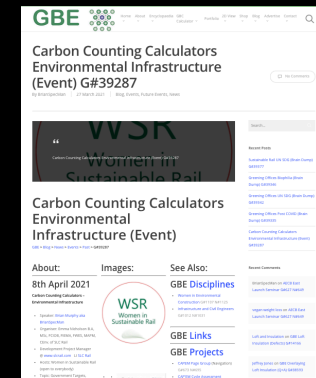


Carbon Counting Calculators

Environmental Infrastructure
CEEQUAL, PAS 2080, ICE V3 & GBC
Infrastructure Bespoke Module

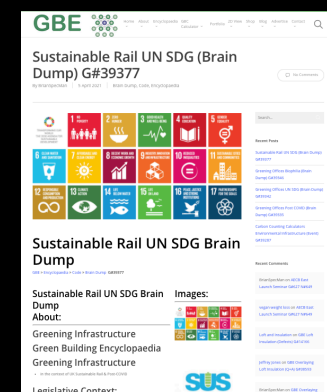
This Presentation on GBE:

- Find this file on GBE website at:
 - <https://GreenBuildingEncyclopaedia.uk/?P=39287>
- GBC CPD
 - <https://GreenBuildingEncyclopaedia.uk/?P=39145>
- Intrapenny Intrapound Sustainable Infrastructure
 - <https://GreenBuildingEncyclopaedia.uk/?P=398>
- UN SDG For Railways
 - <https://GreenBuildingEncyclopaedia.uk/?P=39377>
- Go there for:
 - the latest update
 - versions presented to different audiences
 - the whole presentation all of the hidden slides
 - other file formats:
 - Handout, Show, PDF, Go to GBE Shop for PPTX
 - Links to other related GBE CPD and related GBE content



Sustainable Infrastructure

15/10/2012 Just a superficial skim above the surface, from a **greenie's** perspective of course



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Green or Violet Materials

- **Construction/Infrastructure/Rail**
 - Are energy, carbon and labour intensive
 - to create and maintain
- **Imported materials:**
 - High Carbon: Cement, Concrete, precast,
 - High Energy: Reinforcement, steel, copper, other metals
 - Carbon Sequestration: growing aggregates: C8S
 - Biogenic Carbon Sequestration: timber, bio-based materials
 - Revert to timber sleepers: durable Hardwood not treated softwood
 - Fossil Carbon: Asphalt, bitumen (Some fossil carbon)
 - Fossil Carbon: Plastics, hydro-carbons, petro-chemicals
 - High Energy & Emissions: Rail joining chemistry
- **Heavy haulage and emissions: concrete, aggregates, soil, steel, green waste:**
 - via rail v road?
- **Labour Miles: rail v trucks v trucks on rails**

Material choices

- In particular **OPC cement** replacement in concrete (after water, concrete is the most used material)
 - GGBS or PFA: low carbon, Slower set
 - **OPC** & GGBS or PFA blended cements: normal setting forced on by **OPC**
- Risks of **product or material surreptitious substitution** raising the carbon count
- Robust specifications control substitution,
 - Policing the specification is essential
 - Be Proactive about it
 - Get it right first time

Energy and Carbon in Rail

- Energy In use:
 - Energy Efficiency in production
 - Steam generators: lost opportunity? revert to steam trains!
 - Dispersed production: Local to Rail lines, along rail lines: PVs (EU examples)
 - Energy Efficiency in distribution: HV overhead or buried cable 11,000V radiation losses
 - Energy Efficiency in consumption
 - Catenaries? Bottom Rails? 11,000V radiation losses
- Embodied Energy
 - Copper & catenaries, electrical power and communications cables,
 - Steel: rails, signalling cables, steel tube piling
 - Galvanized steel Catenary supports,
- Embodied Carbon
 - Cement, Concrete
 - Fossil carbon: Plastics, Hydro carbons, natural Asphalt, natural Bitumen,
- Sequestered Carbon
 - Biogenic carbon calculations: few opportunities in rail? Acoustic fences in roads
 - Not Fossil carbon
 - Growing aggregates (rounded: not ideal for concrete or rail support)

What New Rail Infrastructure?

- Signaling: Great Western Rail: (done)
- Goods Yards, Train parking Yards
- Logistics Yards: Container handling, Rail to Rail, Road to Rail to Road
- Passenger routes: Increasing capacity
 - Jubilee Line (done)
 - CTRL Channel Tunnel Rail Link to London St Pancras (done)
 - Cambs Pboro Bedford St Albans > St Pancras > South Coast (done)
 - HS2 London to North (over budget and open purse) via SSSIs and AFs
 - Cross rail: Queen Elizabeth Line (later still and bankrupt contracts?)
 - Cross rail 2?
- Stations: more platforms, more lines, ease train congestion?
 - Birmingham, London Bridge, Reading, Cambridge, Peterborough

What New Road Infrastructure?

- Consolidation centres & pallet services
 - Forced by Lorry driver Working Practices Directive
 - 12,000 lorry drivers too few overnight
 - Brexit: (Temporary?) Lorry parks
 - replacing M2 to Dover parking lanes
- Potholes repairs
- Central reservation barrier improvements (finished)
- Bridge/Flyover load capacity improvements (finished EU wide)
- Digital Technology cable laying (G5)
- Digital mapping below ground services (Ongoing)
- Road improvements? (local to GBE)
 - A604 > A14 (M1/M6 to A1) dual carriageway and lorry laybys
 - A1 > A1M Huntingdon A14 to Peterborough A1
 - A1 to M1 Bedford Bypass
 - A1 upgrades by-passing roundabouts
 - A14: A1 to M11 increase capacity (opened 1 year early)

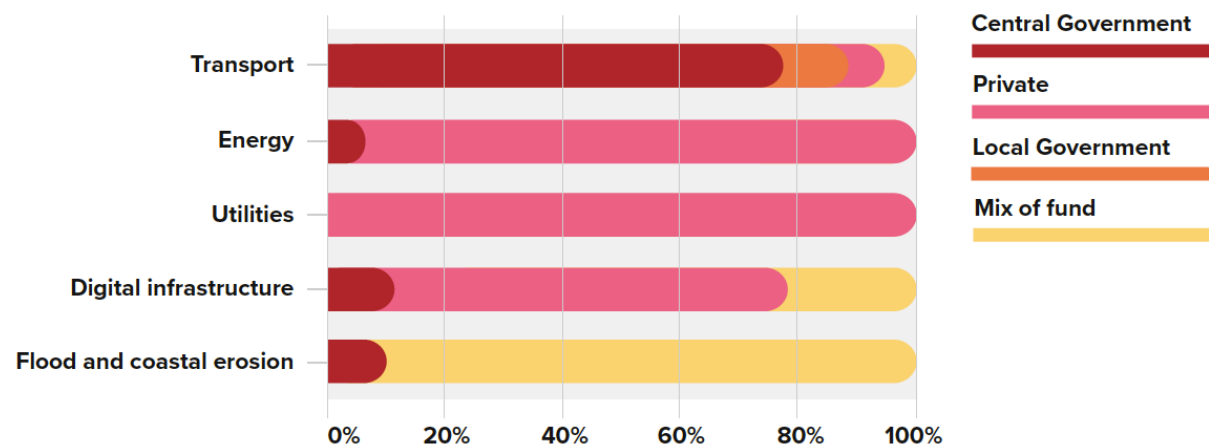
Green Infrastructure?

- **Green Grids**
 - Green Spaces and linking corridors
- **Blue ribbons**
 - Water bodies, SuDS, rivers, canals, dykes,
- **Often associated with Grey (Road and Rail) Infrastructure modifications**
- **Critically important especially with COVID**
 - Socially and mentally important places
 - Support Biodiversity recovery

Who is commissioning/Funding Infrastructure/rail?

- Government <80% Rail
 - Network Rail?
- Local Government 10% Rail
- Private: >5% Goods Yards
- Private: 95% Energy: Wind and PV (+Gov. FIT? RHI?)

Funding mix of UK investment between 2018/19 and 2020/21 by sector



Source: 2018 National Infrastructure and Construction Pipeline

Who designs and specifies?

- **Stations and other buildings:**
 - **Starchitects to get planning**
 - **NF: How heavy are your buildings**
 - (ignoring his foundations) (ignoring lightweight buildings overheat > A/C)
 - Asked to leave Architects Declare to carry on designing holiday airports
 - **BA: In use impacts, for some decades**
 - promoted BRE GGTS before it was scrutinized and found wanting
 - **Passivhaus Designers: In use impacts not embodied**
 - Embodied Plug in developed and available now
 - **ACAN: Championing Embodied Carbon and Use of timber against fire**
 - **LETI: Championing Energy in use and Embodied Carbon**
 - **Greenies: WLC Embodied and In Use, as always**
- **Routes:**
 - Civil Engineers
 - Rail Engineers
 - Bridge Engineers
 - Tunnel Engineers
 - Water & Utilities Engineers
 - Landscape Architects
 - Ecologists
 - Archeologists

Sustainable Infrastructure?

- **Contracts?**
 - PFI or PPP (Do they still do them?) Focus on money, **lax on spec**
 - Superseded by better systems in Scotland
- **Carbon targets: Implementation by:**
 - **Development Control?**
 - Planning? Land owners?
 - Building Control? Pending BRADZ
 - **Railways England?**
 - National Rail Design Standards
 - National Rail Specification?
 - **Highways England**
 - DoT Standards
 - National Road Specification?
- **Guidance**
 - **Missed opportunity: No promotion just updated and reissued**
 - Example recycled content permitted, what about carbon?
 - **WRAP's Aggregain website: no longer funded so gone**
 - **Earth Exchange website: also gone**

Sustainable Engineering Specification?

- Engineer's use Specification Templates
 - New cover for each job
 - List all materials and techniques Green and Violet
 - Little or no editing to be job specific
 - Rely on drawings to specify which where
 - Permit greener options but do not require it
- Concrete Mixing Plants
 - Have two cement silos
 - OPC & GGBS
 - They save money by blending OPC and GGBS
 - Just enough GGBS so you won't notice
 - OPC drives GGBS hydration to maintain 7 & 28 day strengths
 - Colour difference: Warm grey not cold grey

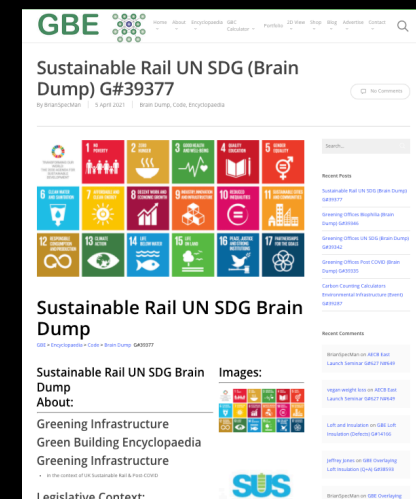
Sustainable World & UK?

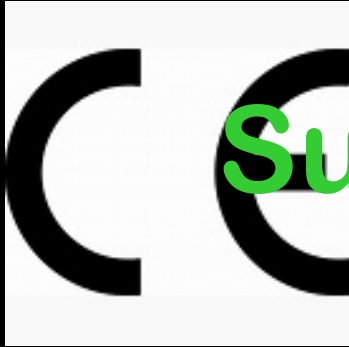
- **UN SDG United Nations 25th Sept 2015**
 - 193 world leaders committed to 17 SDGs
 - 17 Sustainable Development Goals by 2030
- **Climate and Biodiversity Emergency**
 - UK Government Signed up 1st May 2019
 - Local authorities followed suit: without any idea how and little follow up action
- **Extinction Rebellion: frustration at lack of action by all governments**
- **Greta Thunberg's behaviour change campaign**
 - Global call to Adults to join
 - Architects Declare: Oct 2019
 - Construction Declare: Oct 2019
 - Education Declare
 - Structural & Civil Engineers Declare
 - Interior Design Declare: March 2021
- **Dictatorship Boris:**
 - Hard Brexit/Border controls/Irish unrest/Riots
 - Dilute Human Rights
 - COVID Incompetence
 - Ban all Protests no matter how bad he and his projects/actions get



UK Architects
Declare Climate
and Biodiversity
Emergency

- **United Nations**
 - 25th Sept 2015
 - 193 world leaders
 - committed to 17 SDGs
 - Sustainable Development Goals by 2030
- **Green Building Encyclopaedia**
 - Sustainable Rail UN SDG (Brain Dump) G#39377
 - <https://GreenBuildingEncyclopaedia.uk/?p=39377>
- **Interreg SusStations Project**
 - Environmental Assessment Method
 - Like **BREEAM** only more Rail
 - <https://GreenBuildingEncyclopaedia.uk/?p=916>





Sustainable Government Procurement



- Water Sector: Gov. driver: TOTEX = CAPEX + OPEX (saving £ms)
 - Other Sector roll out? Nothing happening
- Government Procurement: Post-Brexit:
 - EU Procurement Rules V2: No longer
 - CE mark Essential Requirements
 - Environmental added
 - TC 350 and TC351 rolled out >
 - LCA > EN 15804 > Product Category Rules > Impacts > EPD reports
 - CE mark replaced by UKCA for goods in UK Jan. '21
 - Essential requirements still relevant: but aim at BSs not ENs
 - GPP Green Public Procurement: Still possible
 - OGC Office of Government Commerce:
 - Gateway Process Reviews:
 - More due diligence than spec?

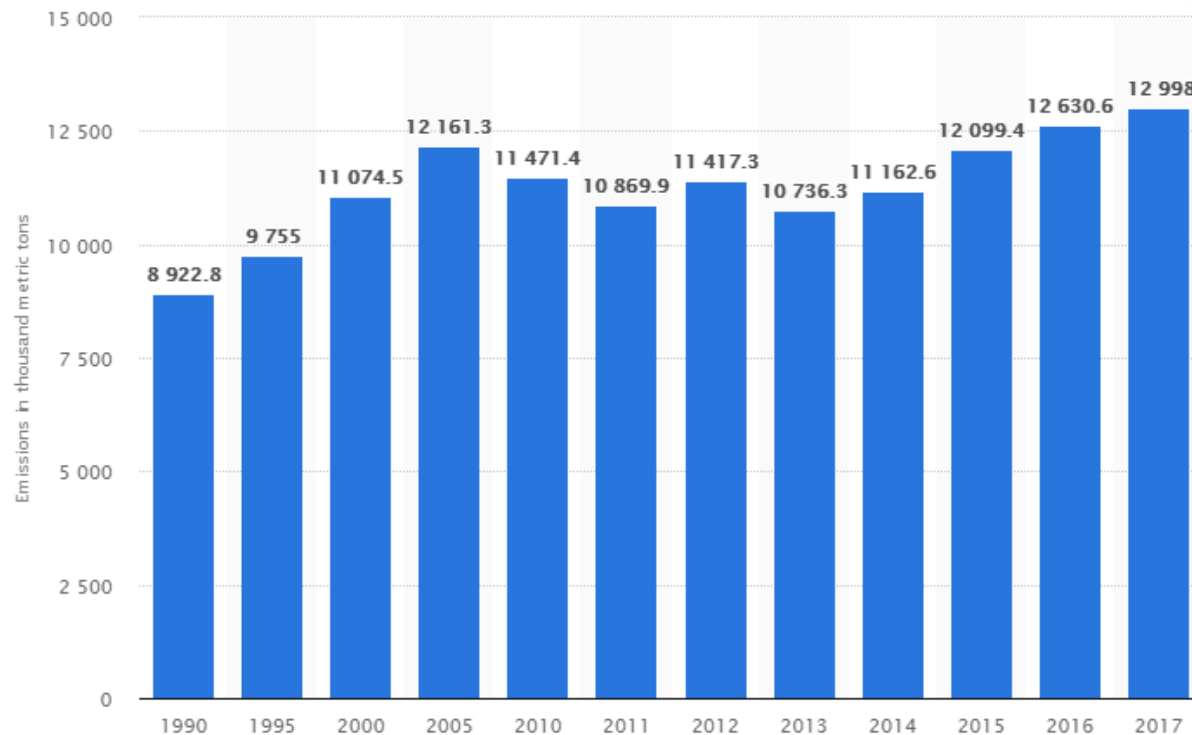
UK Government Publishes others join in

- But is anybody in the industry reading?
 - Yes: Librarian or Knowledge Manager
 - No: Everybody else is busy
- UK Government Commitment to Net Zero Carbon 2050
 - Construction 2025: July 2013
 - Committee on Climate Change: May 2019:
 - The Construction Playbook: V1 Dec. 2020
- Infrastructure
 - National Infrastructure Strategy Nov. 2020 CP 329
- Government Soft landings

UK Government Commitment to Net Zero Carbon 2050

Carbon dioxide (CO₂) emissions from the construction industry in the United Kingdom (UK) from 1990 to 2017

(in 1,000 metric tons)



Additional Information: [Report Page 10 of 10](#)

© Statista 2019

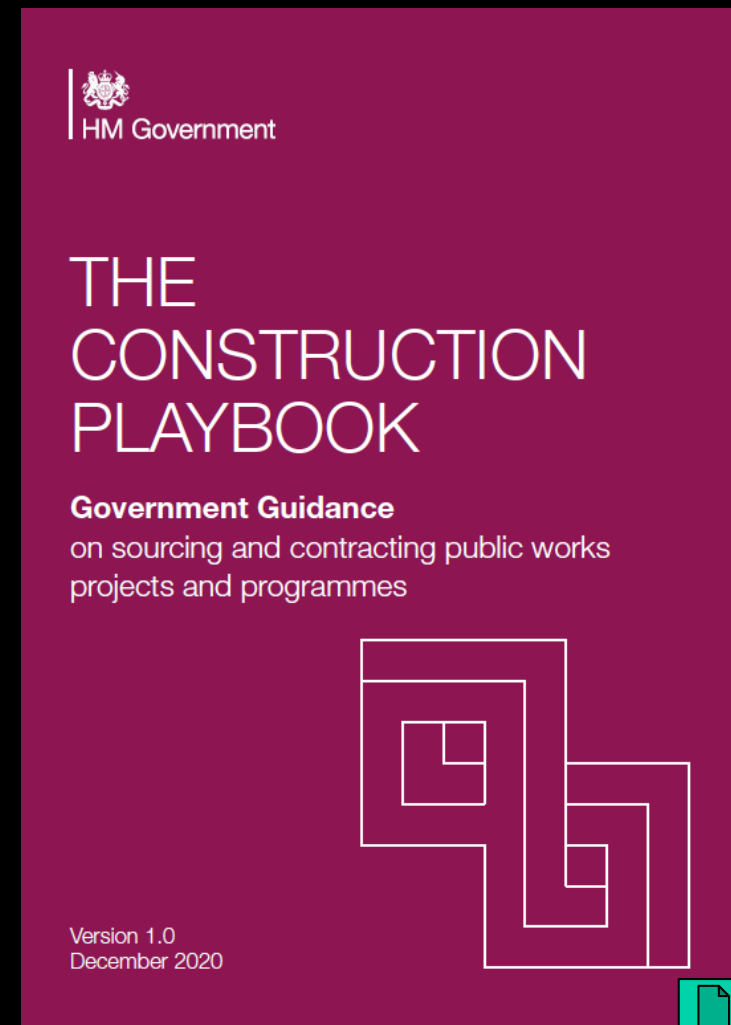
- **Industrial Strategy:
Government and Industry in
Partnership**
 - Did anybody sign up to this?
- **July 2013**
- **Discounts on top of
Constructing Excellence's**
 - 10% year on year
improvement challenge
- **The Construction industry is
already effectively bankrupt**
 - Supported by supply chain
funding MC with 90+ delay on
payments
 - And severe mental stress

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The Construction Playbook V1 Dec. 2020

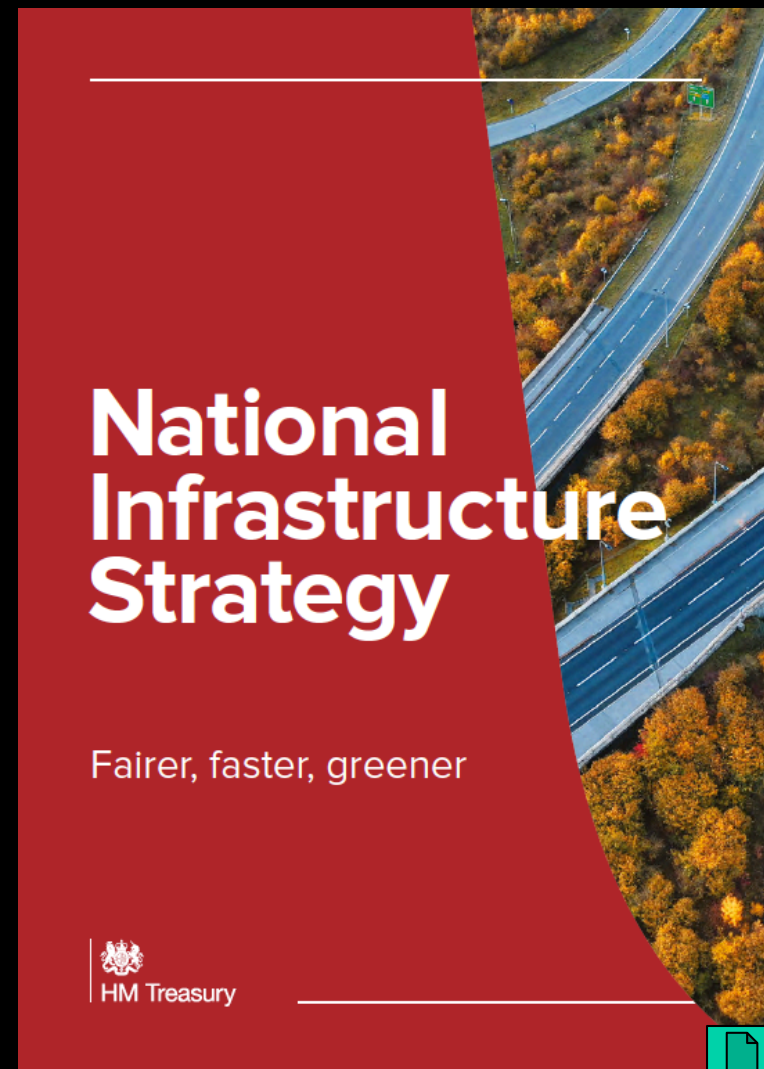
- Sourcing and contracting public works projects and programmes
- 'Build Back Greener'



Infrastructure

- National Infrastructure Strategy
Nov. 2020 CP 329
- Fairer Faster Greener
- COVID recovery
- Decarbonising & Climate Change
Adaptation
- Investment plans
- Transport
 - Tailpipe emissions
 - EVs infrastructure
 - but RE too?
- Energy
 - More renewables % in mix
- Buildings (27m homes)
 - Green homes Grant
 - Withdrawn April 2021
- Nature for Climate fund
 - 30,000 hectares of trees/year
 - To replace HS2 devastation
- 10 Point plan for Green Industrial Revolution

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London Plan Whole Life-Cycle Carbon Assessment

- ADD2363 August 2019
- Operational emissions
- E.g. Heating, Hot water
- Embodied are not currently measured
- LETI London Energy Transformation Initiative (Campaign for better)
 - Energy & Carbon in use and embodied
 - Public consultation on Future Buildings Standard this week (April 2021)

Environment Sectors Prepares

- **LCA Life Cycle Assessment & EPD Environmental Product Declarations**
 - Method: Normalising to EN 15804:2012, over last decade +AMD A1 2013 +AMD A2
 - Sequestered Carbon Method, outside of EN 15804 boundaries
 - Biogenic carbon, EN 16449:2014
 - Manufacturers: 9000 EPDs in market plenty are in construction materials
- **LCA is a broader set of impacts, but we must focus on:**
 - Embodied carbon, \approx CAPEX
 - Sequestered Carbon, Biogenic carbon, Timber and Bio-based materials
 - EN 16449:2014 (we might not be in EU but standards are private enterprise in UK)
 - In use carbon, \approx OPEX
- **PEF Product Environmental Footprinting (Future development)**
- **PAS 2080:2016 Whole Life carbon Assessment**
- **RICS Carbon Calculation methodology Ed. 1 Nov. 2017**
- **ICE Inventory of Carbon & Energy V3 Nov. 2019**

EN 15804 LCA > EPD Dataset

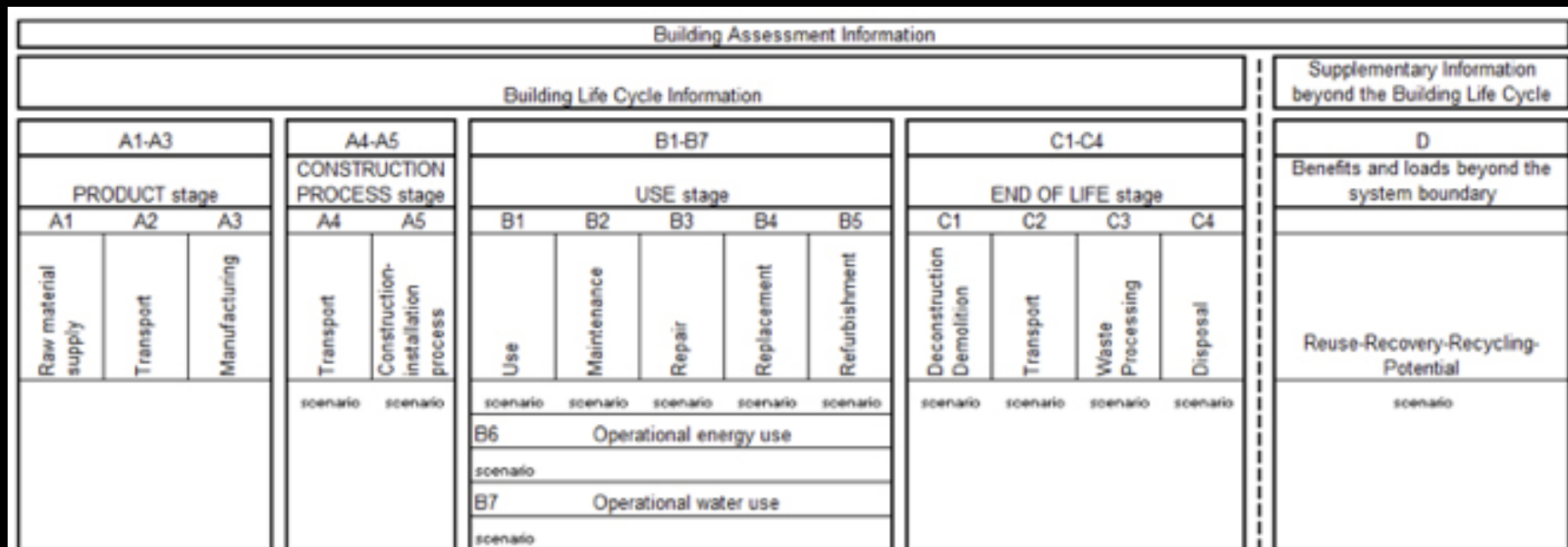


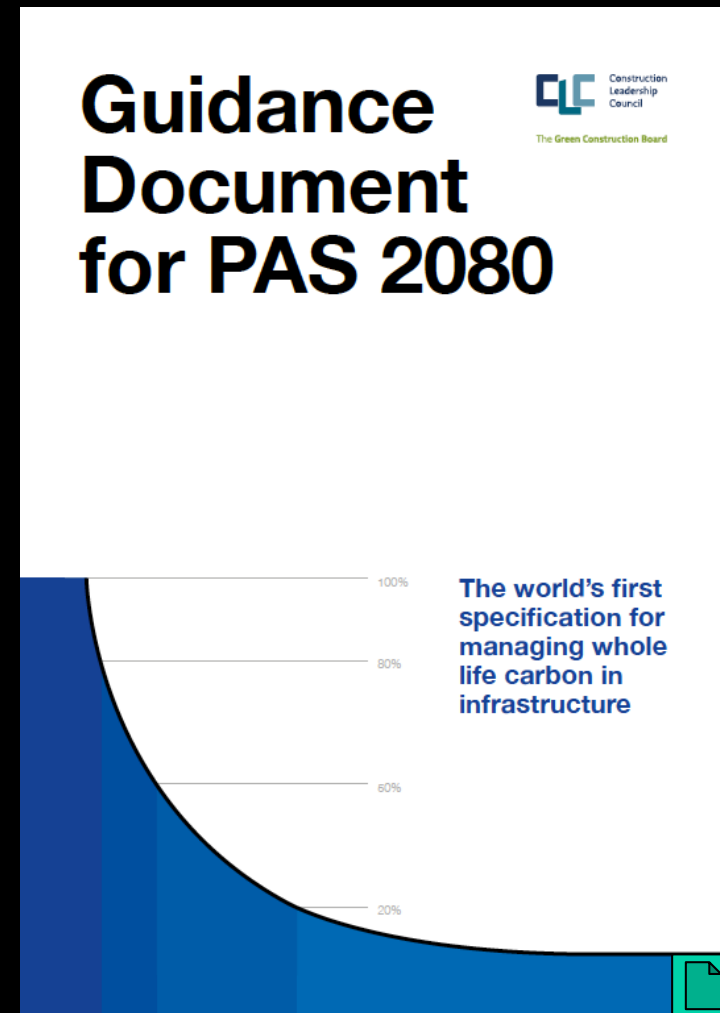
Figure 1: Life cycle stages and modules used in CEN/TC 350 standards such as EN 15804

Whole Building Life Cycle Analysis									
Component Details									
1 Basement Floor (BF)									
2 Basement Perimeter Retaining Walls (BPRW)									
3 Basement External Wall (BEW)									

PAS 2080

- **BSI**
 - Publically Available Specification
 - PAS 2080:2016 Whole Life carbon Assessment
- **The Green Construction Board**
 - Guidance Document for PAS 2080
 - Managing Whole Life Carbon in Infrastructure
 - Roles and Responsibilities
 - Process
 - Introduction to LCA
 - Case Studies
 - Carbon Measurement Tools
 - Rules for Calculations
 - Sample datasets from many sources

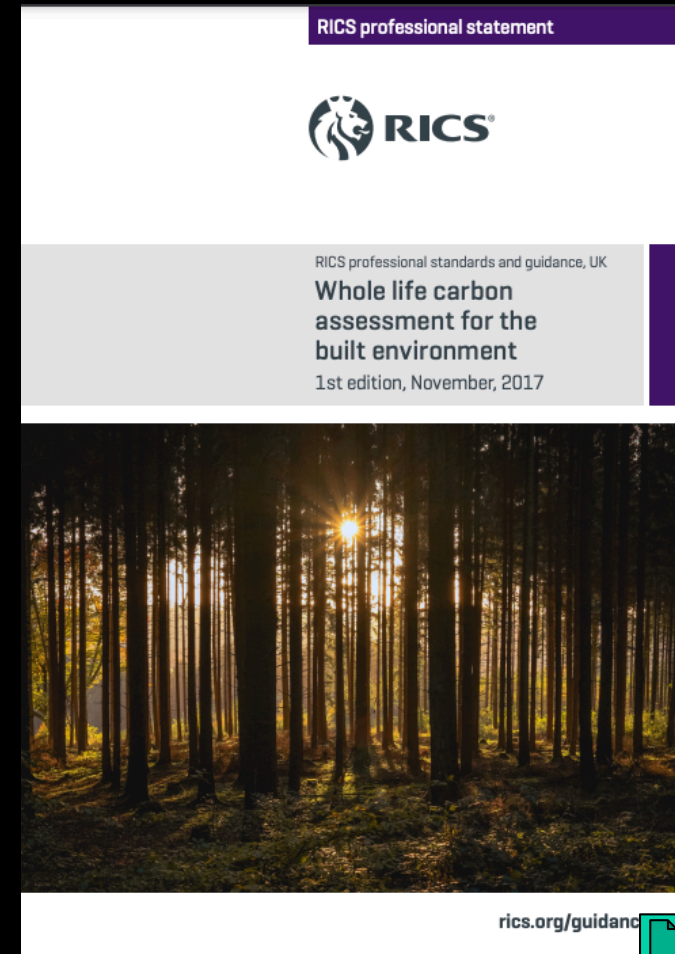
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RICS Whole Life Carbon

- RICS
- Whole Life Carbon Assessment for the built Environment
- Calculation methodology
- Edition 1
- Nov. 2017
- Elemental Assemblies
 - Relates to elemental cost plan
 - Relates to Spon
 - Not confident this helps
 - Bad Cost planning?
 - Bankrupt industry?
 - Crippled Supply chain?
 - Late payments?
 - Mental Stress prevails?
- GBC does components > elements > whole building calculations

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ICE database

- ICE Inventory of Carbon & Energy
- V3 remains free access
- Nov. 2019
- Many more derived from consistent method LCA
- More Infrastructure & Civils Datasets
- Haulage and transport datasets
- Less Energy datasets
- Update funded by infrastructure:
 - Heathrow, RSSB, EA
- <https://circularrecology.com/embodied-carbon-footprint-database.html>

ICE (Inventory of Carbon & Energy)												
Tabular Version - For Improved Machine Readability (MR)												
Unique Data Identification				Data Quality								
Unique ID	Material	Sub-material	ICE EIR Name	DQ1 Method (Max 5)	DQ2 Assessment (Max 5)	DQ3 Temporal (Max 5)	DQ4 Geographic (Max 5)	DQ5 Transparency (Max 5)	DQ6 Disaggregation (Max 5)	DQ7 Sample Size (Min appropriate to calculated average Max 10)	DQ8 Toler % (Max 10%)	DQ9 Total % (Max 10%)
20d40e-ukr-454-MGS 4557704540	Timber	Timber, Laminated veneer lumber	Timber, Laminated veneer lumber - Including Corked Storage	5.00	2.00	4.00	1.00	2.00	10.00	3.00	10%	10%
59567b-ukr-458-MGS 4595504750	Timber	Timber, MDF	Timber, MDF - Including Corked Storage	5.00	2.00	5.00	4.00	1.00	17.00	4.00	10%	10%
2B342D-dan-454-MGS 4557704750	Timber	Timber, Open panel timber frame system	Timber, Open panel timber frame system - Including Corked Storage	5.00	2.00	4.00	3.00	2.00	10.00	4.00	10%	10%
2J102B-chk-454-MGS 4557704750	Timber	Timber, OSB	Timber, OSB - Including Corked Storage	5.00	2.00	4.00	4.00	1.00	17.00	4.00	10%	10%
645fcb-USA-454-MGS 736557104750	Timber	Timber, Plywood	Timber, Plywood - Including Corked Storage	5.00	3.00	5.00	1.00	1.00	10.00	3.00	10%	10%
6c0c9F-usa-458-MGS 740557104750	Timber	Timber, Particle Board	Timber, Particle Board - Including Corked Storage	5.00	3.00	5.00	4.00	1.00	10.00	4.00	10%	10%
e5f83a-usa-470-MGS 740557104750	Timber	Timber, Plywood	Timber, Plywood - Including Corked Storage	3.00	3.00	5.00	3.00	2.00	10.00	3.00	10%	10%
f650ac-ukr-444-MGS 4557704750	Timber	Timber, Softwood	Timber, Softwood - Including Corked Storage	3.00	3.00	5.00	3.00	2.00	10.00	3.00	10%	10%
b4852D-usa-454-MGS 817287704750	Timber	Timber, Wood Joist	Timber, Wood Joist - Including Corked Storage	5.00	2.00	4.00	5.00	2.00	10.00	5.00	10%	10%
c950ab-usa-454-MGS												
ICE V 3.0			<div>Heathrow Airport</div> <div><div>Rail Safety and Standards Board (RSSB)</div><div><div>RSSB</div><div>A Better, Safer Railway</div></div></div>									
Previous versions			This original ICE database was joint funded under the Carbon Vision Buildings program by the Engineering and Physical Sciences Research Council (EPSRC) and the Carbon Trust (before they became a private organisation).									

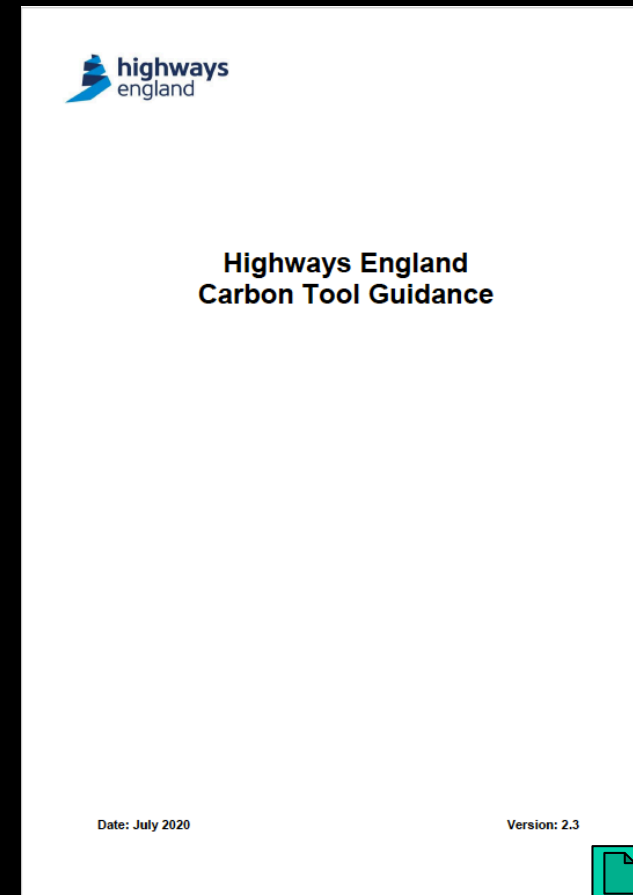
3

GBC V2 EE EC SC Calculator

Embodied Energy Embodied Carbon Sequestered Carbon											Whole Building Embodied Energy Embodied Carbon Sequestered Carbon																	Grand totals														
Component Function	Length	Width	Height	Element Thickness	Quantity	Area	Volume	Primary or all Functions	Primary or all Components	Primary or all Materials	Information Source	Embodied Energy	Embodied Energy	Embodied Energy	Area or section	m2	Embodied Carbon	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Density	Weight	Embodied Energy	Embodied Carbon Dioxide	Required in building?	Embodied Energy Building	Embodied Carbon Building	Is the material bio-based or contain Biogenic carbon?	Sequestered carbon	Total Carbon												
Yes	1 Basement Floor (BF)										m	m	m	m	No.	m2	m3							MJ/m3	MJ/m2	MJ/Item	m2	m2	kg C/kg	kg CO2/kg	kg CO2/m2	kg CO2/Item	kg/m3	kg/m2	MJ/m3	kg CO2/m3	Yes/No	MJ	kg CO2	Yes/No	kg CO2	kg CO2
Yes	Inner decoration															60																										
Yes	Floor finish															0.001	1	60	0.06	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Inner floor lining underlayment															0.025	1	60	1.5	Finish	Finish/wearing	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	336	0	No	0	0
Yes	Inner leveling/wearing															0.048	1	60	2.88	Lining/Sheathing/Sarking	Interior lining	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	648	0	No	0	0
Yes	Internal insulation															0.045	1	60	2.7	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	605	0	No	0	0
Yes	Drainage filtration layer															0.235	1	60	14.1	Thermal Insulation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	3,158	0	No	0	0
Yes	Inner tanking															0.05	1	60	3	Loadbearing capacity, Foundation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0
Yes	Retaining floor															0.001	1	60	0.06	Ground water exclusion	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Damp/Gas proof membrane															0.15	1	60	9	Loadbearing capacity, Basement	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	2,016	0	No	0	0
Yes	Ground gas ventilation labyrinth															0.001	1	60	0.06	Ground gas exclusion	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Blinding layer															0.1	1	60	6	Cross ventilation (below floor)	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	1,344	0	No	0	0
Yes	Insulating backfill															0.05	1	60	3	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0
Yes	Consolidated hardcore															0.15	1	60	9	Thermal Insulation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	2,016	0	No	0	0
Yes	Drainage layer															0.05	1	60	3	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0
Yes	Undisturbed subsoil															1	1	60	60	Loadbearing capacity, Foundation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13,440	0	No	0	0
Component Function											Length	Width	Height	Element Thickness	Quantity	Area	Volume	Primary or all Functions	Primary or all Components	Primary or all Materials	Information Source	Embodied Energy	Embodied Energy	Embodied Energy	Area or section	m2	Embodied Carbon	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Density	Weight	Embodied Energy	Embodied Carbon Dioxide	Required in building?	Embodied Energy Building	Embodied Carbon Building	Is the material bio-based or contain Biogenic carbon?	Sequestered carbon	Total Carbon		
Yes	2 Basement Perimeter Retaining Walls (BPRW)										m	m	m	m	No.	m2	m3	0	0	0				MJ/m3	MJ/m2	MJ/Item	m2	m2	kg C/kg	kg CO2/kg	kg CO2/m2	kg CO2/Item	kg/m3	kg/m2	MJ/m3	kg CO2/m3	Yes/No	MJ	kg CO2	Yes/No	kg CO2	kg CO2
Yes	Undisturbed subsoil															1	1	200	200	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Backfill															0.3	1	200	60	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Protection mat															0.01	1	200	2	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Drainage filtration layer															0.05	1	200	10	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Outer tanking															0.006	1	200	1.2	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	External retaining supporting wall															0.3	1	200	60	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Smoothing waterproof render															0.02	1	200	4	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Drainage layer															0.05	1	200	10	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Internal insulation															0.1	1	200	20	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Inner lining															0.0125	1	200	2.5	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0
Yes	Inner finish															0.003	1	200	0.6	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0

Highways England Carbon Tool

- Guidance
- July 2020
- Version v 2.3
- Excel On-line tool
- E.g. Schedules for data collection



GBC V2 Transport datasets

Transport Dataset		© GBE Green Building Calculator 2017-2021						
Category	Item	Material/Product	Input unit	Materials Type	Carbon factor	Carbon Factor	Conversion Factor	Methodology
Transport Dataset	Laden	Van	km	Energy and Fuel	0.000616280	tCO ₂ e/t.km		Carbon factor taken directly from Government Carbon Factors 2020: Freightage Goods > Average van > Diesel > tonne/km.
		HGV	km	Energy and Fuel	0.000106500	tCO ₂ e/t.km		Carbon factor taken directly from Government Carbon Factors 2020: Freightage Goods > Average HGV > Average laden > tonne/km.
		Rail	km	Energy and Fuel	0.000025560	tCO ₂ e/t.km		Carbon factor taken directly from Government Carbon Factors 2020: Freightage Goods > Rail > tonne/km.
		Ship	km	Energy and Fuel	0.000013230	tCO ₂ e/t.km		Carbon factor taken directly from Government Carbon Factors 2020: Freightage Goods > Cargo Ship > General Cargo > Average > tonne/km.
	Unladen	Van	km	Energy and Fuel	0.000247100	tCO ₂ e/km		Carbon factor taken from Government Carbon Factors 2020: Delivery Vehicles > Average van > Diesel > km. Assumed average load is 1 tonnes to calculate number of return journeys.
		HGV	km	Energy and Fuel	0.000087748	tCO ₂ e/km		Carbon factor taken from Government Carbon Factors 2020: Delivery Vehicle > Average HGV > 0% laden > km. Assumed average load is 7.5 tonnes to calculate number of return journeys.
		Rail	km	Energy and Fuel	0	tCO ₂ e/t.km		Assumed rail transport returns laden for purposes not related to the reporting contract and thus a zero carbon factor is applied.
		Ship	km	Energy and Fuel	0	tCO ₂ e/t.km		Assumed ship transport returns laden for purposes not related to the reporting contract and thus a zero carbon factor is applied.
	Ready mix concrete	General	m ³	Concrete	0.103361345	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > General. Please note that ICE strongly recommend to avoid selecting a 'general' value for concrete. Selecting data for a specific cement content in the concrete type will give much greater accuracy.
		General - C6/8 (Gen 0, ST1)	m ³	Concrete	0.065413856	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > Gen 0
		General - C8/10 (Gen 1, ST 2)	m ³	Concrete	0.089870082	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > Gen 1
		General - C12/15 (Gen 2, ST 3)	m ³	Concrete	0.097099819	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > Gen 2
		General - C16/20 (Gen 3, ST 4)	m ³	Concrete	0.104183166	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > Gen 3
		General - C20/25 (ST 5)	m ³	Concrete	0.112022811	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 20/25 mpa.
		General - C25/30	m ³	Concrete	0.119017286	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 25/30 mpa.
		General - C28/35	m ³	Concrete	0.126021336	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 28/35 mpa.
		General - C32/40	m ³	Concrete	0.138244351	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 32/40 mpa.
		General - C35/45	m ³	Concrete	0.148699729	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 35/45 mpa.
		General - C40/50	m ³	Concrete	0.159124859	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 40/50 mpa.
		100% CEM I - C6/8 (Gen 0, ST1)	m ³	Concrete	0.070437227	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > Gen 0
		100% CEM I - C8/10 (Gen 1, ST 2)	m ³	Concrete	0.097192891	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > Gen 1
		100% CEM I - C12/15 (Gen 2, ST 3)	m ³	Concrete	0.104959551	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > Gen 2
		100% CEM I - C16/20 (Gen 3, ST 4)	m ³	Concrete	0.112663883	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > Gen 3
		100% CEM I - C20/25 (ST 5)	m ³	Concrete	0.120928209	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 20/25 mpa.
		100% CEM I - C25/30	m ³	Concrete	0.128571933	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 25/30 mpa.
		100% CEM I - C28/35	m ³	Concrete	0.136185061	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 28/35 mpa.
		100% CEM I - C32/40	m ³	Concrete	0.149482537	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 32/40 mpa.
		100% CEM I - C35/45	m ³	Concrete	0.160874182	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 35/45 mpa.
		100% CEM I - C40/50	m ³	Concrete	0.172289283	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > CEM I > 40/50 mpa.
		14% Limestone replacement - C6/8 (Gen 0, ST1)	m ³	Concrete	0.061434468	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > Gen 0
		14% Limestone replacement - C8/10 (Gen 1, ST 2)	m ³	Concrete	0.154224250	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > Gen 1
		14% Limestone replacement - C12/15 (Gen 2, ST 3)	m ³	Concrete	0.090489451	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > Gen 2
		14% Limestone replacement - C16/20 (Gen 3, ST 4)	m ³	Concrete	0.096635030	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > Gen 3
		14% Limestone replacement - C20/25 (ST 5)	m ³	Concrete	0.104028062	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 20/25 mpa.
		14% Limestone replacement - C25/30	m ³	Concrete	0.110827786	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 25/30 mpa.
		14% Limestone replacement - C28/35	m ³	Concrete	0.117384856	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 28/35 mpa.
		14% Limestone replacement - C32/40	m ³	Concrete	0.128834231	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 32/40 mpa.
		14% Limestone replacement - C35/45	m ³	Concrete	0.140281057	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 35/45 mpa.
		14% Limestone replacement - C40/50	m ³	Concrete	0.152869896	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 14% Limestone > 40/50 mpa.
		35% natural pozzolanic ash replacement - C6/8 (Gen 0, ST1)	m ³	Concrete	0.055653295	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 35% NPA > Gen 0
		35% natural pozzolanic ash replacement - C8/10 (Gen 1, ST 2)	m ³	Concrete	0.075670552	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 35% NPA > Gen 1
		35% natural pozzolanic ash replacement - C12/15 (Gen 2, ST 3)	m ³	Concrete	0.081413702	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 35% NPA > Gen 2
		35% natural pozzolanic ash replacement - C16/20 (Gen 3, ST 4)	m ³	Concrete	0.087165950	tCO ₂ e/t	2.4	Carbon factor taken directly from the ICE V3: Concrete > 35% NPA > Gen 3

Life Cycle Analysis of Transport

- Impact of road and rail transport in LCA
 - Flights are very carbon and energy inefficient
 - Ships are very efficient
 - Rail is very efficient
 - Road is worse
 - Big trucks are better than small vans
- Role of consolidation centres
 - Long haul in big trucks or trains
 - Pallet services removes many small vehicles off road
 - Needs less drivers
 - Switch goods to smaller trucks in consolidation centres
 - Short haul in small trucks for easy access
 - Round robin journeys: site <> consolidation centres

GBC V2 Civils & Infra Datasets

										To be completed by GBC user		Completed by GBC				
Yes	Civils and Infrastructure							Yes	No	Yes	No	Yes	Yes			
Group				Item	Type: Specification	Quantity	Unit	Transport Distance	Unit	Vehicle Type	Vehicle Size/weight	To be completed by GBC user	Completed by GBC	13/10/2020	BRM	Highways England Carbon Tool Guidance
1 Bulk Materials																
Yes	1 Bulk Materials	Ready mix concrete	General	No.	many	No.	km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C6/8 (Gen 0, ST1)		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C8/10 (Gen 1, ST 2)		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C12/15 (Gen 2, ST 3)		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C16/20 (Gen 3, ST 4)		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C20/25 (ST 5)		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C25/30		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Ready mix concrete	General C28/35		m3		km	Concrete Mixer Lorry		Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Fill, aggregate and sand	Expanded clay		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Fill, aggregate and sand	Expanded foamed glass		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Fill, aggregate and sand	Secondary resources		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	1 Bulk Materials	Road salt/grit	Road salt/grit		tonnes		km	Gritter lorry		Yes	No	13/10/2020	BRM			
2 Earthworks				Item	Type: Specification	Quantity	Unit	Transport Distance	Unit	Vehicle Type	Vehicle Size/weight	To be completed by GBC user	Completed by GBC	13/10/2020	BRM	
Yes	2 Earthworks	Imported Soil	General soil/top soil		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Imported Soil	Stabilised soil - Cement, Fly Ash or GGBS		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Site won soil/ muck shift	General soil		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Ground stabilisation	Portland CEM I cement		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Ground stabilisation	GGBS		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Ground stabilisation	Fly ash		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Ground stabilisation	Lime		tonnes		km			Yes	No	13/10/2020	BRM			
Yes	2 Earthworks	Geotextiles	Polypropylene geotextile / matting		m2		km			Yes	No	13/10/2020	BRM			
3 Fencing, Barriers and Road Restraint Systems				Item	Type: Specification	Quantity	Unit	Transport Distance	Unit	Vehicle Type	Vehicle Size/weight	To be completed by GBC user	Completed by GBC	13/10/2020	BRM	
Yes	3 Fencing, Barriers and Road Restraint Systems	Fence	Fence timber (by volume)		m3		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Fence	Timber rail fence (all types, includes posts)		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Fence	Timber panels and posts		No.		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Fence	Steel/wire/chain fence (includes posts)		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Timber barrier 2m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Timber barrier 3m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Timber barrier 4m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Steel barrier 2m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Steel barrier 3m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Steel barrier 4m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Aluminium barrier 2m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Aluminium barrier 3m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Aluminium barrier 4m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Plastic barrier 2m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Plastic barrier 3m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Noise Barriers	Plastic barrier 4m		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Road Restraint System/ Safety Barrier	Steel RRS barrier single sided		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Road Restraint System/ Safety Barrier	Steel RRS barrier double sided		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Road Restraint System/ Safety Barrier	Pre-cast concrete step barrier		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Paint or timber treatment	Solvent based paint		Litres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	3 Fencing, Barriers and Road Restraint Systems	Paint or timber treatment	Water based paint		Litres		km	Lorry		Yes	No	13/10/2020	BRM			
4. Drainage				Item	Type: Specification	Quantity	Unit	Transport Distance	Unit	Vehicle Type	Vehicle Size/weight	To be completed by GBC user	Completed by GBC	13/10/2020	BRM	
Yes	4. Drainage	Plastic pipework (HDPE)	150mm diameter		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	4. Drainage	Plastic pipework (HDPE)	225mm diameter		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	4. Drainage	Plastic pipework (HDPE)	300mm diameter		metres		km	Lorry		Yes	No	13/10/2020	BRM			
Yes	4. Drainage	Plastic pipework (HDPE)	450mm diameter		metres		km	Lorry		Yes	No	13/10/2020	BRM			

ISE Carbon tool: Structures

- Institute of Structural Engineers
- The Structural Carbon Tool
- Launched: March 2021: Free to use
- <https://greenbuildingencyclopaedia.uk/encyclopaedia/the-structural-carbon-tool-calculator/>
- Building Structure only
 - (more with user effort endless hours)
- SCORS:
- <https://www.istructe.org/IStructE/media/Public/TSE-Archive/2020/Setting-carbon-targets-an-introduction-to-the-proposed-SCORS-rating-scheme.pdf>
- Embodied carbon:
- <https://www.istructe.org/IStructE/media/Public/Resources/istructe-how-to-calculate-embodied-carbon.pdf>
- Sequestered Carbon:
- <https://www.istructe.org/IStructE/media/Public/TSE-Archive/2021/Timber-and-carbon-sequestration.pdf>

09/04/21

The screenshot shows the GBE website interface. At the top is a navigation bar with links: Home, About, Encyclopaedia, GBC Calculator, Portfolio, 2D View, Shop, Blog, Advertise, and Contact. Below the navigation bar is the main heading 'The Structural Carbon Tool (Calculator) G#39232' with a sub-heading 'By BrianSpecMan | 19 March 2021 | Calculators, Elemental, Encyclopaedia, Files, Whole Building'. The main content area is titled 'The Structural Carbon Tool Calculator' and includes a search bar. To the right, there are sections for 'Recent Posts' and 'Recent Comments'. The 'Recent Posts' section lists several articles related to sustainable rail, biophilia, and carbon counting. The 'Recent Comments' section shows comments from BrianSpecMan and Jeffrey Jones. The main content area also includes sections for 'The Structural Carbon Tool Calculator About:', 'The Structural Carbon Tool Calculator See Also:', 'GBE Shop', 'GBE Equations', and 'GBE Datasets'.

37

Environmental Assessment Methods: Drive change?

- **BREEAM driven via GGtS & Green Book Live**
 - **Green Guide to Specification**
 - Industry average Generic Materials (no incentive to improve)
 - 1200 Readymade Assemblies (probably not what you are doing)
 - Bespoke assessments (BRE take their time)
 - 400 more assemblies added?
 - **GreenBook Live Products**
 - Mostly plastic or bitumen backed carpets
 - BRE EP = EPD once recalculated to EN 15804
- **BREEAM Infrastructure (Pilot)**
 - **Like all BREEAM Tools**
 - it records what you did,
 - not change the way you did it
 - “If not BREEAM could have been greener”
 - **HS2 destroys easy targets (whilst COVID lockdown hides evidence)**
 - Many SSSI Sites of Special Scientific Interest
 - Many Ancient forests
 - 400 year old tree felled for a maintenance slip road
- **It completely fails on behaviour change**

Infrastructure Environmental Assessment Method: Drive change?

- CEEQUAL V5
- 15 years, 1300 trained assessors,
- now BRE's
- + BREEAM Infrastructure Pilot
- = CEEQUAL 6
 - June 2019,
 - + Whole Life Carbon

<https://www.ceequalonline.com/login/>

Must be trained to use it

Cannot even see it

Video Thank you BRE, link will not work

09/04/21 Fee: £3000 (£3m)-£38,000 (£1000m)

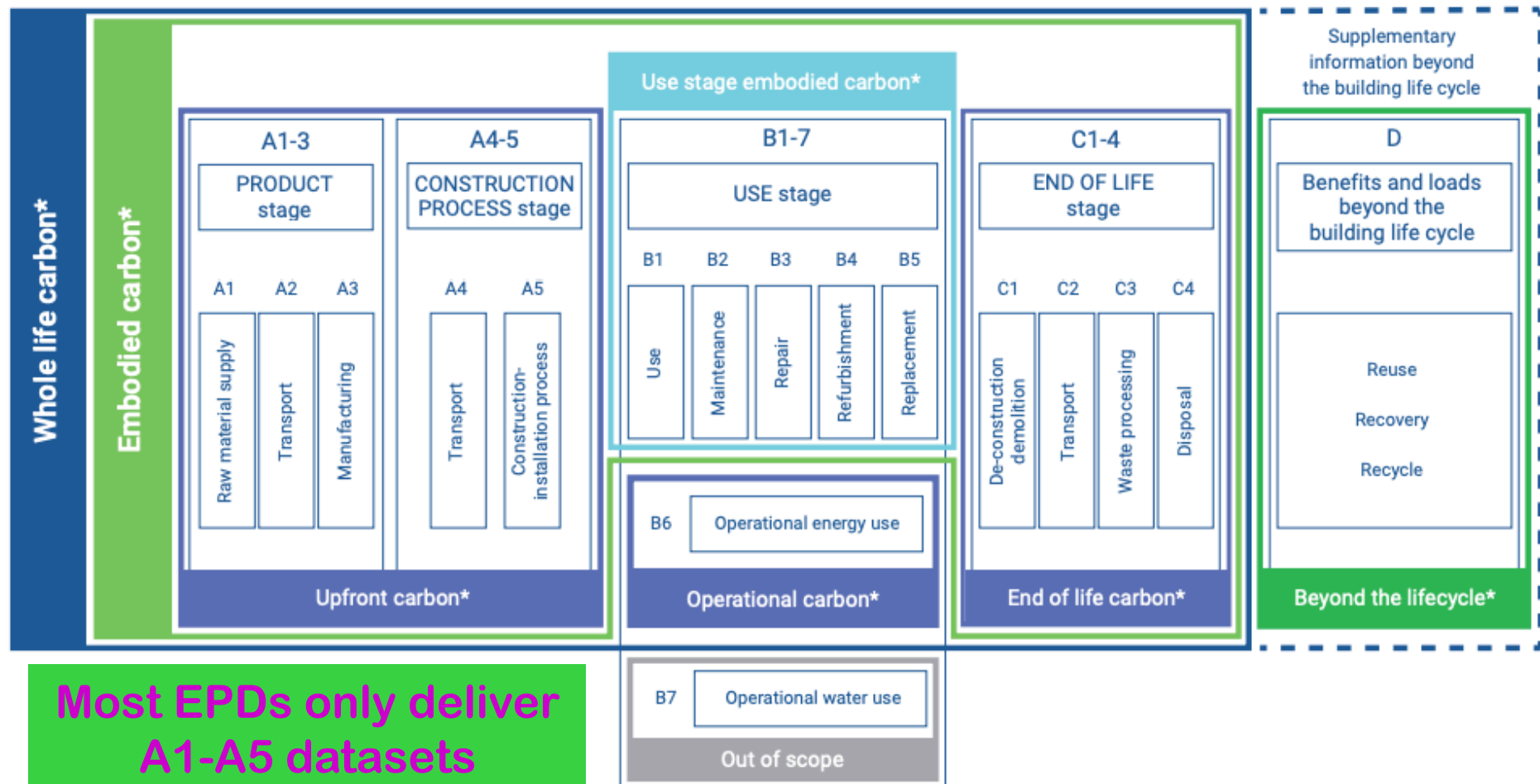
CEEQUAL[®]
delivered by bre

World & UK GBC

- **WorldGBC Net Zero Carbon Buildings Commitment by 2030**
Sept. 2018
- **UKGBC Net Zero Carbon Buildings:**
 - A Framework Definition: April 2019
- **WGBC Bringing Embodied Carbon Upfront**
 - Sept. 2019 'Upfront Carbon'
 - disconnecting from OPEX therefore TOTEX
 - Whole live VE becomes more complicated
- **Budget March 2021:**
 - Government: Build Back Better
 - UKGBC: Build Back Business as Usual
- **Net Zero Whole Life Carbon Roadmap for the Built Environment:**
 - March 2021

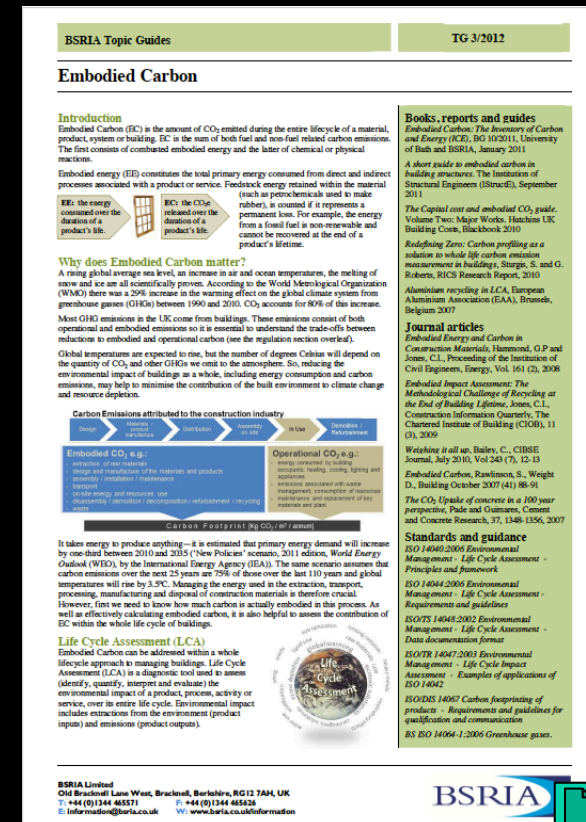
'Upfront' carbon A1-A5

used within this report. In the following definitions we make reference to the lifecycle stages or modules defined in the widely-adopted European standard EN 15978 shown in figure 1.



MEP Services Carbon Accounting

- BSRIA carbon accounting for services:
- Rules of engagement
- Topic Guide TG3/2012
- Metals and Plastics
- Sections:
 - duct simplicity
 - cable complexity
- Components & Accessories
- Circuit boards:
 - generic values/mm2



GBC V2 Sections Calculations

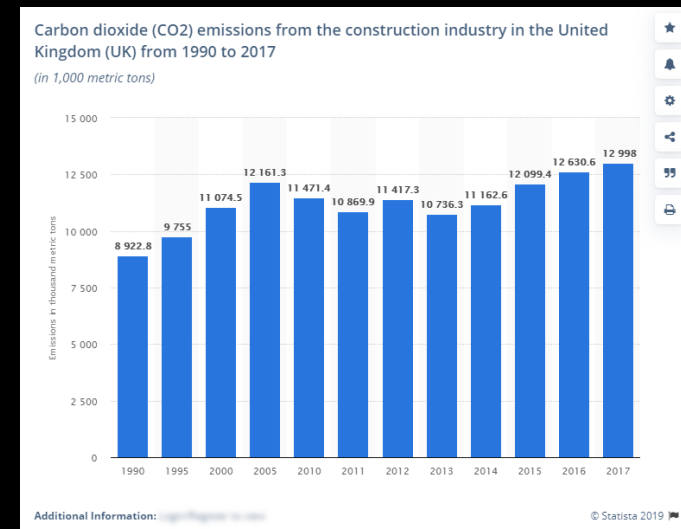
MEP Services & Structures

Profiles XSA Lengths Volumes

				Yes	Auto-filled		Yes	Auto-filled		Yes	Auto-filled		Yes	Auto-filled		Yes	Result		Yes	Auto-filled		Result	Auto-filled									
Profiles Dimensions Cross Section Areas Lengths Volumes						Pi = 3.142857143	© GBE Green Building Calculator 2017-2021																									
Section profile		Applications		Query	External radius	Units	External Radius	Units	Internal radius	Units	Internal radius	Units	Wall thickness	Units	Wall thickness	Units	Length wall thickness	Units	Length wall thickness	Units	Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units
•	CSS	Circle Solid Section	Frames, Piles, Reinforcement, ties	Di. to CSA & Vol.	2	mm	0.002	m													12.571	mm2	0.0126	m2	1000	mm	1	m	12,571.43	mm3	0.013	m3
•	CSS	Circle Solid Section	Frames, Piles, Reinforcement, ties	CSA to Dia.	2	mm	0.002	m													12.5	mm2	0.013	m2	1000	mm	1	m	12,500.00	mm3	0.013	m3
Section profile		Applications		Query	External radius	Units	External Radius	Units	Internal radius	Units	Internal radius	Units	Wall thickness	Units	Wall thickness	Units	Length wall thickness	Units	Length wall thickness	Units	Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units
○	CHS	Circle Hollow Section	Frames, Pipes, Conduit	Di. to CSA & Vol.	20	mm	0.020	m	10	mm	0.010	m	10	mm	0.010	m	10	mm	125.714	mm2	0.126	m2	1000	mm	1	m	125,714.29	mm3	0.126	m3		
○	CHS	Circle Hollow Section	Frames, Pipes, Conduit	Di. to CSA & Vol.	20	mm	0.020	m	10	mm	0.010	m	10	mm	0.010	m	10	mm	125.714	mm2	0.126	m2	1000	mm	1	m	125,714.29	mm3	0.126	m3		
○	CHS	Circle Hollow Section	Frames, Pipes, Conduit	CSA to Dia.	20	mm	0.020	m	10	mm	0.010	m	10	mm	0.010	m	10	mm	125.714	mm2	0.126	m2	1000	mm	1	m	125,714.29	mm3	0.126	m3		
Section profile		Section profile		Width	Units	Width	Units	Length	Units	Length	Units									Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units	
■	SSS	Square Solid Section	Frames, Piles, Reinforcement	Di. to CSA & Vol.	15	mm	0.015	m	15	mm	0.015	m								225.000	mm2	0.225	m2	1000	mm	1	m	225,000.00	mm3	0.225	m3	
■	SSS	Square Solid Section	Frames, Piles, Reinforcement	CSA to Dims.	15	mm	0.015	m	15	mm	0.015	m								225.000	mm2	0.225	m2	1000	mm	1	m	225,000.00	mm3	0.225	m3	
Section profile		Section profile		Width	Units	Width	Units	Length	Units	Length	Units	Wall thickness	Units	Wall thickness	Units					Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units	
□	SHS	Square Hollow Section	Frames, ducts,	Di. to CSA & Vol.	15	mm	0.015	m	15	mm	0.015	m	3	mm	0.003	m				81.000	mm2	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.081	m3	
□	SHS	Square Hollow Section	Frames, ducts,	CSA to Dims.	9	mm	0.009	m	9	mm	0.009	m	3	mm	0.003	m				81.000	mm2	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.081	m3	
Section profile		Applications		Width	Units	Width	Units	Height	Units	Height	Units									Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units	
■	RSS	Rectangular Solid Section	Frames, Bars,	Di. to CSA & Vol.	16	mm	0.016	m	20	mm	0.020	m								320.000	mm2	0.320	m2	1000	mm	1	m	320,000.00	mm3	0.320	m3	
■	RSS	Rectangular Solid Section	Frames, Bars,	Di. to CSA & Vol.	16	mm	0.016	m	20	mm	0.020	m								320.000	mm2	0.320	m2	1000	mm	1	m	320,000.00	mm3	0.320	m3	
■	RSS	Rectangular Solid Section	Frames, Bars,	CSA to Dims.	16	mm	0.016	m	20	mm	0.020	m								320.000	mm2	0.320	m2	1000	mm	1	m	320,000.00	mm3	0.320	m3	
Section profile		Applications		Width	Units	Width	Units	Height	Units	Height	Units	Wall thickness	Units	Wall thickness	Units	Length wall thickness	Units	Length wall thickness	Units	Cross section Area	Units	Cross section Area	Units	Length	Units	Length	Units	Volume	Units	Volume	Units	
□	RHS	Rectangular Hollow Section	Frames, ducts, conduits	Di. to CSA & Vol.	20	mm	0.020	m	25	mm	0.025	m	10	mm	0.010	m	12	mm	0.012	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
□	RHS	Rectangular Hollow Section	Frames, ducts, conduits	Di. to CSA & Vol.	20	mm	0.020	m	18.5	mm	0.019	m	10	mm	0.010	m	12	mm	0.012	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
□	RHS	Rectangular Hollow Section	Frames, ducts, conduits	CSA to Dims.	14.8	mm	0.015	m	25	mm	0.025	m	10	mm	0.010	m	12	mm	0.012	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	Units	Flange wall thickness	Units	Flange wall thickness	Units	125.7142857	Units	0.126	m2	1000	mm	1	m	125,714.29	mm3	0.126	m3	
L	REA or PFEA	Rolled or Parallel Flange Equal Angle	Framing, Edge restraints, supports	Di. to CSA & Vol.	20	mm	0.020	m	20	mm	0.020	m	10	mm	0.010	m	10	mm	0.010	m	300.000	mm2	0.300	m2	1000	mm	1	m	300,000.00	mm3	0.300	m3
L	REA or PFEA	Rolled or Parallel Flange Equal Angle	Framing, Edge restraints, supports	Di. to CSA & Vol.	20	mm	0.020	m	18.5	mm	0.019	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
L	REA or PFEA	Rolled or Parallel Flange Equal Angle	Framing, Edge restraints, supports	CSA to Dims.	15.0	mm	0.015	m	20	mm	0.020	m	10	mm	0.010	m	10	mm	0.010	m	300.000	mm2	0.300	m2	1000	mm	1	m	300,000.00	mm3	0.300	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	0	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	225	Units	0.225	m2	1000	mm	1	m	225,000.00	mm3	0.081	m3	
L	RA or PFA	Rolled or Parallel Flange Unequal Angle	Framing, Edge restraints, supports	Di. to CSA & Vol.	20	mm	0.020	m	26	mm	0.026	m	10	mm	0.010	m	10	mm	0.010	m	360.000	mm2	0.360	m2	1000	mm	1	m	360,000.00	mm3	0.360	m3
L	RA or PFA	Rolled or Parallel Flange Unequal Angle	Framing, Edge restraints, supports	Di. to CSA & Vol.	20	mm	0.020	m	18.5	mm	0.019	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
L	RA or PFA	Rolled or Parallel Flange Unequal Angle	Framing, Edge restraints, supports	CSA to Dims.	14.2	mm	0.014	m	26	mm	0.026	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
C	RC or PFC	Rolled or Parallel Flange Channel	Framing, stair strings, floor edges,	Di. to CSA & Vol.	20	mm	0.020	m	100	mm	0.100	m	10	mm	0.010	m	10	mm	0.010	m	1100.000	mm2	1.100	m2	1000	mm	1	m	1,100,000.00	mm3	1.100	m3
C	RC or PFC	Rolled or Parallel Flange Channel	Framing, stair strings, floor edges,	Di. to CSA & Vol.	20	mm	0.020	m	18.5	mm	0.019	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
C	RC or PFC	Rolled or Parallel Flange Channel	Framing, stair strings, floor edges,	CSA to Dims.	10	mm	0.010	m	100	mm	0.100	m	10	mm	0.010	m	10	mm	0.010	m	1000.000	mm2	1.000	m2	1000	mm	1	m	1,000,000.00	mm3	1.000	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
H	H or I	H or I or Composite section	Columns, Beams, Studs, Rafters, Joists	Di. to CSA & Vol.	20	mm	0.020	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	380.000	mm2	0.380	m2	1000	mm	1	m	380,000.00	mm3	0.380	m3
H	H or I	H or I or Composite section	Columns, Beams, Studs, Rafters, Joists	Di. to CSA & Vol.	20	mm	0.020	m	18.5	mm	0.019	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
H	H or I	H or I or Composite section	Columns, Beams, Studs, Rafters, Joists	CSA to Dims.	13.2	mm	0.013	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
+	+	Cruciform Section	Columns	Di. to CSA & Vol.	20	mm	0.020	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	380.000	mm2	0.380	m2	1000	mm	1	m	380,000.00	mm3	0.380	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
+	+	Cruciform Section	Columns	CSA to Dims.	13.2	mm	0.013	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
+	+	Cruciform Section	Columns	Di. to CSA & Vol.	20	mm	0.020	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	380.000	mm2	0.380	m2	1000	mm	1	m	380,000.00	mm3	0.380	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
+	+	Cruciform Section	Columns	CSA to Dims.	13.2	mm	0.013	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	370.000	mm2	0.370	m2	1000	mm	1	m	370,000.00	mm3	0.370	m3
Section profile		Applications		Web	Units	Web	Units	Flange	Units	Height	Units	Web wall thickness	Units	Web wall thickness	0	Flange wall thickness	0	Flange wall thickness	0	81	Units	0.081	m2	1000	mm	1	m	81,000.00	mm3	0.32	m3	
+	+	Cruciform Section	Columns	Di. to CSA & Vol.	20	mm	0.020	m	28	mm	0.028	m	10	mm	0.010	m	10	mm	0.010	m	380.000	mm2	0.380	m2	1000	mm						

What purpose carbon counting?

- Growing designer's awareness of growing impacts
- Carbon reduction potential opportunities and consequences
- Materials decision making
 - More performance
 - Conflicting performances
 - = less long term impacts
 - = more initial impacts
- As designed v as built
 - Performance Gap
- Substitution Value Engineering
 - Cost cutting in disguise
- Belgium's 2012 ambition
 - 'fine not tax development'
 - Based on designed impacts
 - Not forgetting substitutions



Project Carbon Accounting

- CAD & BIM Apps:
 - ready to interrogate the models and datasets?
- Or getting ahead of the game
 - and doing it for yourself in Excel

Green Building Calculator V2

- Excel for now V1 July 2020; V2 April-May 2021
- Building Elemental Assemblies V1 & V2
- Bill of Materials, Quantities, Costs V2
- Materials EE EC SC datasets & Calculator V2
- Materials and Products LCA Datasets & Calculator V2
- Infrastructure materials Datasets V2
- Transport emissions Datasets V2 Calculator Later
- Services & Structures Sections Calculator V2
- Building Landscape Road Readymade Assemblies V3 & V4
- Services Design Calculator: Later
- Rail Elemental Assemblies Later needs specialist advice
- Infrastructure Module Calculators V10
 - (sooner if any demand shown, or funded to develop early)
- BIM App later V20 (but early discussions have started)

GBC V2 EE EC SC Calculator

Embodied Energy Embodied Carbon Sequestered Carbon											Whole Building Embodied Energy Embodied Carbon Sequestered Carbon																			Grand totals					
Component Function	Length	Width	Height	Element Thickness	Quantity	Area	Volume	Primary or all Functions	Primary or all Components	Primary or all Materials	Information Source	Embodied Energy	Embodied Energy	Embodied Energy	Area or section	m ²	Embodied Carbon	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Embodied Carbon Dioxide	Density	Weight	Embodied Energy	Embodied Carbon Dioxide	Required in building?	Embodied Energy Building	Embodied Carbon Building	Is the material bio-based or contain Biogenic carbon?	Sequestered carbon	Total Carbon					
Yes	m	m	m	m	No.	m ²	m ³					MJ/m ³	MJ/m ²	MJ/Item	m ²	m ²	kg C/kg	kg CO2/kg	kg CO2/m ²	kg CO2/Item	kg/m ³	kg/m ²	MJ/m ³	kg CO2/m ³	Yes/No	MJ	kg CO2	Yes/No	kg CO2	kg CO2					
1 Basement Floor (BF)																																			
Yes						60																													
Yes	Inner decoration				0.001	1	60	0.06	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Floor finish				0.025	1	60	1.5	Finish	Finish/wearing	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	336	0	No	0	0				
Yes	Inner floor lining underlayment				0.048	1	60	2.88	Lining/Sheathing/Sarking	Interior lining	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	648	0	No	0	0				
Yes	Inner leveling/wearing				0.045	1	60	2.7	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	605	0	No	0	0				
Yes	Internal insulation				0.235	1	60	14.1	Thermal Insulation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	3,158	0	No	0	0				
Yes	Drainage filtration layer				0.05	1	60	3	Loadbearing capacity, Foundation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0				
Yes	Inner tanking				0.001	1	60	0.06	Ground water exclusion	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Retaining floor				0.15	1	60	9	Loadbearing capacity, Basement	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	2,016	0	No	0	0				
Yes	Damp/Gas proof membrane				0.001	1	60	0.06	Ground gas exclusion	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Ground gas ventilation labyrinth				0.1	1	60	6	Cross ventilation (below floor)	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	1,344	0	No	0	0				
Yes	Blinding layer				0.05	1	60	3	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0				
Yes	Insulating backfill				0.15	1	60	9	Thermal Insulation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	2,016	0	No	0	0				
Yes	Consolidated hardcore				0.15	1	60	9	Gap filler / Formation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	2,016	0	No	0	0				
Yes	Drainage layer				0.05	1	60	3	Loadbearing capacity, Foundation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	672	0	No	0	0				
Yes	Undisturbed subsoil				1	1	60	60	Loadbearing capacity, Foundation	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13,440	0	No	0	0				
2 Basement Perimeter Retaining Walls (BPRW)																																			
Yes	Undisturbed subsoil				1	1	200	200	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Backfill				0.3	1	200	60	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Protection mat				0.01	1	200	2	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Drainage filtration layer				0.05	1	200	10	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Outer tanking				0.006	1	200	1.2	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	External retaining supporting wall				0.3	1	200	60	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Smoothing waterproof render				0.02	1	200	4	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Drainage layer				0.05	1	200	10	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Internal insulation				0.1	1	200	20	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Inner lining				0.0125	1	200	2.5	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				
Yes	Inner finish				0.003	1	200	0.6	Decoration	Decoration	Choose	E-CT	0.1	0	0	0	0	0.005	0	0	0	2240	0	224	0	Yes	13	0	No	0	0				

3

Element

TCHL

Floor area	4,838	m2		
Watts	19,339	W	Biomass	Fuel
KiloWatts	19	kW	0.025	conversion
kiloWattHours	2.4	kWh	0.060	kg CO2
KiloWatts/floor area	0.004	kW/m2	CarbonDioxide	CO2
KiloWattHours/floor area	0.0005	kWh/m2	0.00001	kg CO2/m2
Hours/Floor area/annum		kWh/m2/Year		

GBC V2 BofM Q C

Bill of Materials Quantities Costs

	Component Function	Rehab Actions	Material	Area GIFA	Labour rate	Labour Cost	Accessories rate	Accessories Cost	Products or Materials rate	Products or Materials Cost	Total Cost
Yes	1 Basement Floor (BF)			m2	£/m2	£	£/m2	£	£/m2	£	£
				60							
Yes	Inner decoration	New	lacquer	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Floor finish	New	Hardwood flooring	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Inner floor lining underlayment	New	Gypsum fibreboard	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Inner levelling/wearing	New	Cement Lime Screed	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Internal insulation	New	PIR Insulation	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Drainage filtration layer	New	HDPE	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Inner tanking	New	Polyethylene (PE)	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Retaining floor	New	Concrete	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Damp/Gas proof membrane	New	Polyethylene (PE)	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Ground gas ventilation labyrinth	New	Expanded polystyrene EPS	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Blinding layer	New	Sand	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Insulating backfill	New	LECA	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Consolidated hardcore	New	Recycled masonry	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Drainage layer	New	Sea shells	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
Yes	Undisturbed subsoil	New	Clay	60	£1.00	£60	£1.00	£60	£1.00	£60	£180
				£45.00	£15	£900	£15	£900	£15	£900	£2,700
				Elemental Cost/m2	Elemental Labour Rate/m2	Elemental Labour Cost	Elemental Accessories rate/m2	Elemental Accessories Cost	Elemental Material Rate/m2	Elemental Material Costs	Elemental Cost: Materials Accessories & Labour

GBC CPD

- Find this file on GBE website at:
 - <https://GreenBuildingEncyclopaedia.uk/?P=39287>
- GBC CPD
 - <https://GreenBuildingEncyclopaedia.uk/?P=39145>
- GBC Website
 - <https://GreenBuildingCalculator.uk>

Revisions

Rev	Comment	Date	Author
A00	Prep for GBE page G#39145	14/02/2021	BRM of GBE
A01	Prep for Webinar	08/04/2021	BRM of GBE
A02	Post Webinar update for GBE page	09/04/2021	BRM of GBE

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- Brian Murphy ONC HNC Construction, BSc Dip Architecture (Hons+Dist)
 - Technician and Architect by Training
 - Specification Writer by Choice
 - Environmentalist by Actions
 - Writer and Educator as a Calling
 - Number Cruncher by Necessity
- Greening up my act since 1999
- Founded National Green Specification 2001
- Launched www.greenspec.co.uk 2003
- Created: GBE at <https://GreenBuildingEncyclopaedia.uk> 2012 – 2021
- Created: GBL Learning: <https://GBELearning.com> 2020 - 2021
- Created: GBC at <https://GreenBuildingCalculator.uk> 2011 - 2021
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