshore wind GHG emissions, as presented in **Section 2**.

44. In order to estimate the total offshore GHG emissions for the Bellrock Project, the GHG emissions associated with additional elements that form the OfTDA are estimated.

45. The indicative emissions estimate for the OfTDA encompassed embodied carbon in materials used for the offshore substations and offshore export cables, and an estimate of the O&M phase emissions from the offshore substation. These components are expected to be representative of the order of magnitude of emissions from the OfTDA, to form a reasonable indicative estimate for the purposes of the whole project assessment.

46. To estimate the GHG emissions from the offshore substation, an environmental product declaration (EPD) for a 16 kVA-100 MVA transformer (ABB, 2003) is used. Transformers form one of the most carbon-intensive components of the offshore substations, and are therefore considered to be representative of the scale of embodied carbon and operational GHG emissions in the offshore substations. The LCA reports a manufacturing emissions rate of 2,190 kg CO_2 per Megavolt-Ampere (MVA) and an O&M phase emissions rate of 212,227 kg CO_2 per MVA. To estimate the GHG emission value, the respective emissions rate values are multiplied by the capacity of the Bellrock Project of 1,800 MW.

47. To estimate embodied carbon from the offshore export cables, emission factors for embodied GHGs detailed in **Table 3.2** are applied to the mass of standard cable materials per km, and scaled based on the indicative length of the offshore export cables (1,200 km).

48. The same assumption of 1.2% of total whole lifecycle GHG emissions are applied to calculate emissions during the decommissioning phase of the OfTDA, as obtained from literature (Thompson and Harrison, 2015).

49. Details surrounding the OnTDA are less clearly defined at this stage, however based on proxy information available at the time of the assessment, the onshore export cable length is expected to be approximately 2.5% of the length of offshore export cable. Therefore an indicative assumption of 5% of total whole project GHG emissions is applied to estimate GHG emissions from the OnTDA, to cover emissions from the construction, O&M and decommissioning phases. This is further supported by proxy information available from previous projects on the proportion of onshore GHG emissions compared to offshore GHG emissions.

50. The GHG emissions for the whole project are therefore estimated in accordance with the following formulas:

$$E_{whole} = E_{WFDA} + E_{OfTDA} + E_{OnTDA}$$

$$E_{whole} = E_{WFDA} + E_{OfTDA} + E_{whole} * 0.05$$

Therefore, $$E_{whole} = \frac{E_{WFDA}+E_{OfTDA}}{1-0.05} = \frac{E_{WFDA}+E_{OfTDA}}{0.95}$$

Where:

E_{whole} – Indicative emissions estimated for the whole project (tonnes CO_2e)

E_{WFDA} – Emissions calculated for the WFDA, as presented in Section 17.7.1 of the EIA (tonnes CO_2e)

E_{OfTDA} – Indicative emissions estimated for the OfTDA (tonnes CO_2e)

E_{OnTDA} – Indicative emissions for the OnTDA, assumed to be 5% of E_{whole} (tonnes CO_2e)

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