Great North Road Solar and Biodiversity Park

Environmental Statement

Volume 4 – Technical Appendices

Technical Appendix A15.1 – Lifecycle Greenhouse Gas Evaluation

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A15.1.1 SUMMARY

1 A note on precision: For ease of interpretation and to minimise risk of providing greater precision than accuracy, numbers in this document have been rounded to three significant figures or the decimal point, whichever gives the greater precision, with the exception of the emissions factor. Rounding errors are therefore of the order of 0.1% or less, which would not affect the conclusions of the assessment.

Table A15.1.1 – Summary of Emissions Produced (Worst-Case Scenario)

Development Phase	**Total Emissions ($teCO_2e$)**
Production Emissions – Material	1,855,627
Production Emissions – Transport	74,983
Construction Emissions – Waste	1,533
Construction Emissions – Other	3,619
Operational Emissions	1,256
Operational Emissions – Waste Transport	405
Sheep – Methane	43,421
Sheep – Water	51
Equipment Replacement	749,328
Decommissioning – Waste	1,105
Decommissioning – Waste Transport	9,761
Decommissioning – Other	4,245
Total	**2,745,335**

Table A15.1.2 – Summary of Emissions Savings (with 2024 grid carbon intensity baseline for solar PV)

Development Phase	**Total Emissions ($teCO_2e$)**
Land Use Change	44,218
Solar PV Generation	6,503,763
BESS	3,246,690
Total	**9,794,671**

Table A15.1.3 – Summary of Emissions Savings (Worst-Case Scenario)

Development Phase	**Total Emissions ($teCO_2e$)**
Land Use Change	44,218
Solar PV Generation	692,648
BESS	3,246,690
Total	**3,983,556**

Table A15.1.4 - Summary of Net Emissions (with 2024 grid carbon intensity baseline for solar PV)

Total Emissions	**Total Emissions ($teCO_2e$)**
Total Emissions Produced	2,745,335
Total Emissions Saved	(-) 9,794,671
Net Emissions	**(-) 7,049,337**

Table A15.1.5 – Summary of Net Emissions (Worst-Case Scenario)

Total Emissions	**Total Emissions ($teCO_2e$)**
Total Emissions Produced	2,745,335
Total Emissions Saved	(-) 3,983,556
Net Emissions	**(-) 1,238,221**

A15.1.2 ASSESSMENT

Table A15.1.6 – Production Emissions

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Battery storage (BESS) Cells	880,000	kWh (Storage capacity)	89	Forbes (2020). Estimating the carbon footprint of utility scale battery storage.[1]	313,280	Based on a 440 MW/2-hour BESS. It is possible that the BESS will have a higher MWh storage capacity, however, this is considered the worst-case outcome for climate change due to the beneficial carbon avoidance associated with the BESS, see table A15.1.21.
PV Panels	45,024,000	MWh	20	Louwen, van Sark, Faaij & Schropp (2016). Re-assessment of net energy production and greenhouse gas emissions avoidance after 40 years of	900,480	Take 20 gCO_2/kWh (data from 2018, downward trend so likely over-estimate). Based on 1,005 MWh/MWp output from site-specific modelling for 40-year operational life

[1] Rapier (2020). Estimating The Carbon Footprint of Utility Scale Battery Storage. [Online]. Available at: https://www.forbes.com/sites/rrapier/2020/02/16/estimating-the-carbon-footprint-of-utility-scale-battery-storage/. (Accessed 05/03/2025).

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				photovoltaics development.[2]		
PV Inverters	800,000	kW	65.31	Rajput & Singh (2017). Reduction in CO2 emission through photovoltaic system: a case study.[3]	52,248	Based on 800 MW(AC) capacity.
PV Framework (steel) (Chinese blast furnace steel)	44,800	Tonnes of steel (stainless)	4,180	Inventory of Carbon and Energy (ICE) Version 4[4]	187,264	Approx 40 tonnes steel per MWp-dc PV capacity, various data sources. Assumes 100% stainless steel.
PV framework (aluminium)	23,520	Tonnes of aluminium	14,600	Inventory of Carbon and Energy (ICE) Version 4[4]	343,392	Approx 21 tonnes Aluminium per MWp-dc PV capacity, various data sources. Sourced from China.

[2] Louwen, van Sark, Faaij & Schropp (2016). Re-assessment of net energy production and greenhouse gas emissions avoidance after 40 years of photovoltaics development. Nature Communications. [Online]. Available at: https://core.ac.uk/download/pdf/161700754.pdf. (Accessed 05/03/2025).
[3] Rajput & Singh (2017). Reduction in CO2 Emission through Photovoltaic System: A Case Study. [Online]. Available at: https://www.researchgate.net/publication/327832806_Reduction_in_CO2_Emission_through_Photovoltaic_System_A_Case_Study. (Accessed 05/03/2025).
[4] Circular Ecology (2024). Embodied Carbon - The ICE Database v4, 2024. Available at: https://circularecology.com/embodied-carbon-footprint-database.html. (Accessed 05/03/2025).

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
BESS Inverters	440,000	kW	65.31	Rajput & Singh (2017). Reduction in CO2 emission through photovoltaic system: a case study.[3]	28,736	Based on 440 MW maximum capacity.
Transformers - steel	510	Tonnes of Steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	1,382	Assumes emissions from manufacturing transformers are negligible (less than 1%). This is unlikely to be true for an individual transformer, but very likely for the whole Development (1% of total emissions would be c. 14,000 teCO2). Assumes steel will be 'finished cold-rolled coil steel', as the best estimate of kg CO2e from the ICE database.
Transformers - oil (mineral)	255	Tonnes of Oil	1,401	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	357	The tonnes of mineral oil have been estimated by client's construction team.

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				Reporting: Conversion Factors, 2024.[5]		
Security fence (substations)	145	Tonnes of Steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	394	2.75 km of fencing. 4 m high palisade fencing (scaled from 3 m high). 90 kgplus one pole at 19 kg per 2.75m.[6]
Security fence (BESS)	60	Tonnes of Steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	163	Security fence, BESS, 2.5 km, 4 m high (scaled from 3 m high), paladin/mesh, 26 kg plus one pole at 19 kg per 2.5 m.
Paint (security fence)	6,480	kg of paint	3.76	Inventory of Carbon and Energy (ICE) Version 4[4]	24	Worst-case fence parameters: BESS fence: 2.75 km x 4 m x 70% solid x 2 sides. Substation fence: 2.5 km x 4 m x 31% solid x 2 sides. 1 litre of paint covers 5 m^2. 1 litre of paint weighs

[5] Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024. Available at: Greenhouse gas reporting: conversion factors 2024 - GOV.UK. (Accessed 05/03/2025).
[6] First Fence (2025). 1.8m High Stripe Mesh Security Fencing Kit. [Online]. Available at: https://firstfence.co.uk/3-0m-high-w-section-palisade-security-fencing . (Accessed 13/01/2026).

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
						1.5 kg. Emissions factor is based on ICE solvent-based paint.
Paint (containers)	17,532	kg of paint	3.76	Inventory of Carbon and Energy (ICE) Version 4[4]	66	External paint on containers. Assume 754 BESS containers plus 40 other containers (substations etc). Assume dimensions 6.06 x 2.44 x 2.59 m. 1 litre of paint covers 5 m2. 1 litre of paint weighs 1.5 kg.
Storage Containers (steel)	1,659	Tonnes of Steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	4,495	BESS containers. Assumes the worst case of 754 containers, weighing 2.2 tonnes each[7].
Concrete pad and foundations	4,844	Tonnes of concrete	103	Inventory of Carbon and Energy (ICE) Version 4[4]	499	BESS and PV-field container plinths. 754 BESS and one PCS per BESS container. 204 PV-field containers (total). Assume 8 plinths per container, 90 cm deep and 0.6 m x 0.35 m in area. Assumed to be

[7] ASLG (2025) 20ft, 40ft, and 40HC Container Size, Capacity and Payload. [Online]. Available at: https://www.airsupplycn.com/20ft-40ft-container/. (Accessed on 01/06/2025).

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
						general concrete produced by the British Ready-Mixed Concrete Associated (BRMCa). 2.4 te/m^3.
Steel containers	80	Tonnes of steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	217	For communications, staff and general structures. Approximate figure assuming 40 20ft containers used around the site, weighing 2 tonnes each.
Substation (steel)	2,800	Tonnes of steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]**Error! Bookmark not defined.**	7,588	Based on 400 tonnes per 33/132kV substation and 1200 tonnes for the 132/400kv substation. The tonnage of steel in the substations has been estimated by client's construction team.
Deer fence	164	Tonnes of Steel (galvanised)	2,710	Inventory of Carbon and Energy (ICE) Version 4[4]	443	110 kg/100 m for steel deer fence. Based on a maximum 150 km of fencing required. 100 m/roll, 1,500 rolls. 163,500 kg.[8]

[8] Ultimate One (2025). FX13/190/15 Deer Fencing Mesh - High Tensile ~ 190cm x 100m – British. [Online]. Available at: https://www.ultimate-one.co.uk/fx1319015-deer-fencing-mesh-high-tensile-190cm-100m-british-p-1640. (Accessed 28/05/2025).

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Deer fence poles	477	Tonnes of wood	493	Inventory of Carbon and Energy (ICE) Version 4[4]	235	A maximum of 150 km of fencing. One pole every 3 m. 50,000 poles. 2.4 m pole 100mm diam = 9.14 kg. Bracing timber: 6 m x 150 mm every 60 m of fence. 2,500 units @ 8kg each[9]
Access tracks (Grit)	58,050,000	kg	0.00747	Inventory of Carbon and Energy (ICE) Version 3[10]	434	43 km of tracks, 4.5 m wide, 15 cm deep. 28,350 m^3 @ 2,000 kg/m^3. The emissions factor from ICE v3 has been used as a best estimate, as it was not included within ICE v4.
Access Tracks Tarmac	4,320	tonnes of Tarmac	52.2	Inventory of Carbon and Energy (ICE) Version 4[4]	226	2 km at 4.5m width and 20 cm depth = 1,800 m^3 and 2.4 t/m^3 weight. CO_2e figure Assuming asphalt 4% binder content.

[9] Sure Green (2025). Green Treated Machine-Round Fence Post. [Online]. Available at: https://www.sure-green.com/catalog/product/view/id/353/s/wooden-fencing-posts/category/840/. (Accessed 28/05/2025).
[10] Circular Ecology (2019). Embodied Carbon - The ICE Database v3, 2019. Available at: https://circularecology.com/embodied-carbon-footprint-database.html. (Accessed 01/10/2024). No longer available.

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Concrete	5,244	tonnes	103	Inventory of Carbon and Energy (ICE) Version 4[4]	540	Assumed to be general concrete produced by the British Ready-Mixed Concrete Associated (BRMCa). Assumed 20% of area of 4 intermediate and 1 400 kV substation, to average 30 cm depth. Excludes concrete plinths for containers covered in a separate row of this table.
Stone (around containers and substations)	16,089,000	kg	0.00747	Inventory of Carbon and Energy (ICE) Version 3	120	Assumed stone under and 50 cm around each container in PV-fields and BESS area. Assumed 30% of substation areas covered by stone. 20 cm depth assumed.
Aggregate	36,000,000	kg	0.00747	Inventory of Carbon and Energy (ICE) Version 3[10]	269	Based on an estimate of market average aggregate. Unbound stone for construction compounds. 32 (based on access tracks) construction compounds, 50 m by 75 m each, 15 cm

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
						depth) (2 tonnes per m^3 of aggregate). The emissions factor from ICE v3 has been used as a best estimate, as it was not included within ICE v4.
Cabling - Copper	736,165	kg	2.71	Inventory of Carbon and Energy (ICE) Version 4[4]	1,995	Estimated by the Applicant's construction team.
Cabling - Tin	12,145	kg	14.47	Inventory of Carbon and Energy (ICE) Version 4[4]	176	Estimated by the Applicant's construction team.
Cabling - Polyethylene	351,235	kg	2.9	Benavides, Lee, & Zarè-Mehrjerdi (2020). Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene,	1,019	Estimated by the Applicant's construction team. General Polyethylene.

Embodied Carbon - Component/Material	Activity Data	Units	Emission factor, kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				and fossil-derived polyethylene.[11]		
Cabling - Polypropylene	114,955	kg	4.77	CarbonCloud (2024). Plastic, PP resin, fossil based.[12]	548	Estimated by the Applicant's construction team. Polypropylene.
Cabling - thermal sand (cement component)	9,332,736	kg	0.84	Inventory of Carbon and Energy (ICE) Version 4[4]	7,839	Estimated by the Applicant's construction team Cables trench lengths, based approximately on illustrative design: 33kV, 138km length, 1m width, 0.4m depth of sand 132kV, 44km length, 1.5m width, 0.6m depth of sand 400kV, 1.8km length, 2.4m width, 0.96m depth of sand
Cabling - thermal sand (sand component)	123,992	Tonnes of sand	7.47	Inventory of Carbon and Energy (ICE) Version 4[4]	926	

[11] Benavides, Lee, & Zarè-Mehrjerdi (2020). Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene, and fossil-derived polyethylene. Journal of Cleaner Production. Vol 277. Available at: Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene, and fossil-derived polyethylene - ScienceDirect.

[12] CarbonCloud (2024). Plastic, PP resin, fossil based. [Online]. Available at: https://apps.carboncloud.com/climatehub/product-reports/id/128828874513#:~:text=%E2%80%9DPlastic%2C%20PP%20resin%2C%20fossil,of%204.77%20kg%20CO%E2%82%82e%2Fkg. (Accessed 05/03/2025).

Embodied Carbon - Component/Material	**Activity Data**	**Units**	**Emission factor, kg CO_2e per unit**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
						Estimated by the Applicant's construction team
Geotextile - polypropylene	57,000	kg	4.77	CarbonCloud (2024). Plastic, PP resin, fossil based.[12]	272	43 km tracks, 4.5m wide. A roll 4.5m wide and 100m long weighs 75 kg (Fasttrack 609). 430 rolls = 32.25 te. Construction compounds 32 no. 50mx75m = 224 rolls at 112 kg (Terram) = 25 te. Total geotextile weight 57 te
Total					**1,855,627**	

Table A15.1.7 – Materials Transport Emissions

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Battery storage (BESS) Cells; HGV (within China)	7,644	30	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	55	Guandong to Yantian International Container Terminal (Shenzhen)
Battery storage (BESS) Cells; sea	7,644	18174	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,945	Approximately 8.686 tonnes per MWh based on spec. sheet provided by BYD, including the container for shipping. Distance from Shenzhen. https://sea-distances.org/ says Hong Kong (nearest) to Immingham is 9,813 nm, which is 18,174 km.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Battery storage (BESS) Cells; HGV	7,644	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	440	Estimated by the Applicant's construction team.
PV Panels; HGV (within China)	58,585	500	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	7,030	Approximately 500 km from Xinjiang province to Shanghai by train.
PV Panels; train (within China)	58,585	4,000	0.02779	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	6,512	Approximately 4,000 km from Xinjiang province to Shanghai by train.
PV Panels; sea	58,585	19,613	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	16,086	Assuming 34 kg per 650-watt panel (average between Trina, Sunway &

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Reporting: Conversion Factors, 2024[5]		Canadian Solar Panels).
PV Panels; HGV	58,585	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	3,374	Estimated by the Applicant's construction team.
PV Inverters; HGV (within China)	3,600	449	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	388	Using the 6 m Sungrow SG3425, 4 MW, 18 te. Distance from Anhai (world's largest cluster of inverter manufacturers) to Shangai Port by road.
PV Inverters; sea	3600	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting:	988	Using the 6 m Sungrow SG3425, 4 MW, 18 te.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Conversion Factors, 2024[5]		
PV Inverters; HGV	3600	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	207	Using the 6 m Sungrow SG3425, 4 MW, 18 te.
PV framework; HGV (within China)	44,800	13	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	140	Xiamen Torch Hi-tech zone to Port of Xiamen.
PV framework (steel); sea	44,800	18,531	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting:	11,623	Approx. 40 tonnes steel per MWp-dc PV capacity, various data sources.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Conversion Factors, 2024[5]		
PV framework (steel); HGV	44,800	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	2,580	Estimated by the Applicant's construction team.
PV framework (aluminium); HGV (within China)	23,520	214	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,208	Distance from Linqu Country, Weifang City (aluminuim capital of china) to Port of Qingdao.
PV framework (aluminium); sea	23,520	20,031	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	6,596	Estimated by the Applicant's construction team.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
PV framework (aluminium); HGV	23,520	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,355	Approx 21 tonnes Aluminium per MWp-dc PV capacity, various data sources.
BESS Inverter; HGV (within China)	2,640	449	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	284	Hefei, Anhui Province to Port of Shanghai.
BESS Inverters; sea	2,640	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	724	Estimated by the Applicant's construction team.
BESS Inverters; HGV	2,640	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	152	PCS + MV Skid (including inverters) shown in tech sheet at 30 tonnes per

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Reporting: Conversion Factors, 2024[5]		5MW unit - so 6 kg/kw).
Transformers Steel; HGV (within China)	510	273	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	33	Distance from Zhejiang province to Ningbo Port.
Transformers Steel; Shipping	510	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	140	Estimated by the Applicant's construction team.
Transformers Steel; HGV	510	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	29	Estimated by the Applicant's construction team.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Transformers Mineral Oil; HGV (within China)	255	281	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	17	Distance from Zhejiang province to Ningbo Port.
Transformers Mineral Oil; Shipping	255	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	70	Estimated by the Applicant's construction team.
Transformers Mineral Oil; HGV	255	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	15	Estimated by the Applicant's construction team.
Storage containers	1,739	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	100	Estimated by the Applicant's construction team.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Reporting: Conversion Factors, 2024[5]		
Substation	2,800	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	161	Estimated by the Applicant's construction team.
Fencing and gates; HGV (within China)	963	273	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	63	Estimated by the Applicant's construction team Deer fencing, deer fence poles, and security fencing. Distance from Zhejiang province to Ningbo Port. Assumed fencing comes in 3.75 te containers, each of which can carry 27 te.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Fencing and gates; shipping	963	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	264	
Fencing and gates; HGV (UK)	963	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	55	
Track grit	58,050	100	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	1,393	Assume 100km for transport - likely much less than this.
Tarmac	4,320	100	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	104	Assume 100km for transport - likely much less than this.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
				Reporting: Conversion Factors, 2024		
Sand	133,325	100	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	3,200	Assume 100km for transport - likely much less than this. Includes sand and cement within the sand.
Concrete; HGV	10,088	150	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	363	Estimated by the Applicant's construction team.
Aggregate; HGV	52,089	100	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,250	Assume 100 km for aggregate transport - likely much less than this.

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Cabling; HGV	10,671	350	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	896	Estimated by the Applicant's construction team.
Containers for transporting inverters (HGV China)	1,258	449	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	136	Weight of PV inverters = 3,600 te. Centralised inverters are often packaged in a container and this is expected to be included in the other embodied quantities, however to account for uncertainty in this we agree to add the transport emissions from additional container weight. Assume 6.5 te per PV inverter, so 554 inverters and 2 per container so 277 containers at 3.75 te

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
						each, so 1,038 te of containers. BESS – 4 MW per inverter (SG3425) would give 110 inverters. Often these are packaged with a transformer into a "PCS" unit, in a single container. But as a worst-case we assume they're in individual containers, so 110 containers at half size, 2 te each, 220 te of containers. BESS+PV = 1,258 te of containers.
Containers for transporting inverters (shipping)	1,258	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	345	

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Containers for transporting inverters (HGV UK)	1,258	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	72	
Containers for transporting PV panels (HGV China)	8,137	500	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	976	Approximately 500 km from Xinjiang proveince to Shanghai by train 27 te per container (max). Each container weighs 3.75 te itself - additional transport load
Containers for transporting PV panels (train China)	8,137	4,000	0.02779	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	904	Approximately 4,000 km from Xinjiang proveince to Shanghai by train 27 te per container (max). Each container weighs 3.75 te itself -

Transport - Component or material and mode of transport	**Mass in tonnes**	**Distance in km**	**Emissions factor, kg CO_2e per tonne.km**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
						additional transport load
Containers for transporting PV panels (shipping)	8,137	19,600	0.014	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	2,233	Assuming 34kG per 650watt panel (average between Trina, Sunway & Canadian Solar Panels) 27 te per container (max). Each container weighs 3.75 te itself - additional transport load
Containers for transporting PV panels (HGV UK)	8,137	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	469	Estimated by the Applicant's construction team 27 te per container (max). Each container weighs 3.75 te itself - additional transport load

Transport - Component or material and mode of transport	Mass in tonnes	Distance in km	Emissions factor, kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Geotextile - polypropylene	57	240	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	3	Assuming round trip transportation of 240 km
Total					**74,983**	

Table A15.1.8 – Construction Waste and Transport Emissions

Construction Waste - Component and Method	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Concrete; landfill	0	Tonnes	1.23393	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Minimal or no waste is anticipated.

Construction Waste - Component and Method	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Concrete; recycled	1	Tonnes	0.98485	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Minimal or no waste is anticipated.
Aggregate; landfill	0	Tonnes	1.23393	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Minimal or no waste is anticipated.
Aggregate; recycled	94,050	Tonnes	0.98485	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	93	All construction compounds and temporary access tracks are removed following construction. Tarmac track will remain.
Steel; recycled	448	Tonnes	0.98485	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Estimate by Applicant.

Construction Waste - Component and Method	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Aluminium; recycled	235	Tonnes	0.98485	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Estimate by Applicant.
Plastic; landfill	1	Tonnes	8.88386	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0.00888	Minimal or no waste is anticipated.
Plastic; recycled	298	Tonnes	6.41061	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Estimate by Applicant.
Paperboard; recycling	1,493	Tonnes	6.41061	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	10	Estimate by Applicant.

Construction Waste - Component and Method	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Wood; landfill	0	Tonnes	925.24423	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Minimal or no waste is anticipated.
Wood; recycling	5	Tonnes	6.41061	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Based on an emissions factor for the closed loop recycling of wood, where the product is recycled back into the same product.
Worker waste	100	Tonnes	497.04416	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	50	Assumes 0.5 kg of waste per day per worker. 400 workers for 500 days. Assumes an emissions factor of household waste.
Total water consumption	18,000	m^3	0.18574	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	3	90 L of water per worker per day. 400 workers for 500 days.

Construction Waste - Component and Method	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Waste transport	5,731,550	Tonne.km	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,376	Sum of tonnes, multiplied by 50 km multiplied by emissions factor.
Total					**1,533**	

Table A15.1.9 – Construction Other

Construction Other	Activity data	Units	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Worker commuting (total car journeys)	8,000,000	km	0.16691	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,335	Assuming 400 workers, average of 1.5 workers per car, average of 60 km round trip distance per day and 500 total days of construction.

Construction Other	**Activity data**	**Units**	**Emissions factor kg CO_2e per unit**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Total fuel consumption – Plant	520,000	Litres	2.75541	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,433	Plant and machinery are assumed to consume 5,000 L of diesel per week across full construction period of 2 years.
Total fuel consumption - generators	308,880	Litres	2.75541	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	851	Generators are assumed to consume 16.5 litres per hour, 6 hours a day, 26 days a month. An average of 5 generators assumed to be running throughout the 2-year construction period.
Total					**3,619**	

Table A15.1.10 – Land Use Change: Baseline Habitat

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Cereal and non-cereal crops	1,482	Arable / cultivated land	120	No vegetation stocks are given - as management (grazing and cutting) removes biomass annually	177,816	652,051	Natural England (2014)[13]
Arable Field margins tussocky, temporary grass and clover leys, other neutral grassland	32.4	Neutral grassland (soil depth 15 cm)	60	No data	1,944	7,129	Natural England (2014)[13]
Mixed scrub, bramble, blackthorn, hawthorn scrubs	5.6	Scrubs	72	60	739	2,711	Natural England (2014)[13]
Modified Grassland	187	Improved Grassland	130	No vegetation stocks are given - as management (grazing	24,245	88,806	Natural England (2014)[13]

[13] Natural England (2021). Carbon Storage and Sequestration by Habitat 2021 (NERR094). Available at: Carbon Storage and Sequestration by Habitat 2021 - NERR094

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
				and cutting) removes biomass annually			
Wet Woodland, Lowland mixed deciduous, other broadleaved woodland	28.3	30-year mixed broadleaved native wood	55	114	4,783	17,538	Natural England (2014)[13]
Other	31.4		98.7	21.4	3,771	13,829	Natural England (2014)[13]
Total	**1,766**				**Total**	**782,164**	

Table A15.1.11 – Land Use Change: Habitat Lost in Development

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Cereal and non-cereal crops	1,338	Arable / cultivated land	120	No vegetation stocks are given - as management (grazing and cutting) removes biomass annually	160,704	589,248	Natural England (2014)[13]
Arable Field margins tussocky, temporary grass and clover leys, other neutral grassland	32.4	Neutral grassland (soil depth 15 cm)	60	No data	1,944	7,129	Natural England (2014)[13]
Mixed scrub, bramble, blackthorn, hawthorn scrubs	0	Scrubs	72	60	0	0	Natural England (2014)[13]
Modified Grassland	0	Improved Grassland	130	No vegetation stocks are given - as management (grazing and cutting) removes biomass annually	0	0	Natural England (2014)[13]

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Wet Woodland, Lowland mixed deciduous, other broadleaved woodland	0	30-year mixed broadleaved native wood	55	114	0	0	Natural England (2014)[13]
Other	0		98.7	21.4	0	0	Natural England (2014)[13]
TOTAL	**1,370**				**Total**	**595,876**	
Notes: The Carbon stock has been converted to CO_2e using the standard converter 1 tC = 3.667 tCO_2e.							

Table A15.1.12– Land Use Change: Habitat Created Post Development

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Cereal and non-cereal crops	0	Arable / cultivated land	120	No vegetation stocks are given - as management (grazing and cutting) removes biomass annually	0	0	Natural England (2014)[13]

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Arable Field margins tussocky, temporary grass and clover leys, other neutral grassland	0	Neutral grassland (soil depth 15 cm)	60	No data	0	0	Natural England (2014)[13]
Mixed scrub, bramble, blackthorn, hawthorn scrubs	17.8	Scrubs	72	60	2,351	8,621	Natural England (2014)[13]
Modified Grassland	1,271	Improved Grassland	130	No vegetation stocks are given - as management (grazing and cutting) removes biomass annually	165,247	605,960	Natural England (2014)[13]
Wet Woodland, Lowland mixed deciduous, other broadleaved woodland	13.8	30-year mixed broadleaved native wood	55	114	2,339	8,579	Natural England (2014)[13]

Habitat type	Hectares	Habitat category for assessment	Carbon stock factor (tC/ha) (Soil)	Carbon stock factor (tC/ha) (Vegetation)	Carbon Stock (tC)	Equivalent CO_2 if released (tCO_2e)	Reference
Other	38.5		98.7	21.4	4,618	16,934	Natural England (2014)[13]
TOTAL	**1,341**				**Total**	**640,094**	

Table A15.1.13 – Land Use Change Summary: Net CO_2e released.

Habitat loss in CO_2e if released (tCO_2e)	595,876
Habitat gained in CO_2e if released (tCO_2e)	640,094
Net change in CO_2e if released (tCO_2e)	44,218*

* Positive number means a net store of carbon.

Table A15.1.14 – Operational Emissions

2 Operational emissions from the maintenance of the Development are estimated below, based on a single on-site warehouse estimated to have a continuous electricity draw of 10 kW, supplied by the national grid, amounting to 87,600 kWh per year. It is estimated that there will be 60 members of staff, but only 30 will attend the Development each day for 300 days of the year, with two people commuting per car for an average of 60 km, totalling 270,000 km across the year. Each employee is estimated to use 90 L of water a day and produce 0.5 kg of waste.

#	Year	Commercial/Public Section Consumption-Based Grid Average Carbon Intensity (kg CO_2e/kWh)	On Site Warehouse Power Draw (10 kW continuous) (kWh)	Energy Consumption Based Emissions (tonnes CO_2e)	30 Employees commuting an average of 60 km daily in 15 vehicles (300 days of year) @ average of 100 gCO_2e/km* (tonnes CO_2e)	Water use and treatment of 90L each for 30 workers for 300 days (tonnes CO_2e)	Food and drink waste of 0.5 kg each for 30 workers for 300 days (tonnes CO_2e)	Total Embodied Carbon Emissions (tonnes CO_2e)
1	2028	0.0964	87600	8.44	27	0.34	2.24	38.0
2	2029	0.0718	87600	6.29	27	0.34	2.24	35.9
3	2030	0.0623	87600	5.45	27	0.34	2.24	35.0
4	2031	0.0526	87600	4.61	27	0.34	2.24	34.2
5	2032	0.0485	87600	4.25	27	0.34	2.24	33.8
6	2033	0.0408	87600	3.57	27	0.34	2.24	33.1
7	2034	0.0321	87600	2.81	27	0.34	2.24	32.4
8	2035	0.0255	87600	2.23	27	0.34	2.24	31.8
9	2036	0.0205	87600	1.80	27	0.34	2.24	31.4
10	2037	0.0198	87600	1.73	27	0.34	2.24	31.3
11	2038	0.0193	87600	1.69	27	0.34	2.24	31.3

#	Year	Commercial/Public Section Consumption-Based Grid Average Carbon Intensity (kg CO_2e/kWh)	On Site Warehouse Power Draw (10 kW continuous) (kWh)	Energy Consumption Based Emissions (tonnes CO_2e)	30 Employees commuting an average of 60 km daily in 15 vehicles (300 days of year) @ average of 100 gCO_2e/km* (tonnes CO_2e)	Water use and treatment of 90L each for 30 workers for 300 days (tonnes CO_2e)	Food and drink waste of 0.5 kg each for 30 workers for 300 days (tonnes CO_2e)	Total Embodied Carbon Emissions (tonnes CO_2e)
12	2039	0.0180	87600	1.58	27	0.34	2.24	31.2
13	2040	0.0176	87600	1.54	27	0.34	2.24	31.1
14	2041	0.0165	87600	1.45	27	0.34	2.24	31.0
15	2042	0.0157	87600	1.38	27	0.34	2.24	31.0
16	2043	0.0150	87600	1.31	27	0.34	2.24	30.9
17	2044	0.0142	87600	1.25	27	0.34	2.24	30.8
18	2045	0.00896	87600	0.785	27	0.34	2.24	30.4
19	2046	0.00833	87600	0.730	27	0.34	2.24	30.3
20	2047	0.00774	87600	0.678	27	0.34	2.24	30.3
21	2048	0.00757	87600	0.663	27	0.34	2.24	30.2
22	2049	0.00523	87600	0.458	27	0.34	2.24	30.0
23	2050	0.00509	87600	0.446	27	0.34	2.24	30.0
24	2051	0.00323	87600	0.283	27	0.34	2.24	29.9
25	2052	0.00246	87600	0.215	27	0.34	2.24	29.8
26	2053	0.00246	87600	0.215	27	0.34	2.24	29.8
27	2054	0.00246	87600	0.215	27	0.34	2.24	29.8

#	Year	Commercial/Public Section Consumption-Based Grid Average Carbon Intensity (kg CO_2e/kWh)	On Site Warehouse Power Draw (10 kW continuous) (kWh)	Energy Consumption Based Emissions (tonnes CO_2e)	30 Employees commuting an average of 60 km daily in 15 vehicles (300 days of year) @ average of 100 gCO_2e/km* (tonnes CO_2e)	Water use and treatment of 90L each for 30 workers for 300 days (tonnes CO_2e)	Food and drink waste of 0.5 kg each for 30 workers for 300 days (tonnes CO_2e)	Total Embodied Carbon Emissions (tonnes CO_2e)
28	2055	0.00246	87600	0.215	27	0.34	2.24	29.8
29	2056	0.00246	87600	0.215	27	0.34	2.24	29.8
30	2057	0.00246	87600	0.215	27	0.34	2.24	29.8
31	2058	0.00246	87600	0.215	27	0.34	2.24	29.8
32	2059	0.00246	87600	0.215	27	0.34	2.24	29.8
33	2060	0.00246	87600	0.215	27	0.34	2.24	29.8
34	2061	0.00246	87600	0.215	27	0.34	2.24	29.8
35	2062	0.00246	87600	0.215	27	0.34	2.24	29.8
36	2063	0.00246	87600	0.215	27	0.34	2.24	29.8
37	2064	0.00246	87600	0.215	27	0.34	2.24	29.8
38	2065	0.00246	87600	0.215	27	0.34	2.24	29.8
39	2066	0.00246	87600	0.215	27	0.34	2.24	29.8
40	2067	0.00246	87600	0.215	27	0.34	2.24	29.8
Total								**1,242**

Table A15.1.15 – Operational Waste, Transport

Operational Waste - Transport	**Activity data**	**Units**	**Emissions factor kg CO_2e per unit**	**Emissions factor data source**	**Emissions (tCO_2e)**	**Assumptions**
Waste transport	1,629,000	Tonne.km	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	391	Assumes 30 workers per day for 300 days a year. Includes 32,400 tonnes of water and 180 tonnes of waste. Sum of tonnes, multiplied by 50 km multiplied by emissions factor.
Water use/treatment	32,400	m^3	0.421	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	14	90 L of water per day for 30 workers for 300 days, for 40 years.
Total					**405**	

Table A15.1.16 – Methane Emissions from Sheep

Sheep type	**Number of sheep**	**Number of days on Site**	**Data source**	**Methane per day (in kg/CO_2e)**	**Total Methane over 40 years (tCO_2e)**	**Assumptions**
Ewe	4,000	365	Scottish Government (2021) Greenhouse gas inventory: estimated sheep emissions and their mitigation[14]	0.559	32,640	Assumes 204 kg CO_2e per year per sheep Assumes 4,000 ewes on Site all year.
Lamb	5,600	183	Scottish Government (2021) Greenhouse gas inventory: estimated sheep emissions and their mitigation[14]	0.263	10,781	Assumes 96 kg CO_2e per year per lamb Assumes 5,600 lambs on site between April and September.
Total					**43,421**	

[14] Scottish Government (2021) Greenhouse gas inventory: estimated sheep emissions and their mitigation. [Online]. Available at: https://www.gov.scot/publications/estimated-sheep-emissions-mitigation-smart-inventory/. (Accessed 28/05/2025).

Table A15.1.17 – Emissions from Sheep Care, Water

Sheep type	Number of sheep	Number of days on Site (per year)	Water consumption (per day in litres)	Total water usage (m^3) (40 years)	Carbon per m^3 (in kg/CO_2e)	Data source	Total Emissions (tCO_2e)	Assumptions
Ewe	4,000	365	2.75	160,600	0.186	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	30	Assumes 4,000 ewes on Site all year. Assumed 2.75 litres per day[15].
Lamb	5,600	183	2.75	112,728	0.186	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	21	Assumes 5,600 lambs on site between April and September. Assumed 2.75 litres per day[15].
Total							**51**	

[15] AHDB (2025) Effective Use of Water on Dairy Farms, The Dairy Farm DIY Full Water Audit Pack. [Online]. Available at: https://projectblue.blob.core.windows.net/media/Default/Tools/Tool%20Download/thedairyfarmdiyfullwaterauditpack.pdf. (Accessed on 28/05/2025).

Table A15.1.18 – Component Replacement

Item	Design life replacement rate	Original embodied emissions (tCO_2e)	Original transport emissions (tCO_2e)	Replacement embodied and transport emissions (tCO_2e)
Transformers	5%	1,739	305	102
PV Panels	10%	900,480	37,588	93,807
Panel Supports	10%	530,656	23,502	55,416
PV Inverter	150%	52,248	2,137	81577
BESS Inverter	150%	28,736	1,161	44,846
BESS cells	150%	313,280	2,440	473,580
Transformer mineral oil	100%	357	102	459
Wooden fence posts	100%	235	190	425
Total				**749,328**

Table A15.1.19 – Solar PV Carbon Savings

#	Year	Generation-based long-run marginal Carbon Intensity (kgCO_2e/kWh)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes CO_2e)
1	2026	0.174	560,549	264,829	295,719	51,485
2	2027	0.154	837,460	256,885	580,575	89,525
3	2028	0.133	1,112,147	249,178	862,969	114,602
4	2029	0.110	1,107,698	241,703	865,996	95,000
5	2030	0.085	1,103,267	234,452	868,816	73,849
6	2031	0.0652	1,098,854	227,418	871,436	56,818
7	2032	0.0501	1,094,459	220,595	873,863	43,781
8	2033	0.0384	1,090,081	213,978	876,103	33,642
9	2034	0.0295	1,085,721	207,558	878,162	25,906
10	2035	0.0226	1,081,378	264,829	816,548	18,454
11	2036	0.0174	1,077,052	256,885	820,168	14,271
12	2037	0.0133	1,072,744	249,178	823,566	10,953
13	2038	0.0102	1,068,453	241,703	826,751	8,433
14	2039	0.0079	1,064,179	234,452	829,728	6,555
15	2040	0.006	1,059,923	227,418	832,505	4,995
16	2041	0.0057	1,055,683	220,595	835,087	4,760
17	2042	0.0036	1,051,460	213,978	837,483	3,015
18	2043	0.0028	1,047,254	207,558	839,696	2,351

#	Year	Generation-based long-run marginal Carbon Intensity (kgCO_2e/kWh)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes CO_2e)
19	2044	0.002	1,043,065	201,332	841,734	1,683
20	2045	0.0013	1,038,893	264,829	774,064	1,006
21	2046	0.0013	1,034,738	256,885	777,853	1,011
22	2047	0.0013	1,030,599	249,178	781,421	1,016
23	2048	0.0014	1,026,476	241,703	784,774	1,099
24	2049	0.0014	1,022,370	234,452	787,919	1,103
25	2050	0.0013	1,018,281	227,418	790,863	1,028
26	2051	0.0023	1,014,208	220,595	793,612	1,825
27	2052	0.0023	1,010,151	213,978	796,173	1,831
28	2053	0.0023	1,006,110	207,558	798,552	1,837
29	2054	0.0023	1,002,086	201,332	800,754	1,842
30	2055	0.0023	998,077	264,829	733,248	1,686
31	2056	0.0023	994,085	256,885	737,201	1,696
32	2057	0.0023	990,109	249,178	740,931	1,704
33	2058	0.0023	986,148	241,703	744,446	1,712
34	2059	0.0023	982,204	234,452	747,752	1,720
35	2060	0.0023	978,275	227,418	750,857	1,727
36	2061	0.0023	974,362	220,595	753,766	1,734
37	2062	0.0023	970,464	213,978	756,487	1,740

#	Year	Generation-based long-run marginal Carbon Intensity (kgCO_2e/kWh)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes CO_2e)
38	2063	0.0023	966,583	207,558	759,024	1,746
39	2064	0.0023	962,716	201,332	761,385	1,751
40	2065	0.0023	958,865	195,292	763,574	1,756
Total						**692,648**

Notes: The annual energy production is calculated by multiplying the phase capacity by the yield and by the annual degradation.

e.g. for year 4, this includes the following: Phase 3 capacity (1120 MWp-dc) x yield (1005 kWh/kWp/annum) x annual degradation (1-0.4% x year).

1120 x 1005 x ((1-0.4)*4) = 1,107,698 MWh.

Table A15.1.20 – Solar PV Carbon Savings with 2024 Baseline for Generation-based Marginal Carbon Intensity

#	Year	Generation-based marginal Carbon Intensity, 2024 baseline ($kgCO_2e/kWh$)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes)
1	2026	0.20705	560,549	264,829	295,719	61,229
2	2027	0.20705	837,460	256,885	580,575	120,208
3	2028	0.20705	1,112,147	249,178	862,969	178,678
4	2029	0.20705	1,107,698	241,703	865,996	179,304
5	2030	0.20705	1,103,267	234,452	868,816	179,888
6	2031	0.20705	1,098,854	227,418	871,436	180,431
7	2032	0.20705	1,094,459	220,595	873,863	180,933
8	2033	0.20705	1,090,081	213,978	876,103	181,397
9	2034	0.20705	1,085,721	207,558	878,162	181,824
10	2035	0.20705	1,081,378	264,829	816,548	169,066
11	2036	0.20705	1,077,052	256,885	820,168	169,816
12	2037	0.20705	1,072,744	249,178	823,566	170,519
13	2038	0.20705	1,068,453	241,703	826,751	171,179
14	2039	0.20705	1,064,179	234,452	829,728	171,795
15	2040	0.20705	1,059,923	227,418	832,505	172,370
16	2041	0.20705	1,055,683	220,595	835,087	172,905

#	Year	Generation-based marginal Carbon Intensity, 2024 baseline ($kgCO_2e/kWh$)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes)
17	2042	0.20705	1,051,460	213,978	837,483	173,401
18	2043	0.20705	1,047,254	207,558	839,696	173,859
19	2044	0.20705	1,043,065	201,332	841,734	174,281
20	2045	0.20705	1,038,893	264,829	774,064	160,270
21	2046	0.20705	1,034,738	256,885	777,853	161,054
22	2047	0.20705	1,030,599	249,178	781,421	161,793
23	2048	0.20705	1,026,476	241,703	784,774	162,487
24	2049	0.20705	1,022,370	234,452	787,919	163,139
25	2050	0.20705	1,018,281	227,418	790,863	163,748
26	2051	0.20705	1,014,208	220,595	793,612	164,317
27	2052	0.20705	1,010,151	213,978	796,173	164,848
28	2053	0.20705	1,006,110	207,558	798,552	165,340
29	2054	0.20705	1,002,086	201,332	800,754	165,796
30	2055	0.20705	998,077	264,829	733,248	151,819
31	2056	0.20705	994,085	256,885	737,201	152,637
32	2057	0.20705	990,109	249,178	740,931	153,410
33	2058	0.20705	986,148	241,703	744,446	154,137

#	Year	Generation-based marginal Carbon Intensity, 2024 baseline ($kgCO_2e/kWh$)	Annual Energy Production (MWh)	Estimate charged to BESS (MWh)	Solar Energy to Grid (MWh)	Carbon Avoidance (tonnes)
34	2059	0.20705	982,204	234,452	747,752	154,822
35	2060	0.20705	978,275	227,418	750,857	155,465
36	2061	0.20705	974,362	220,595	753,766	156,067
37	2062	0.20705	970,464	213,978	756,487	156,631
38	2063	0.20705	966,583	207,558	759,024	157,156
39	2064	0.20705	962,716	201,332	761,385	157,645
40	2065	0.20705	958,865	195,292	763,574	158,098
Total						**6,503,763**

Notes: The annual energy production is calculated by multiplying the phase capacity by the yield and by the annual degradation.

e.g. for year 4, this includes the following: Phase 3 capacity (1120 MWp-dc) x yield (1005 kWh/kWp/annum) x annual degradation (1-0.4% x year).

1120 x 1005 x ((1-0.4)*4) = 1,107,698 MWh.

Table A15.1.21 – Battery Energy Storage System (BESS) Carbon Savings

#	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO_2e/kWh)	Energy Charged from PV (MWh)	Energy Discharged to Grid (MWh)	Carbon Avoidance (tonnes)
1	2026	0.365	264,829	254,236	92,796
2	2027	0.365	256,885	246,609	90,012
3	2028	0.365	249,178	239,211	87,312
4	2029	0.365	241,703	232,035	84,693
5	2030	0.365	234,452	225,074	82,152
6	2031	0.365	227,418	218,321	79,687
7	2032	0.365	220,595	211,772	77,297
8	2033	0.365	213,978	205,419	74,978
9	2034	0.365	207,558	199,256	72,728
10	2035	0.365	264,829	254,236	92,796
11	2036	0.365	256,885	246,609	90,012
12	2037	0.365	249,178	239,211	87,312
13	2038	0.365	241,703	232,035	84,693
14	2039	0.365	234,452	225,074	82,152
15	2040	0.365	227,418	218,321	79,687
16	2041	0.365	220,595	211,772	77,297
17	2042	0.365	213,978	205,419	74,978
18	2043	0.365	207,558	199,256	72,728

#	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO_2e/kWh)	Energy Charged from PV (MWh)	Energy Discharged to Grid (MWh)	Carbon Avoidance (tonnes)
19	2044	0.365	201,332	193,278	70,547
20	2045	0.365	264,829	254,236	92,796
21	2046	0.365	256,885	246,609	90,012
22	2047	0.365	249,178	239,211	87,312
23	2048	0.365	241,703	232,035	84,693
24	2049	0.365	234,452	225,074	82,152
25	2050	0.365	227,418	218,321	79,687
26	2051	0.365	220,595	211,772	77,297
27	2052	0.365	213,978	205,419	74,978
28	2053	0.365	207,558	199,256	72,728
29	2054	0.365	201,332	193,278	70,547
30	2055	0.365	264,829	254,236	92,796
31	2056	0.365	256,885	246,609	90,012
32	2057	0.365	249,178	239,211	87,312
33	2058	0.365	241,703	232,035	84,693
34	2059	0.365	234,452	225,074	82,152
35	2060	0.365	227,418	218,321	79,687
36	2061	0.365	220,595	211,772	77,297
37	2062	0.365	213,978	205,419	74,978

#	Year	Evening Peak Carbon Intensity (Gas Peaker) (kg CO_2e/kWh)	Energy Charged from PV (MWh)	Energy Discharged to Grid (MWh)	Carbon Avoidance (tonnes)
38	2063	0.365	207,558	199,256	72,728
39	2064	0.365	201,332	193,278	70,547
40	2065	0.365	195,292	187,480	68,430
Total					**3,246,690**

Table A15.1.22 – Decommissioning Waste

Category	Mass in tonnes	Waste type	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Concrete; recycled	10,088	Construction–concrete	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	10	Estimated by the Applicant's construction team.
Aggregate; recycled	16,089	Construction - aggregate	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	16	Stone around substations and BESS/PV containers only. All track/construction compound aggregate and grit is included in calculations of recycling and waste transport in the Construction sheet - although it

Category	Mass in tonnes	Waste type	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
						may be retained until later in the project. As a result, it is already accounted for and doesn't need including here.
Asphalt; recycled	4,321	Construction - aggregate	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	4	Estimated by the Applicant's construction team. Tarmac road removal.
Steel, recycled	54,723	Construction – metals	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	54	Estimated by the Applicant's construction team. Includes all steel, including replacement where appropriate.
Aluminium; recycled	25,872	Construction – metals	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	25	Estimated by the Applicant's construction team. Includes replacements.
Plastic; recycled	466	Plastic	6.41	Department for Business, Energy & Industrial Strategy,	3	Cable plastic. Estimated by the Applicant's construction team.

Category	Mass in tonnes	Waste type	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				Greenhouse Gas Reporting: Conversion Factors, 2024[5]		
Batteries (cells only), recycled	19,109	Electrical items – batteries	21.29	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	407	Assuming 2 tonnes per MWh of battery system, from a combination of technical specifications.
Solar PV inverters, recycled	9,000	Electrical items - WEEE mixed	6.41	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	58	Incl. replacement rate (150%). Factor for large electrical items
BESS PV inverters, recycled	6,600	Electrical items – WEEE mixed	6.41	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	42	Incl. replacement rate (150%). Factor for large electrical items
Transformers - oil (mineral)	510	Tonnes of Oil	6.41	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	3	Incl. replacement rate (100%)

Category	Mass in tonnes	Waste type	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				Reporting: Conversion Factors, 2024[5]		
Cabling - Copper	736	tonnes	0.98	Inventory of Carbon and Energy (ICE) Version 4[4]	1	Estimated by the Applicant's construction team.
Wood (deer fence poles)	954	tonnes	6.41	Inventory of Carbon and Energy (ICE) Version 4[4]	6	All fence timber, incl. 100% replacement rate.
Worker waste	100	Tonnes	497	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	50	Assumes 0.5 kg of waste per day per worker. 400 works, 500 days. Assumes a household waste emissions factor.
Total water consumption	18,000	m^3	0.186	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	3	90 L of water per worker per day. 400 workers for 500 days.
PV Modules	64,443	Tonnes	6.41	Department for Business, Energy & Industrial Strategy, Greenhouse Gas	413	Figure as in production emissions + 10% to account for module replacement over lifetime in line with replacement rate

Category	Mass in tonnes	Waste type	Emissions factor kg CO_2e per unit	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				Reporting: Conversion Factors, 2024[5]		expectations. Assumes all panels will be recycled.
Cable sand (cement-bound)	9,457	tonnes	0.985	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	9	Figures as in production emissions.
Total					**1,105**	

Table A15.1.23 – Decommissioning Waste Transport

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Concrete	10,088	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	121	Estimated by the Applicant's construction team.

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Aggregate	16,089	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	193	Estimated by the Applicant's construction team.
Asphalt (Tarmac Track)	4,321	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	52	Estimated by the Applicant's construction team.
Steel	54,723	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	2,627	Estimated by the Applicant's construction team.

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Aluminium	25,872	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,242	Estimated by the Applicant's construction team.
Plastic	466	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	22.4	Estimated by the Applicant's construction team.
Batteries	19,109	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	917	Estimated by the Applicant's construction team.

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Miscellaneous other (WEEE)	0	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	0	Estimated by the Applicant's construction team.
Transformers - oil (mineral)	510	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	24	Estimated by the Applicant's construction team.
Cabling - Copper	736	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024	35	Estimated by the Applicant's construction team.

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Wood (deer fence poles)	954	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	11	Estimated by the Applicant's construction team.
Worker Waste	100	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1	Sum of tonnes, multiplied by 50 km multiplied by emissions factor.
Water Consumption	18,000	50	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	216	Sum of tonnes, multiplied by 50 km multiplied by emissions factor.
PV Modules	64,443	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting:	3,093	Figure as in production emissions + 10% to account for module replacements over lifetime in line with

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
				Conversion Factors, 2024[5]		replacement rate expectations.
PV Inverters	9,000	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2025	432	Figure as in Production Emissions + 150% replacements
BESS Inverters	6,600	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2025	317	Figure as in Production Emissions + 150% replacements
Geotextile - polypropylene	57	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2025	3	Figures as in Production Emissions.

Category	Mass in tonnes	Distance (km)	Emissions factor kg CO_2e per tonne.km	Emissions factor data source	Emissions (tCO_2e)	Assumptions
Cable sand (cement-bound)	9456.728	200	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2025	454	Figures as in Production Emissions.
Total					**9,761**	

Table A15.1.24 – Decommissioning: Other

Decommissioning Other	Activity data	Units	Emissions factor kg CO2e per unit	Emissions factor data source	Emissions (tCO2e)	Assumptions
Worker commuting (total car journeys)	8,000,000	km	0.16691	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,335	Assuming 400 workers, average of 1.5 workers per car, average of 60 km roundtrip distance per day and 500 total days of decommissioning.

Decommissioning Other	Activity data	Units	Emissions factor kg CO2e per unit	Emissions factor data source	Emissions (tCO2e)	Assumptions
Total fuel consumption – Plant	520,000	Litres	2.75541	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	1,433	Plant and machinery are assumed to consume 5,000 litres of diesel per week across full decommissioning period of 2 years.
Total fuel consumption - generators	308,880	Litres	2.75541	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2024[5]	851	Generators are assumed to consume 16.5 litres per hour, 6 hours a day, 26 days a month. An average of 5 generators assumed to be running throughout the 2-year decommissioning period.
Temporary trackways	200	Tonnes	2.9	Benavides, Lee, & Zarè-Mehrjerdi (2020). Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene, and	580	Would be moved around the site as required (if required). Assume 2 km of trackway is needed. E.g., https://grassform.co.uk/wp-content/uploads/2025/07/Grassform-HD-Grassform-Product-Specsheet-2025.pdf 3m length, 300 kg, Polyethylene

Decommissioning Other	Activity data	Units	Emissions factor kg CO2e per unit	Emissions factor data source	Emissions (tCO2e)	Assumptions
				fossil-derived polyethylene.[16]		
Temporary trackways – transport to/from site	96,000	Tonne.km	0.24	Department for Business, Energy & Industrial Strategy, Greenhouse Gas Reporting: Conversion Factors, 2025	46	240 km round trip, twice, once to collect, once to drop off. No waste - would be re-used.
Total					**4,245**	

[16] Benavides, Lee, & Zarè-Mehrjerdi (2020). Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene, and fossil-derived polyethylene. Journal of Cleaner Production. Vol 277. Available at: Life cycle greenhouse gas emissions and energy use of polylactic acid, bio-derived polyethylene, and fossil-derived polyethylene - ScienceDirect.