APPENDIX 30-2

CARBON CALCULATIONS

1. CARBON CALCULATIONS

Table 1-1 CO_2e emissions from the Project

Phase		Non-Biogenic CO_2e (t)
Offshore		
Embodied carbon, shipping, & installation	Pre-construction vessel emissions	65,039
	Gravity Based Structure (GBS) foundations	132,151
	Wind Turbine Generator (WTG)	396,811
	Offshore Cables	61,074
	Offshore 220kV Electrical Substation (OSS)	12,959
	Rock placement	731,569
	Component transport from fabrication sites	28,922
	Construction vessel emissions	244,207
Offshore operational phase	Vessel emissions (excluding replacement shipping)	169,864
	Replacement components (embodied carbon and shipping) - total	371,576
Offshore Total		**2,214,172**
Onshore		
Embodied carbon, shipping, & installation	Cable grid	7,923
	Peat removal	580
	Onshore compound	34,857
	Construction vehicle emissions	2,982
Onshore operational phase	Vehicle emissions total	4,821
	Operational and Maintenanc emissions (Scope 2) - total	2,009
Onshore Total		**53,172**
Overall Project		
Decommissioning		**20,629**
TOTAL PROJECT EMISSIONS		**2,287,973**

2. ASSUMPTIONS

2.1 Shipping

2.1.1 Shipping routes

SITE	DESTINATION	SEA DISTANCE [KM]	TRANSIT SPEED [KM/HR]
Port of Glensanda	SROWF	678	18.52
Hartlepool	SROWF	1,370	21.3
Karlskrona Port	SROWF	2,269	21.3
Langosteira	Foynes	1,135	18.52
Rotterdam	Foynes	1,428	18.52

2.1.1.1 Component shipping

COMPONENT	DEPARTING	DESTINATION	VESSEL	SEA DISTANCE [KM]	NO. TRIPS
Export Cable (EC)	Karlskrona Port	SROWF	CSV	2,269	1
Inter-array cable (IAC)	Hartlepool	SROWF	CSV	1,370	1
GBS	Langosteira	Foynes	HLV - Prop	1,135	22
WTG	Rotterdam	Foynes	HLV - Prop	1,428	20
OSS	Rotterdam	Foynes	HLV - Prop	1,428	1
Rock	Port of Glensanda	SROWF	Rockdump Vessel	678	168

2.2 Component Data

2.2.1 Component quantities

COMPONENT	DESCRIPTION	CATEGORY	QUANTITY
Cast iron cable armour	Applicant provided quantity.	Cables	87,500 m
IAC	Aluminium core, 73.0 km length	Cables	73,000 m

	Assumed to be Cross-Linked Polyethylene (XPLE) submarine cables, with major materials of copper, steel and polyethylene (plastic).		
Offshore EC	Aluminium core, 63.5 km length Assumed to be Cross-Linked Polyethylene (XPLE) submarine cables, with major materials of copper, steel and polyethylene (plastic).	Cables	63,500 m
GBS Foundation	› Total concrete – 11,411 t › Steel – 982 t › Sand (ballast) – 8,650 t	Foundations	31 unit(s)
WTG	› Blades – 3 x 85 t (Corio) › Nacelle – 1,200 t (Corio) › Tower – assumed to be 1,674 t (NREL reference design). › Material composition (steel, plastic, copper, aluminium, and fibreglass) estimated based on a Vestas WTG of similar specification (Allekotte & Garrett, 2024).	WTG	30 unit(s)
Top-side OSS	OSS topside (2,600 t) assumed to be composed entirely of carbon steel. Contains SF6; assumes no leakage of SF6;	Infrastructure	1 unit(s)
Sulphur hexafluoride (contained in 220 kV high-voltage switchgear)	2.8 te SF6	Material	2.8 te
Granite	GBS foundations 185,839 m3 WTIV positioning 702,209 m3 IAC 1,475,032 m3 EC 182,511 m3 Total volume: 2,545,591 m3 Applicant provided quantities granite density = 2,700 kg/m3	Seabed preparation	6,837,096 te
Concrete (General)	Concrete joint bays 43 bays at 15m^3 per bay (Applicant provided quantity) Assumed concrete density of 2.38 t/m3	Material	1,535 m^3
Onshore EC	Copper core, 22.4 km length, 100 kg/m; Assumed to be Cross-Linked Polyethylene (XPLE) onshore cables,	Cables	22,400 m

	with major materials of aluminium, copper, steel and polyethylene (plastic).		
Gravel road	Access roads for the onshore export route third-party lands. Assumed road width of 4 m, and a depth of 0.3 m. Roads will be of aggregate construction	Roads and transport infrastructure	3,929 m
Onshore Compensation Compound (OCC)	Assumed to be 10,000 t of carbon steel Contains SF6; assumes no leakage of SF6;	Infrastructure	1 unit(s)
Sulphur hexafluoride (contained) in onshore GIS	2.5 te of SF_6 associated with GIS	Material	2.5 te
Asphalt road	This value approximates the 3,500 m^2 quantity of asphalt planned for the OCC. Assumes 0.5 m aggregate depth topped with 0.3 m asphalt	Roads and transport infrastructure	875 m

2.2.2 Component compositions

COMPONENT	DESCRIPTION	UNIT WEIGHT	MATERIAL	MASS FRACTION
IAC	Aluminium core, 73.0 km length, 80 kg/m. Assumed to be Cross-Linked Polyethylene (XPLE) submarine cables, with major materials of copper, steel and polyethylene (plastic).	0.08 te/m	Carbon steel	0.312
			Corrosion resistant alloy	0.162
			Plastic	0.521
			Aluminium	0.005
EC	100 kg/m. Assumed to be Cross-Linked Polyethylene (XPLE) submarine cables, with major materials of copper, steel and polyethylene (plastic).	0.1 te / m	Carbon steel	0.312
			Corrosion resistant alloy	0.162
			Plastic	0.521
			Aluminium	0.005
Cable armour	Assumes 250 kg/m cast iron cable armour	0.25 te /m	Cast iron	1
WTG	Combined WTG weight based on: Blades: 85 t x 3 (Applicant provided) Nacelle: 1,200 t (Applicant provided) Tower: 1,674 t (Assumption based on NREL 22 MW reference design)	3,129 te / unit	Carbon steel	0.790
			Plastic	0.040
			Fibreglass	0.085

	Mass fraction assumption based on V236-15 MW turbine material composition		Copper	0.010
			Aluminium	0.076
Top-side OSS	OSS topside (2,600 t) assumed to be composed entirely of carbon steel.	2,600 te / unit	Carbon steel	1
OCC	Assumption based upon comparable projects	10,000 te / unit	Carbon steel	1
GBS Foundation	38.4% concrete 3.3% steel 58.3% ballast (sand) Applicant provided assumptions	29,693 te/unit	Concrete	0.384
			Carbon steel	0.033
			Sand	0.583
Gravel road	Assumed width: 4 meter Assumed depth: 0.3 metre	1.86 te/m	Aggregate	1
Asphalt road	Assumed width: 4 meter Assumed aggregate depth: 0.5 metre Assumed asphalt depth: 0.3 metre.	5.792 te/m	Asphalt	0.46
			Aggregate	0.54

2.3 Construction and Installation

2.3.1 Onshore vehicles

COMPONENT	NAME	VEHICLE	DISTANCE [KM]	NO. TRIPS
Cable grid	HGV	HGV	20	190
	Car (workers)	Car (petrol)	20	190
OCC	HGV	HGV	20	190
	Car (workers)	Car (petrol)	20	190

2.3.2 Onshore Peat Excavation

Carbon losses associated with peat excavation at the Onshore Site were determined based on the SEPA carbon calculator tool methodology (v1.7.0) - http://informatics.sepa.org.uk/CarbonCalculator/. The following guidance was also utilised:

- Revised Guidance (www.gov.scot)
- Modelling the Impacts of Construction and Operation of Wind Farms on Peat - Calculating carbon savings from wind farms on Scottish peat lands: a new approach - www.gov.scot

Assumptions

All assumptions associated with carbon loss calculations for onshore peat excavation are as follows:

- Peat type was assumed as acid bog
- Assume all road is excavated road
- Duration of consent: 38 years
- Access track (assumption provided by Applicant)
  - Length: 1,495 m
  - Width: 2.5 m
  - Volume of peat removed: 1,392 m^3

2.3.3 Offshore vessels

COMPONENTS	NAME	TYPE	ACTIVITY	DURATION
Cables	Cable lay vessel	CSV	Working	98 days
	Trenching vessel	TSHD	Working	40 days
	Support vessel	CSV	Working	23 days
Preconstruction	Survey vessel	DSV	Working	540 days
	CSV	CSV	Working	27 days
GBS Foundations	Semi-sub HTV	HLV - Prop	Working	209 days
	Tug	Tug (Lead)	Working	336 days
	Support vessel	CSV	Working	112 days
WTG	WTIV	HLV - DP (Medium)	Working	100 days
	SOV	W Vessel	Working	82 days
	Jack-up Vessel	HLV - DP	Working	450 days
OSS	Barge	Cargo Barge	Working	47 days
	Tug	Tug (Lead)	Working	33 days
	HLV	HLV - DP	Working	16 days
Rock placement	Rock-dump vessel (DP)	Rock Vessel	Working	537 days
Acceptance testing	Support vessel	CSV	Working	87 days

2.4 Replacement components

2.4.1 Replacement component quantities

COMPONENT	DESCRIPTION	CATEGORY	QUANTITY per year
WTG	Accounts for replacement components with assumption (for each year of operations) that 5 % of the embodied emissions originally associated with blades and nacelles re-occur	WTG	0.7 (Mass proportion of WTG that are blades and nacelle)

2.4.2 Replacement component shipping

NAME	DESCRIPTION	DEPARTING	DESTINATION	VESSEL	NO. TRIPS per year
Blade/Nacelle replacement shipping	Accounts for shipping of replacement components with assumption that 5% of the shipping emissions originally associated with these components re-occur each year	Rotterdam	Foynes	HLV - Prop	1

2.5 Operation and Maintenance

2.5.1 Onshore vehicles

NAME	VEHICLE	DISTANCE [KM]	NO. TRIPS per year
Car	Car (petrol)	20	820
Car (worker)	Car (petrol)	20	720

2.5.2 Offshore vessels

NAME	TYPE	ACTIVITY	DURATION per year
Secondary CTV	Standby Vessel	In Transit	160 days
Primary CTV	Standby Vessel	In Transit	235 days