Proposed Solar PV Development

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EN010139

6.4.5.1 Environmental Statement Appendix 5.1 Greenhouse Gas Assessment

Planning Act 2008

APFP Regulation 5(2)(q)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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Summary

Pas 2080 Module	Emissions source (item)	Emissions over appraisal period (tCO2e)	Assumptions and limitations
Construction Emissions			
Product Stage (A1 - A3)	Embodied Carbon - Materials	176590	See excel tabs for assumptions
Construction Stage (A4 - A5)	Transport of Materials	54110	
	Transport of Workers	556	
	Waste Disposal	128	
	Water use	4092	
	Fuel Use	1121	
	Total	**236597**	
Operation Emissions			
Use Stage (B)	Component Replacement	114024	See excel tabs for assumptions
	Transport of Materials	23594	
	Water use	Negligible	
	Energy use	Negligible	
	Land use change	37492	
	Total	**175110**	
Decommissioning Emissions			
End of Life Stage (C)	Recycling components	448	See excel tabs for assumptions
	Transport of Materials	8521	
	Fuel Use	560	50% of the emissions in construction
	Worker transport	278	
	Water use	2046	
	Total	**11854**	
	Lifetime emissions total	**423561**	

Estimated generation (GWh)		Assumptions and limitations
Energy Generation	**9402**	Estimated energy generation provided by Client. An Energy Degredation factor of 1% has been included.
Comparison of the Proposed Development against the counterfactual CCGT (CO2e/kWh)		
Combined Cycle Gas Turbine	354.0	
Proposed Development	45.0	
Proposed Development in operation	18.6	
CO2 associated with Proposed Development energy generation	423560866915	
CO2 associated with comparable energy generation of CCGT	3328346410827	
CO2 saved relative to the counterfactual CCGT	2904785543912	
tCO2 saved relative to the counterfactual CCGT	2904786	

Contextualisation	GHG Budget (tCO2e)	Proposed Development's contribution per carbon budget (tCO2e)	% emissions against relevant emissions
4th UK Carbon Budget - 2023-2027	1,950,000,000	236,597	0.0121
5th UK Carbon Budget - 2028-2032	1,725,000,000	87,555	0.0051
6th UK Carbon Budget - 2033-2037	965,000,000	99,409	0.0103

Embodied Carbon

Component or material	Activity data	Units	Emissions factor, kg CO2e per unit	Emissions factor source	Emissions (tCO2e)	Assumptions
Battery storage (BESS)	720	MWh (Storage capacity)	89000	Forbes (2020). Estimating the carbon footprint of utility-scale battery storage.	64080	Based on 180MW for 4 hours
PV Panels	88390	kWp	1202	Confidential Pvsyst Simulation Report for the Proposed Development provided by the client	106237	Jinkosolar - Model, JKM570N-72HL4-BDV Based on PV Modules numbers agreed with client
Supports	1550700	kg	3.13	Confidential Pvsyst Simulation Report for the Proposed Development provided by the client	4854	Supporting Equipment includes inverters and transformers based on PV cell numbers contained within Confidential Pvsyst Simulation Report for the Proposed Development provided by the client
Storage containers	113	m3	1.550	Inventory of Carbon and Energy (ICE) Version 3	176	53 containers and 9 for maintenance. General Steel, 25mm thickness
Concrete pad and foundations	105	m3	0.103	Inventory of Carbon and Energy (ICE) Version 3	11	General concrete
Steel containers	81	m3	1.550	Inventory of Carbon and Energy (ICE) Version 3	126	44 containers. General Steel, 25mm thickness
Substation	15	m3	1.550	Inventory of Carbon and Energy (ICE) Version 3	24	General Steel, 25mm thickness
Fencing and gates (wire mesh fence)	42734	km	0.00382	Inventory of Carbon and Energy (ICE) Version 3	163	Steel/wire/chain fence (including posts)
Access tracks (type 1)	118457	m3	0.007	Inventory of Carbon and Energy (ICE) Version 3	829	Fill, aggregate and sand - General mixture
Underground Cables				Wilmott Dixon (2022) Whole life carbon of photovoltaic installations: Technical Report		31km of cables, 9.1 kg per m
Copper	59	Tonnes	271	Circular Ecology (2019). Inventory of Carbon and Energy.	16.0	18.3% copper wire, 2.6% copper, tin 0.3%,
Tin	1	Tonnes	1447	Circular Ecology (2019). Inventory of Carbon and Energy.	1.2	2.6% polyethylene, 3.4% polypropylene,
Polyethylene	7	Tonnes	254	Circular Ecology (2019). Inventory of Carbon and Energy.	1.9	72.8% 'other plastics'
Polypropylene	10	Tonnes	449	Circular Ecology (2019). Inventory of Carbon and Energy.	4.3	
Other plastics	205	Tonnes	331	Circular Ecology (2019). Inventory of Carbon and Energy.	68.0	
Total					**176590**	

Transport of materials					
Component or material and mode of transport	Mass in tonnes	Distance in km	Emissions factor, kg CO2e per tonne.km	Emissions (tCO2e)	Assumptions
Battery storage Sea	3600.0	19377	0.13	9068.4	Shipped from China to Stockton-on-Tees
Battery storage HGV	3600.0	25	0.24	21.6	HGV from Stockton-on-Tees Port
PV Panels Sea	16179.3	19377	0.13	40755.7	Shipped from China to Stockton-on-Tees
PV Panels HGV	16179.3	25	0.24	97.1	HGV from Stockton-on-Tees Port
Supports Sea	1550.7	19377	0.13	3906.2	Shipped from China to Stockton-on-Tees
Supports HGV	1550.7	25	0.24	9.3	HGV from Stockton-on-Tees Port
Steel HGV	210.0	50	0.24	2.5	Locally sourced within 50km
Concrete HGV	5871.7	50	0.24	70.5	Locally sourced within 50km
Aggregate HGV	14914.1	50	0.24	179.0	Locally sourced within 50km
			Total	**54110.3**	

Waste Disposal					
Component or material	**Activity data**	**Units**	**Emissions factor, kg CO2e per unit**	**Emissions (tCO2e)**	**Assumptions**
Waste Material					
Concrete; landfill	146.79	Tonnes	1.239	0.18188	5% of total concrete wasted
Concrete; recycled	146.79	Tonnes	0.9891	0.14519	Concrete it has been assumed that 50% goes to landfill and 50% will be recycled
Aggregate; landfill	372.9	Tonnes	1.239	0.46196	5% of total aggregate wasted
Aggregate; recycled	372.9	Tonnes	0.09891	0.03688	Aggregate, it has been assumed that 50% goes to landfill and 50% will be recycled
Steel; recycled	18.3	Tonnes	0.09891	0.00181	2.5% of total steel wasted
Aluminum; recycled	25.2	Tonnes	0.09891	0.00250	2.5% of total aluminium wasted
Plastic; landfill	1.4	Tonnes	8.902	0.01237	2.5% of total plastics wasted
Plastic; recycled	3.6	Tonnes	21.294	0.07666	Plastics 75%:25% recycling to landfill
Waste transport					
Waste transport	7981.7	Tonnes			Assume licensed landfill site within 100 km radius. 10 tonne per trip
Waste transport (laden)	79816.9	HGV km	0.89061	71.09	
Waste transport (unladen)	79816.9	HGV km	0.703	56.11	
			Total	**128.1**	

Other Construction Activities					
Category	**Activity data**	**Units**	**Emissions factor kg CO2e per unit**	**Emissions (tCO2e)**	**Assumptions**
Worker commuting (total car journeys)	3240000	km	0.17148	555.6	Assume each worker lives within 30km of the site
Total fuel consumption – Plant	360000	Litres	2.75857	993.1	Plant and machinery are assumed to consume 5,000 litres of diesel per week
Total fuel consumption - generators	46332	Litres	2.75857	127.8	Generators are assumed to consume 16.5 litres per hour, 6 hours a day, 26 days a month
Total water consumption	9720000	m3	0.421	4092.1	90L of water per worker per day
			Total	**1120.9**	

Land use	Baseline habitat	Habitat lost in development	Habitat created post development
	169480	145172	107680

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 CO2 if released (tCO2e)	Reference
Cereal and non-cereal crops	342.97		Arable / cultivated land	120	No vegetation stocks are given – as managemer	41156.4	150906.8	Natural England Research Report
Arable field margins tussocky, Temporary grass and clover leys, Other neutra	30.76		Neutral grassland (soil depth 15cm)	60	No data	1845.6	6767.2	Natural England Research Report
Mixed scrub, bramble, blackthorn, hawthorn scrubs	4.30		Scrub - (S Alps, Italy example used as	72	60	567.6	2081.2	Natural England Research Report
Modified grassland	79.01		Improved Grassland	19.5	No vegetation stocks are given – as management (grazing and cutting) removes biomass annually	1540.7	5649.2	Natural England Research Report
Wet woodland, Lowland mixed deciduous, other broadleaved woodland	5.66		30 year mixed broadleaved native wo	55	114	956.5	3507.3	Natural England Research Report
	Length (m)	Conversion to ha						
Native species-rich intact hedge	1861.15	0.56	Minimal/ UnmanagedHedgerows	98.70	45.80	80.7	295.8	Natural England Research Report
Scattered trees – line	1463.21	0.44	30 year mixed broadleaved native wo	55.00	114.00	74.2	272.0	Natural England Research Report

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 CO2 if released (tCO2e)	Reference
Arable / cultivated land	311.46		Arable / cultivated land	120	No vegetation stocks are given – as management (grazing and cutting) removes biomass annually	37375.2	137042	Natural England Research Report
Neutral grassland	16.27		Neutral grassland (soil depth 15cm)	60	No data	976.2	3579	Natural England Research Report
Scrub	0.03		Scrub - (S Alps, Italy example used as	72	60	3.96	15	Natural England Research Report
Improved Grassland	63.09		Improved Grassland	19.5	No vegetation stocks are given – as management (grazing and cutting) removes biomass annually	1230.3	4511	Natural England Research Report
30 year mixed broadleaved native woodland (to 15cm soil depth)	0.00		30 year mixed broadleaved native wo	55	114	0	0	Natural England Research Report
	Length (m)	Conversion to ha						
Native species-rich intact hedge	130.00	0.04	Minimal/ UnmanagedHedgerows	98.70	45.80	5.6	20.7	Natural England Research Report
Scattered trees – line	20.00	0.01	30 year mixed broadleaved native wo	55.00	114.00	1.0	3.7	Natural England Research Report

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 CO2 if released (tCO2e)	Reference
Arable / cultivated land	75.41		Arable / cultivated land	120	No vegetation stocks are given – as management (grazing and cutting) removes biomass annually	9049.2	33180	Natural England Research Report
Neutral grassland	302.29		Neutral grassland (soil depth 15cm)	60	No data	18137.4	66504	Natural England Research Report
Scrub	0.34		Scrub - (S Alps, Italy example used as	72	60	44.88	165	Natural England Research Report
Improved Grassland	63.09		Improved Grassland	19.5	No vegetation stocks are given – as management (grazing and cutting) removes biomass annually	1230.3	4511	Natural England Research Report
30 year mixed broadleaved native woodland (to 15cm soil depth)	1.87		30 year mixed broadleaved native wo	55	114	316.0	1159	Natural England Research Report
Traditional Orchards	0.85		Traditional Orchards	73.75	21.4	80.9	297	Natural England Research Report
	Length (m)	Conversion to ha						
Native species-rich intact hedge	11730	3.52	Minimal/ Unmanaged Hedgerows	98.70	45.80	508.5	1864.5	Natural England Research Report

Component Replacement				
Item	**Design life replacement rate**	**Original embodied emissions (tCO2e)**	**Replacement embodied emssions (tCO2e)**	**Assumptions**
PV Panels	10%	106237	10624	
Supporting equipment	150%	4854	7281	All the supporting equipment is assumed to require replacement once, with a further 50% requiring replacement twice, during the design life.
BESS Cells	150%	64080	96120	All BESS cells are assumed to require replacement once, with a further 50% requiring replacement twice, during the design life.
Total			**114024**	
Item	**Design life replacement rate**	**Original transport emissions (tCO2e)**	**Replacement transport emissions (tCO2e)**	**Assumptions**
PV Panels	10%	40853	4085	
Supporting equipment	150%	3915.5	5873	
BESS Cells	150%	9090.0	13635	
		Total	**23594**	

Decommissioning				
Category	**Mass in tonnes**	**Waste type**	**Emissions factor kg CO2e per unit**	**Emissions (tCO2e)**
Concrete; recycled	5872	Construction– concrete	0.989	5.8
Aggregate; recycled	14914	Construction - aggregate	0.989	14.7
Steel; recycled	1760	Construction – metals	0.989	1.7
Plastic; recycled	222	Plastic	21.294	4.7
Batteries; recycled	3600	Electrical items – batteries	21.294	76.7
Miscellaneous other (WEEE); recycled	16179	Electrical items – WEEE mixed	21.294	344.5
			Total	**448.2**

Category	**Mass in tonnes**	**Distance (km)**	**Emissions factor kg CO2e per unit (laden)**	**Emissions factor kg CO2e per unit (unladen)**	**Emissions (tCO2e)**
Concrete; recycled	5872	50	0.89061	0.703	467.9
Aggregate; recycled	14914	50	0.89061	0.703	1188.4
Steel; recycled	1760	200	0.89061	0.703	561.0
Plastic; recycled	0	200	0.89061	0.703	0.0
Batteries; recycled	3600	200	0.89061	0.703	1147.4
Miscellaneous other (WEEE); recycled	16179	200	0.89061	0.703	5156.7
				Total	**8521.3**