Designer Embodied Carbon (EC) Calculation - Civil & Electrical

Build Table Most Contributing Materials 1%>. Embodied Carbon A1-5

Project Name:	**Embleton Primary Substation 11kV Switchgear Replacement.**
Project Scope:	**11kV Switchgear Replacement using HSS Eclipse Switchgear. In Situ replacement using top entry power cables to reduce civil design and embodied carbon.**

Project Embodied Carbon Breakdown and Totals t(Co2e):	
Total A1-5w	53.31
A5a	1.31
Total A1-5 t(CO2e)	**54.62**

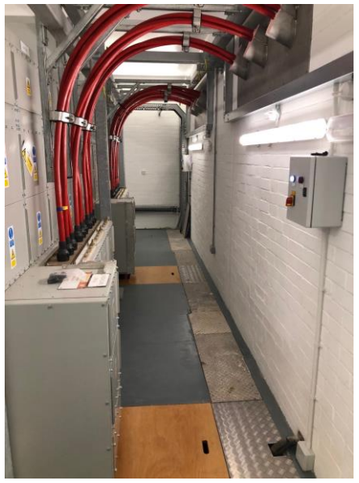
Note: Total A1-5t(CO2e): Total A1-5w + A5a = Ans

Calculation Date:	**18/09/2024**
Project Code:	**50011856**
Project Completed in Financial Year:	**FY24**
Estimated Cost of Civil Build(£): (To Estimate A5a)	£187,302.00

Structural timber: in Tonnes, (To Calculate Sequstration Value)	0
Sequestration Value t(CO2e):	0

Design Values													
Embodied Carbon t(CO2e)					ECF kg(CO2e/kg)			Embodied Carbon t(CO2e)				Total EC t(CO2e)	Notes/ Comments
Stage of works	Material	Units values to input in conversion to tonnes cell	Conversion to Tonnes	Quantity(t)	A1-3	A4	A5w	A1-3	A4	A5w	A1-5w	A1-5w	
Foundation Excavation & Backfill	**Soil assumed 5% cement content.** 1m3 = 1.9 tonnes of clay soil. Ref:	**input value in m3** (in 'conversion to tonnes' cell)	0	0	0.061	0.005	0.004452	0	0	0	0	**Foundation Excavation & Backfill** 0	
Foundation	Asphalt, 8% (Bitumen) binder content (by mass) weight @ 2323kg / m3	**input value in m3** (in 'conversion to tonnes' cell)	0	0	0.086	0.005	0.005777	0	0	0	0	0	
	PVC Pipes (Waste water) weight @ 0.72kg / m	**input value in meters** (in 'conversion to tonnes' cell)	0	0	3.23	0.005	0.172409	0	0	0	0	**Foundation** 0	
	Concrete Kerb 26.74 linear meters per m3	**input value in m3** (in 'conversion to tonnes' cell)	0	0	0.188	0.005	0.00211	0	0	0	0	0	
	Limestone Aggregate. 2650kg/m3	**input value in m3** (in 'conversion to tonnes' cell)	29.06	77.009	0.005	0.005	0.001484	0.385	0.385	0.1143	0.884371356	0.884371356	
Reinforced Concrete	**Ready mix concrete 32/40**. 2350kg / m3	**input value in m3** (in 'conversion to tonnes' cell)	48.05	112.9175	0.132	0.005	0.008215	14.905	0.5646	0.9276	16.39731476	16.39731476	
	Rebar (New) weight @ H10 = 0.62kg / m	**input value in kg** (in 'conversion to tonnes' cell)	4200	4.2	2.77	0.032	0.14946	11.634	0.1344	0.6277	12.396132	12.396132	
	Rebar (New) weight @ H12 = 0.89kg / m	**input value in kg** (in 'conversion to tonnes' cell)	0	0	2.77	0.032	0.14946	0	0	0	0	**Reinforced Concrete** 0	
	Rebar (New) weight @ H20 = 2.47kg / m	**input value in kg** (in 'conversion to tonnes' cell)	0	0	2.77	0.032	0.14946	0	0	0	0	0	
Steelwork	Stainless Steel Windposts Grade 304 weight @ 37.5kg / m	**input value in meters** (in 'conversion to tonnes' cell)	9	0.3375	6.15	0.032	0.062	2.0756	0.0108	0.0209	2.10735	2.10735	
	Steel General (New) weight @ 7900kg / m3 (contractor weights for materials on steel is a must)	**input value in kg** (in 'conversion to tonnes' cell)	370	0.37	2.89	0.032	0.0294	1.0693	0.0118	0.0109	1.092018	**Steelwork** 1.092018	
	Mild Steel Fencing weight @ 25kg per linear meter	**input value in meters** (in 'conversion to tonnes' cell)	0	0	1.53	0.005	0.01553	0	0	0	0	0	
Superstructure	**Clay Brick** (2000kg / m3)	**input value in kg** (in 'conversion to tonnes' cell)	5400	5.4	0.24	0.005	0.06575	1.296	0.027	0.3551	1.67805	1.67805	
	Louvres RSH5700 edition / weight @ 25kg/m2 (Assumed alluminium frame)	**input value in kg** (in 'conversion to tonnes' cell)	0	0	12.79	0.032	0.1284	0	0	0	0	**Superstructure** 0	
	Mineral wool insulation, Rockwool RW3, weight at 60kg/m3	**input value in kg** (in 'conversion to tonnes' cell)	0	0	1.28	0.005	0.069059	0	0	0	0	0	
	Autoclaved Aerated Concrete Block 600kg / m3	**input value in kg** (in 'conversion to tonnes' cell)	0	0	0.375	0.005	0.0995	0	0	0	0	0	
Roof	**Timber truss** weight @ 3kg / m	**input value in kg** (in 'conversion to tonnes' cell)	0	0	0.42	0.005	0.12847	0	0	0	0	0	
	Concrete roof tiles weight @ 3kg / m2	**input value in kg** (in 'conversion to tonnes' cell)	0	0	0.1	0.005	0.00123	0	0	0	0	**Roof** 0	
	Concrete Roof Columns weight @ 355kg / m	**input value in meters** (in 'conversion to tonnes' cell)	0	0	0.188	0.005	0.00211	0	0	0	0	0	
	PVC Pipes (weight @ 0.72kg / m)	**input value in meters** (in 'conversion to tonnes' cell)	0	0	3.23	0.005	0.172409	0	0	0	0	0	
Cable Excavation & Backfill	**Soil assumed 5% cement content.** 1m3 = 1.9 tonnes of clay soil. Ref: (https://coolconversion.com/volume-mass-construction/~1~cubic-meter~of~clay-soil~to~tonne)	**input value in m3** (in 'conversion to tonnes' cell)	32.8	6.232	0.061	0.005	0.004452	0.3802	0.0312	0.0277	0.439056864	**Excavation & Backfill** 0.439056864	'assumed removal of 10% excavated material and backfill'
Cables	**Cable Ducts PVC-3 Phases** -ave weight 3.3kg / m	**input value in meters** (in 'conversion to tonnes' cell)	82	0.2706	3.23	0.005	0.172409	0.874	0.0014	0.0467	0.922044875	0.922044875	
	Single Core Cable 33kV - 3 Phases : ave weight @ 15.6kg/m	**input value in meters** (in 'conversion to tonnes' cell)	0	0	3.81	0.16	0.211364	0	0	0	0	**Cables** 0	
	Single Core Cable 6.6 / 11kV - 3 Phases : av weight @ 13.6kg/m	**input value in meters** (in 'conversion to tonnes' cell)	82	1.1152	3.81	0.032	0.0386	4.2489	0.0357	0.043	4.32764512	4.32764512	
	Muiltcore Cable : av weight @ 1.5kg/m	**input value in meters** (in 'conversion to tonnes' cell)	180	0.27	3.7	0.032	0.0375	0.999	0.0086	0.0101	1.017765	1.017765	
Transformers	**Transformer 33kV**	**input value in Tonnes** (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	0	Unit manufacturers ECF values are available the ECF value for New Copper is used for Power Cables. Multicore cables are assumed to be 80% copper, 20% PVC by weight.
	Transformer 132kV	**input value in Tonnes** (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	**Transformers** 0	
	Transformer EAT	**input value in Tonnes** (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	0	
Switchgear	**6.6/11kV Switchgear:** ave weight 600kg	**input value in Tonnes** (in 'conversion to tonnes' cell)	9	3.105	3.5429	0.032	0.0359288	11.001	0.0994	0.1116	11.21155101	11.21155101	Eclipse Panel Weights Used. ECF based on manufacturer information for similar switchgear.
	Protection Panels: ave weight 260kg	**input value in Tonnes** (in 'conversion to tonnes' cell)	1	0.26	3.03	0.16	0.03208	0.7878	0.0416	0.0083	0.8377408	0.8377408	
		input value in Tonnes (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	**Switchgear** 0	
		input value in Tonnes (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	0	
		input value in Tonnes (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	0	
		input value in Tonnes (in 'conversion to tonnes' cell)	0	0		0.16	0.00178	0	0	0	0	0	

Project Photographs / Drawings



Calculation Notes:	
Weight of structural Timber (Excluding temp works):	tonnes
Weight of Temporary Timber (formworks, Assumed reuse):	tonnes
Foundation -Trench Excavations	At Length[ ] m x Width[ ] m x Depth[ ] m = [ ] m3
Cables - Trench Excavations	At Length[**82**] m x Width[**0.4**] m x Depth[**1**] m = [**32.8**] m3
Power Cable circuit lengths	[**8.2**] m lengths x No. of lengths [10]

Important note:	**All materials calculated in above sheet, includes only imported materials**

Key:	
A1-3	Caculation are based on **Embodied Carbon Factors (ECF)** to **Extract & Manufacture** the material Calculated as: **Tonnes x ECF kg(CO2e/kg) = Embodied Carbon t(CO2e). Sourced IstructE**
A4	Calculation based on **kg of CO2e produced** by Distance travelled in **km**, ECF based on: **Tonnes x ECF kg(CO2e/kg) = Embodied Carbon t(CO2e)**. Distances referenced from **ISstructE: Locally sourced within 50km = 0.005kg(CO2e) / Nationally Sourced within 320km = 0.32kg(COe) / European sourced within 1500km = 0.16kg(CO2e): Sourced IstructE**
ASw	Calculation based on the **Waste Factor (WF) of Materials.** So **brick** has a **waste factor of 20%, Steel 1%** etc. ... Material **WF=(Material ECF x Distance Travelled x Distance travelled forwaste material taken to lanfill (C2) x C02 used for processing disposal (C3-4) = A5w /** Example, assumed waste of concrete is : **0.053 x (A1-3 x x A4 x C2 x C3-4) = A5w : Sourced IStructE**
5a	Typical assumed **costat stage A1-5 of build is 50% so: 700kg(CO2e) per £100,000** so: **0.7 x (cost of build ÷ 100,000)= Ans t(CO2e)**: **Soruced IstructE**

Key:		**Designer to fill in all cells highlighted in light grey**	**Reference note:**	**Calculations & Embodied Carbon factors for materials used in the tableare sourced from the Brisa (ICE) & IstructE**
		The 'Embodied Carbon t(CO2e)' cells are using a traffic light system to indicate, low- high contributing materials. Below this cell in an example of how the colour format works and what they indicate.		
Low		**Medium**	**High**	**Ref for material Embodied Carbon Factors:**	**A BSRIA guide: Hammond.G etal., 'Embodied Carbon'., The inventory of Carbon and Energy., (ICE).**
0	12.5	25	37.5	50	Embodied Carbon - The Inventory of Carbon and Energy (ICE) (greenbuildingencyclopaedia.uk)
				Ref for calculating Embodied Carbon A1-5& Cell colour formatting:	**The Institution of Structural Engineers 'How to calculate embodied carbon'.**
The **notes table** to the left can be used to help **breakdown** and **review calculations**. The **structural timber** values in **tonnes** can be used to **calculate** the **sequestration value**, this is used to calculate the **amount** of **carbon storage throughout the builds life cycle** **Example: 20 tonnes of structural timer x -1.64 kg(CO2e) = -32.8t(CO2e).** For more information see notes calculation A1-5 on the tab below.					A brief guide to calculating embodied carbon (istructe.org)