Measuring Whole Life Carbon in the Built Environment

Part 1: The Basics

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January 2023

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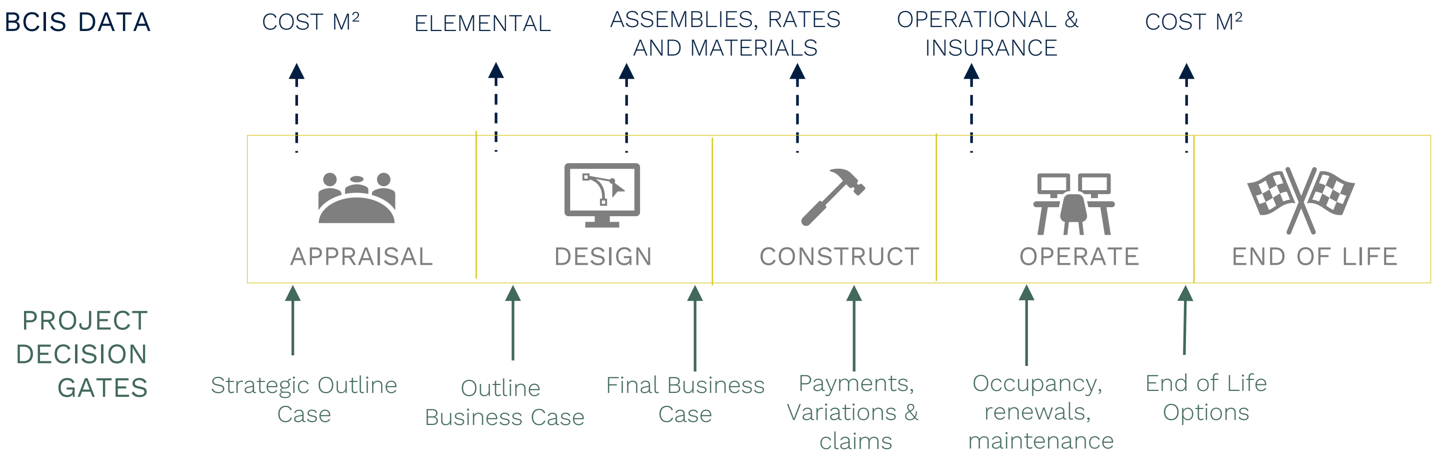
BECD
Built Environment Carbon Database

BUILDING COST INFORMATION SERVICE

- Leading independent provider of cost and price information to the construction industry
- Over 60 years experience in collecting, collating, analysing, modelling and interpreting cost information



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BACKGROUND

Climate change is one of the greatest environmental challenges of our time

Climate change due to ‘human-generated’ greenhouse gas (GHG) emissions to the atmosphere, referred to as carbon emissions, are very likely to have severe adverse environmental, social and financial effects around the world if temperature levels continue to rise.

40% of global greenhouse gas (GHG) emissions come from built environment and, if left unchecked, they’re predicted to double by 2050

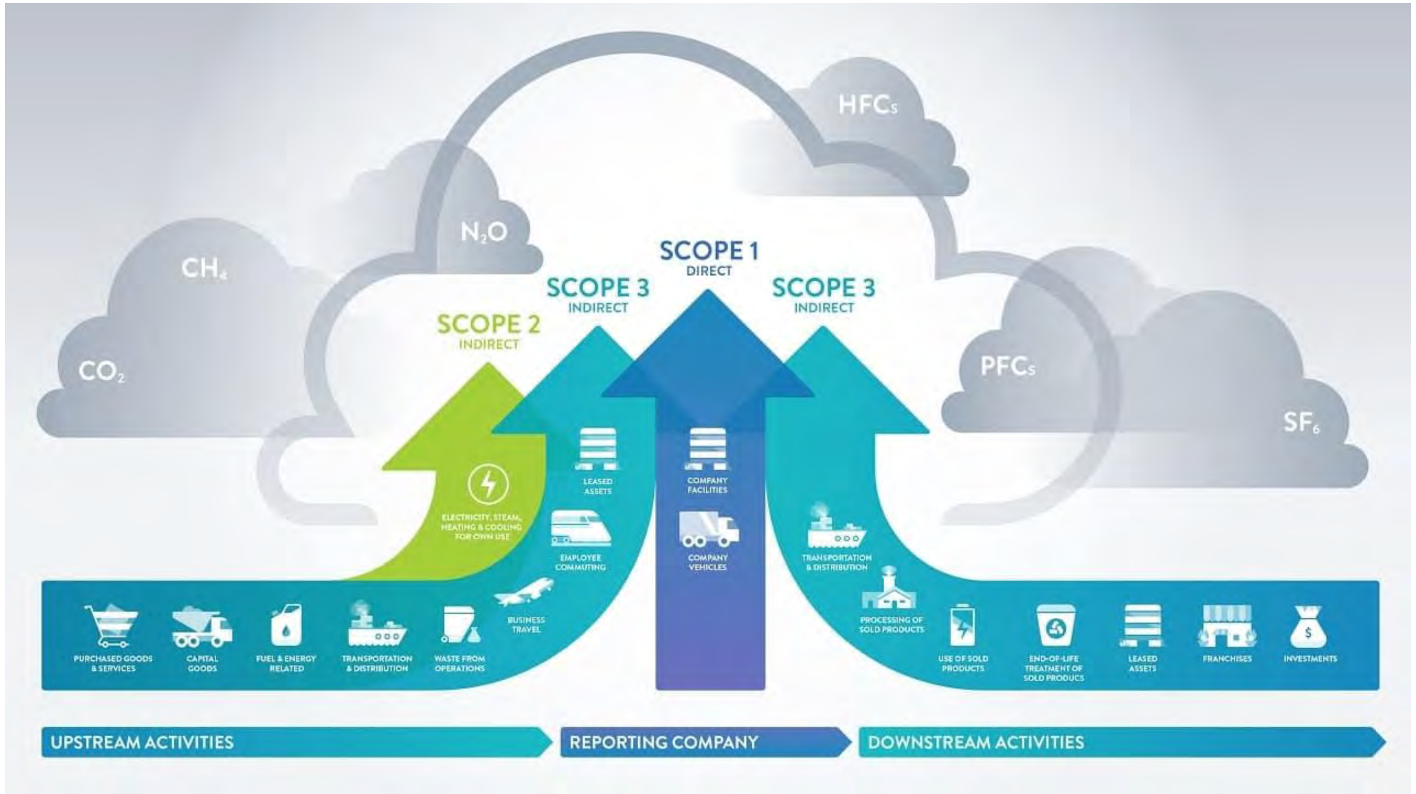
BACKGROUND

Some Businesses need to report their emissions:

•Scope 1 emissions are GHGs released directly from a business.

•Scope 2 emissions are indirect GHGs released from the energy purchased by an organization.

•Scope 3 emissions are also indirect GHG emissions, accounting for upstream and downstream emissions of a product or service, and emissions across a business's value chain.



Source: Green Element

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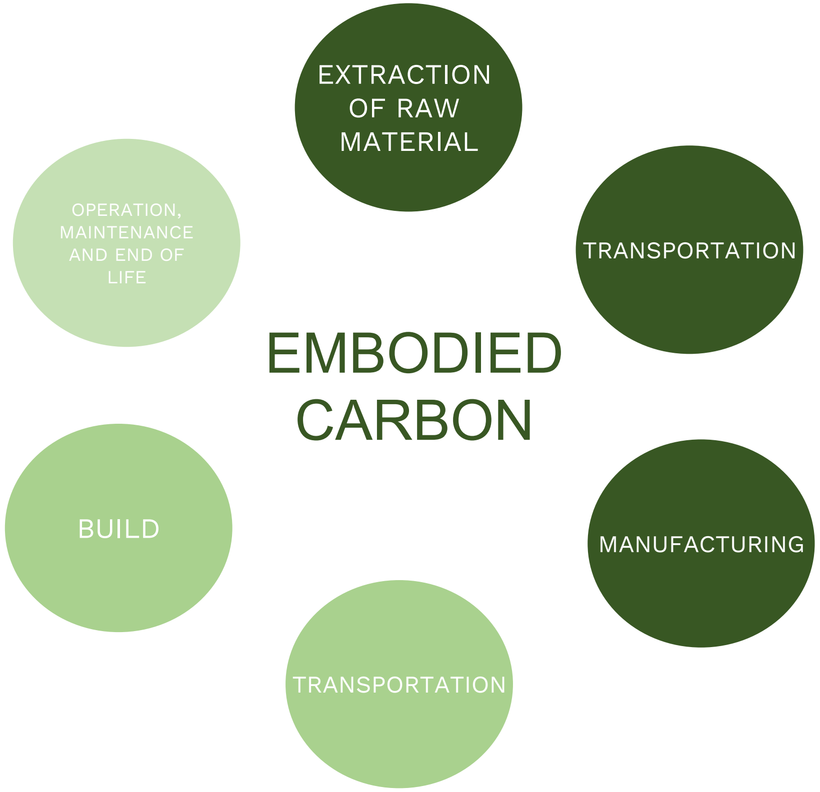
BACKGROUND

In the Built Environment GHG emissions are measured and reported in Carbon (CO^2e) and generally we refer to two types of carbon.

What is embodied carbon?

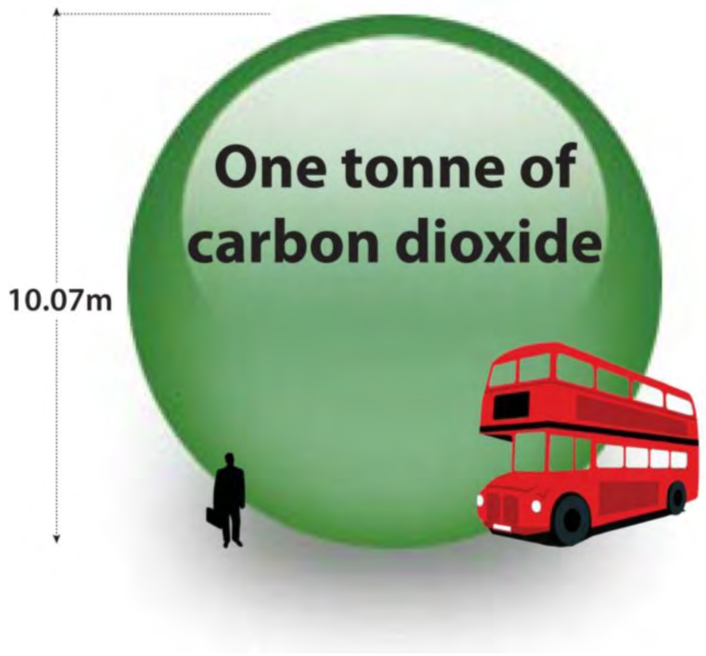
- Cradle to Gate
- Cradle to Site
- Cradle to End of construction
- Cradle to Grave
- Cradle to Cradle

What is operational carbon?



Both measured/reported in weight usually kg or tonnes

BACKGROUND



We now emit over 34 billion tonnes each year, in 1950 the world emitted 6 billion tonnes

BACKGROUND

The typical emissions throughout a buildings life...

Design 0.5% → Manufacture 35% → Distribution 0.1% → Construction 1% → Operation 63% → Refurb/ Demolish 0.4%

But of course this changes dramatically based on the building type and usage...

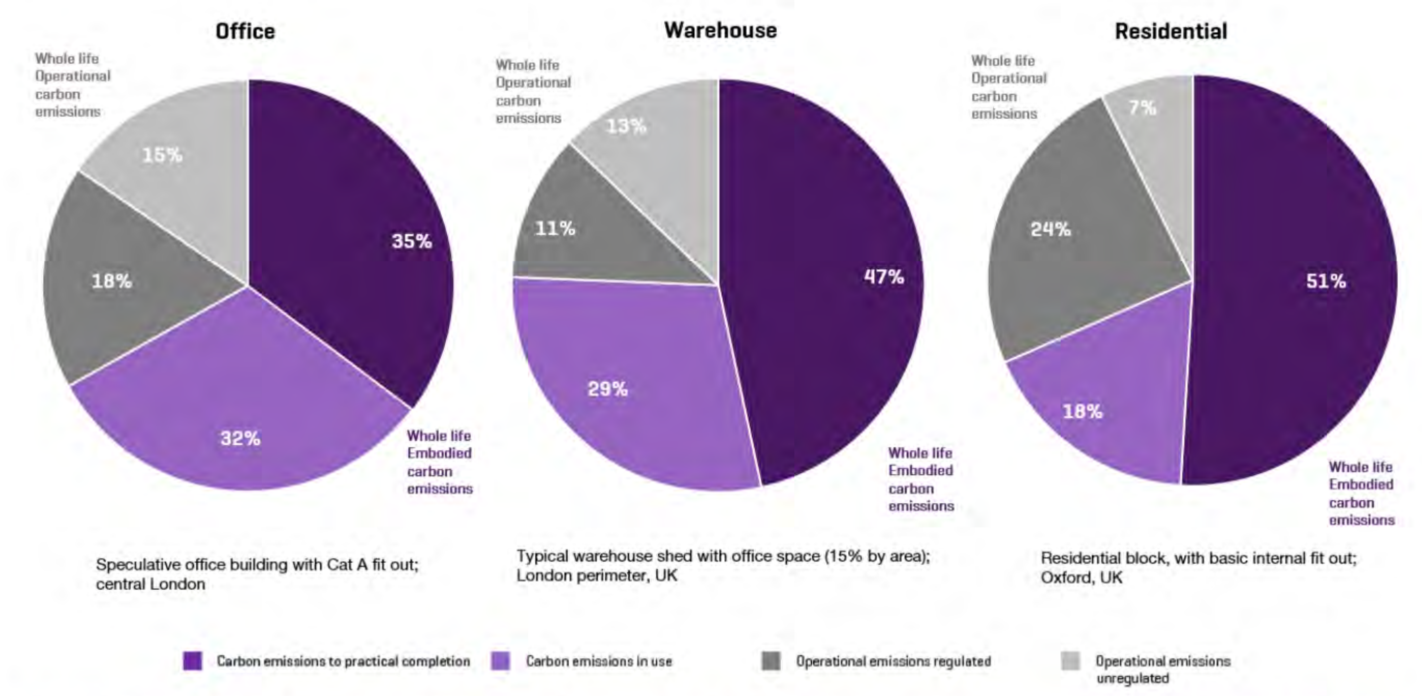


Figure 1: Total whole life carbon emissions breakdown for different building types © Sturgis Carbon Profiling

BACKGROUND

So, why am I here to talk to you today?

As a construction professional it is our duty to the planet to reduce the impacts we make

In the future we cannot reverse the decisions that we make

So, we need to make the right ones

HOW TO MEASURE CARBON

Three important things we need to measure and reduce carbon

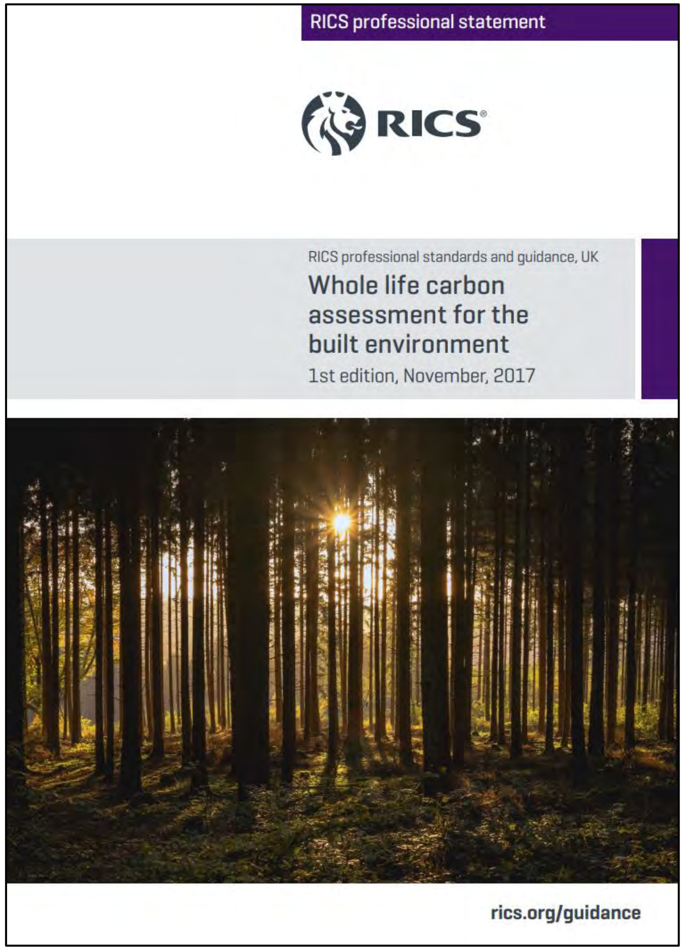
1) A standard methodology (This webinar)

2) Availability of consistent data (The second webinar)

3) Making it as easy as possible (Our third webinar)

THE METHODOLOGY

The framework for appraising the environmental impacts of the built environment is provided by EN 15978


RICS professional statement

RICS

RICS professional standards and guidance, UK

Whole life carbon assessment for the built environment

1st edition, November, 2017

rics.org/guidance

A document that provides RICS members with mandatory requirements or a rule that a member or firm is expected to adhere to.

Freely available on RICS.org to members and non-members of RICS

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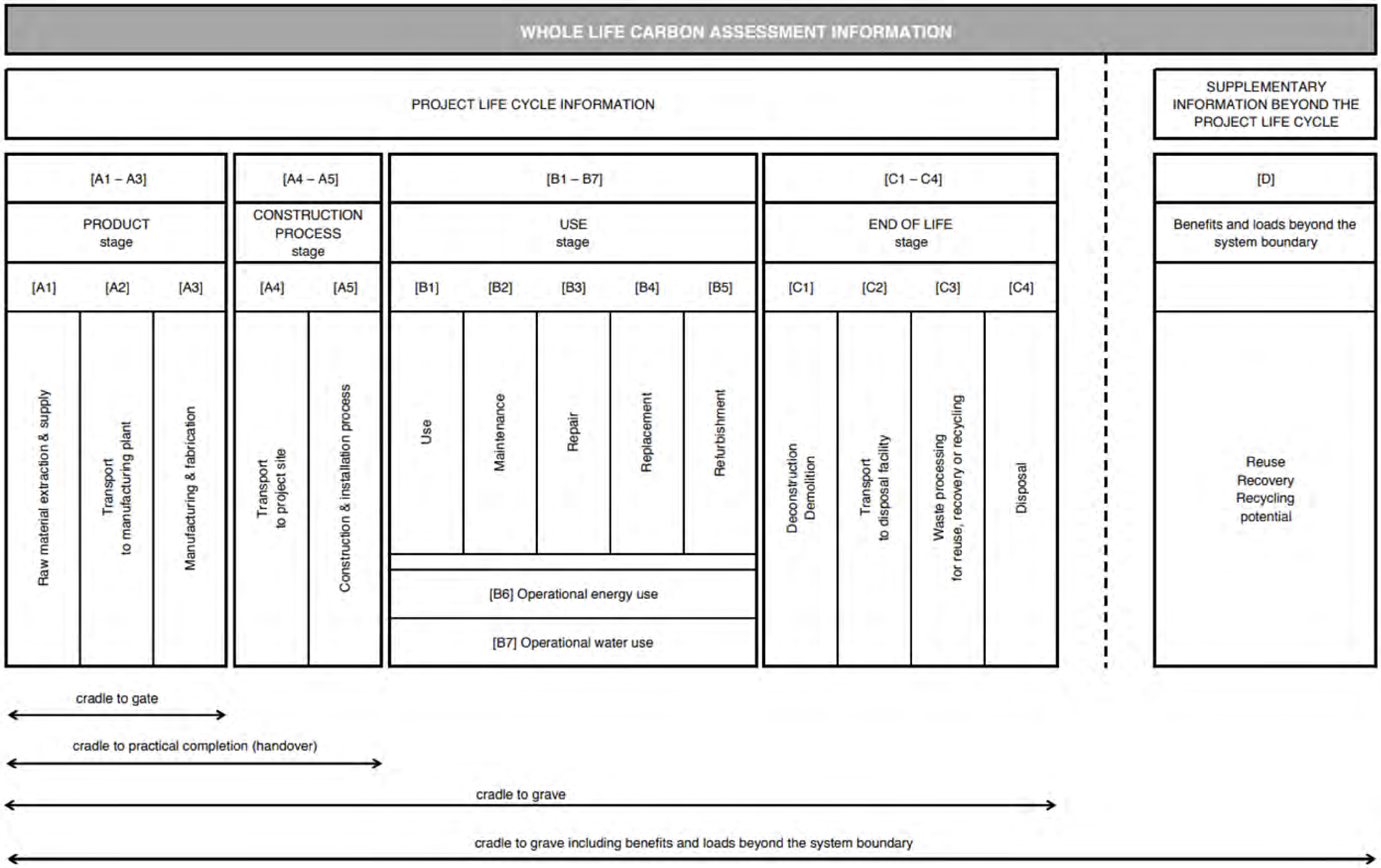
WHOLE LIFE CARBON ASSESSMENT INFORMATION
PROJECT LIFE CYCLE INFORMATION
SUPPLEMENTARY INFORMATION BEYOND THE PROJECT LIFE CYCLE
[A1 – A3]
PRODUCT stage
[A1]
[A2]
[A3]
Raw material extraction & supply
Transport to manufacturing plant
Manufacturing & fabrication
[A4 – A5]
CONSTRUCTION PROCESS stage
[A4]
[A5]
Transport to project site
Construction & installation process
[B1 – B7]
USE stage
[B1]
[B2]
[B3]
[B4]
[B5]
Use
Maintenance
Repair
Replacement
Refurbishment
[B6] Operational energy use
[B7] Operational water use
[C1 – C4]
END OF LIFE stage
[C1]
[C2]
[C3]
[C4]
Deconstruction Demolition
Transport to disposal facility
Waste processing for reuse, recovery or recycling
Disposal
[D]
Benefits and loads beyond the system boundary
Reuse Recovery Recycling potential
cradle to gate
cradle to practical completion (handover)
cradle to grave
cradle to grave including benefits and loads beyond the system boundary

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	Building part/Element group	Building element
	Demolition	0.1 Toxic/Hazardous/Contaminated Material treatment
		0.2 Major Demolition Works
0	Facilitating works	0.3 & 0.5 Temporary/Enabling Works
		0.4 Specialist groundworks
1	Substructure	1.1 Substructure
2	Superstructure	2.1 Frame 2.2 Upper floors incl. balconies 2.3 Roof 2.4 Stairs and ramps
2	Superstructure	2.5 External Walls 2.6 Windows and External Doors
2	Superstructure	2.7 Internal Walls and Partitions 2.8 Internal Doors
3	Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes
4	Fittings, furnishings and equipment (FF&E)	4.1 Fittings, Furnishings & Equipment incl. Building-related* and Non-building-related**
5	Building services/MEP	5.1–5.14 Services incl. Building-related* and Non-building-related**
6	Prefabricated Buildings and Building Units	6.1 Prefabricated Buildings and Building Units
7	Work to Existing Building	7.1 Minor Demolition and Alteration Works
8	External works	8.1 Site preparation works 8.2 Roads, Paths, Pavings and Surfacings 8.3 Soft landscaping, Planting and Irrigation Systems 8.4 Fencing, Railings and Walls 8.5 External fixtures 8.6 External drainage 8.7 External Services 8.8 Minor Building Works and Ancillary Buildings

Table 3: Building element groups to be considered (based on the BCIS SFCA)

The minimum scope that must be covered is as follows:

Minimum requirements for whole life carbon assessment	
Building parts to be included – see 3.2.2	**1. Substructure** **2. Superstructure**
Life stages to be included – see 3.2.4	**Product stage [A1–A3]** **Construction process stage [A4–A5]** **Replacement stage [B4]** for facade **Operational energy use [B6]**
Assessment timing	**At design stage – prior to technical design**

Table 2: Minimum requirements for whole life carbon assessment

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Reference Study Period

The RSPs that must be used for the purposes of whole life carbon assessment are defined as follows for the different types of uses of built assets:

- **domestic projects: 60 years** (BREEAM 2014 New Construction – Mat 01 Life cycle impacts; LEED v.4)
- **non-domestic projects: 60 years** (BREEAM 2014 New Construction – Mat 01 Life cycle impacts; LEED v.4)
- **infrastructure: 120 years** (according to case studies in PAS 2080).

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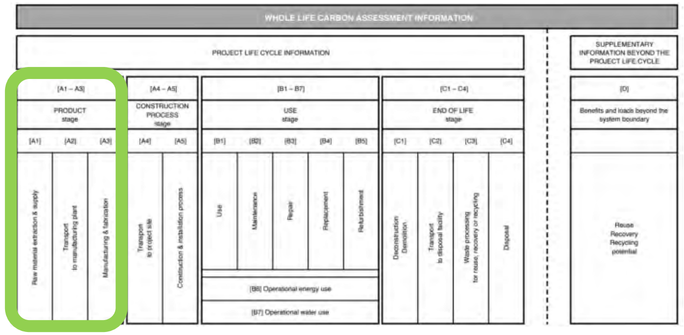

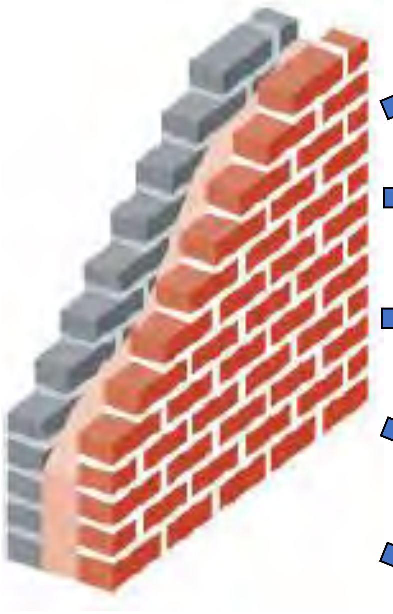

Quantity of concrete blocks	×	Embodied carbon of concrete blocks	=	Embodied carbon of concrete blocks
Quantity of insulation	×	Embodied carbon of insulation	=	Embodied carbon of insulation
Quantity of bricks	×	Embodied carbon of bricks	=	Embodied carbon of bricks
Quantity of mortar	×	Embodied carbon of mortar	=	Embodied carbon of mortar
Quantity of Wall ties	×	Embodied carbon of wall ties	=	Embodied carbon of wall ties

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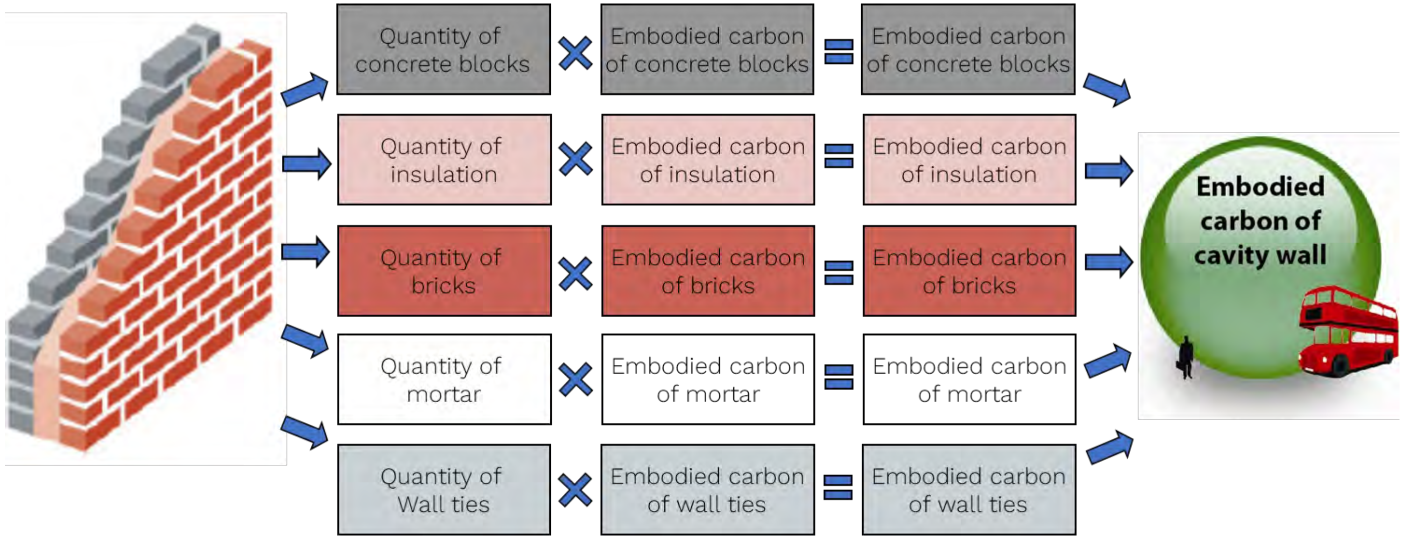

Material quantities from the following sources must be used and clearly stated in the whole life carbon assessment, in the following order of preference and subject to availability at the different project stages: 1. Materials delivery records, 2. BIM model, 3. Bill of quantities (BoQ) or cost plan, 4. Estimations from consultants' drawings.

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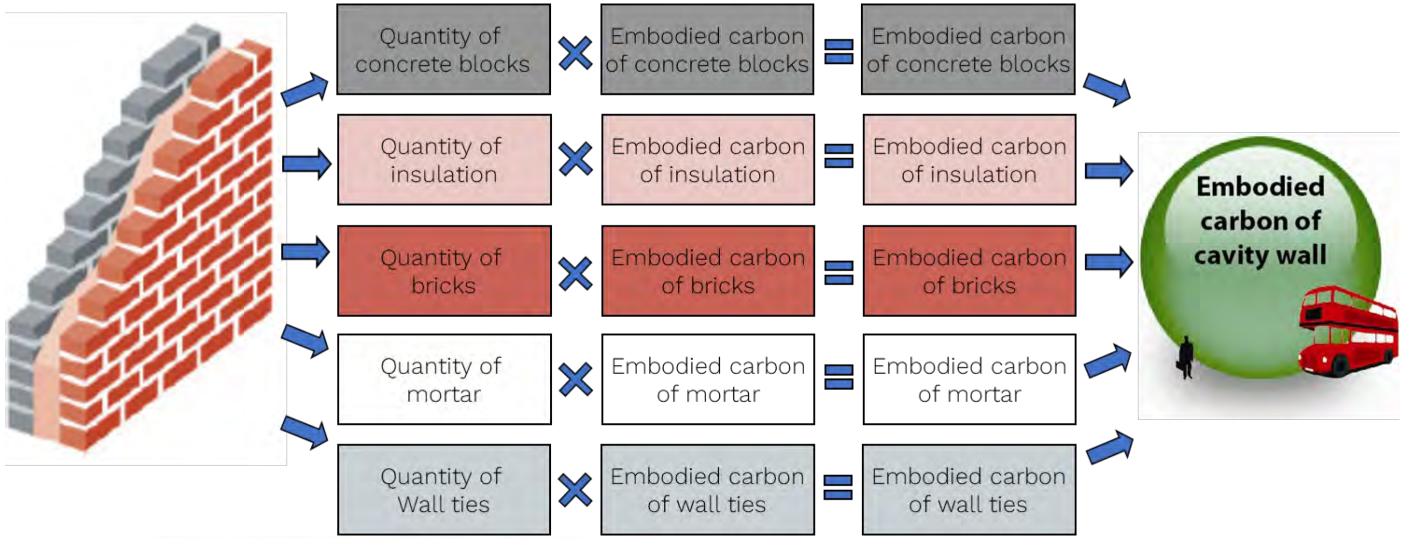

The assessor must explicitly state the data sources used in the whole life carbon assessment.

The following are acceptable sources of carbon data for materials and products, in order of preference:

- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with EN 15804**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 21930**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 14067**
- **EPDs and datasets in accordance with ISO 14025, ISO 14040 and 14044**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with PAS 2050.**

Preferred data	Selected work stages				
	Strategy, Brief and Concept	Design	Construction and commissioning	Operation	End of life
Generic: data typical of the type of component, product and/or material to be used	X	X	O	O	O
Specific: data specific to a manufacturers particular component, product and/or material	O	X	X	X	X
Average: data averaged across different manufacturers or production sites /lines for the same product and/or material	X	X	X	X	X
Collective: data created according to BS EN 15804 representing a category of products	O	X	X	X	X
Measured: data gathered from direct measurement for a component, product and/or material			X	X	X
Other	O	O	O	O	O

NOTE Cross (X) represents the preferred use of data; Circle (O) represents alternative sources if available.

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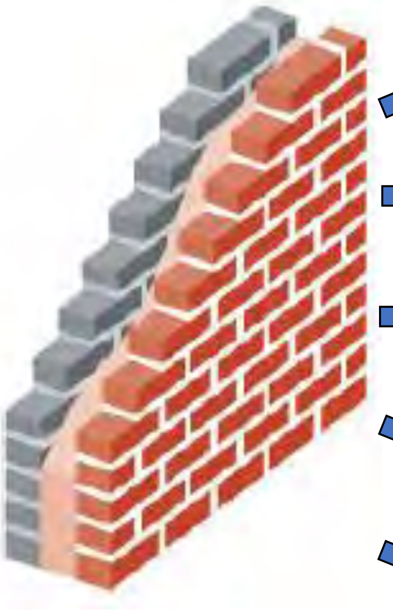
Per m^2 of wall….



63kg	×	0.133 kg CO_2e /kg	=	8.379 kg CO2e
7kg	×	1.280 kg CO2e /kg	=	8.960 kg CO2e
138kg	×	0.551 kg CO2e /kg	=	76.038 kg CO2e
55kg	×	0.221 kg CO2e /kg	=	12.155 kg CO2e
0.25kg	×	6.519 kg CO2e /kg	=	1.630 kg CO2e

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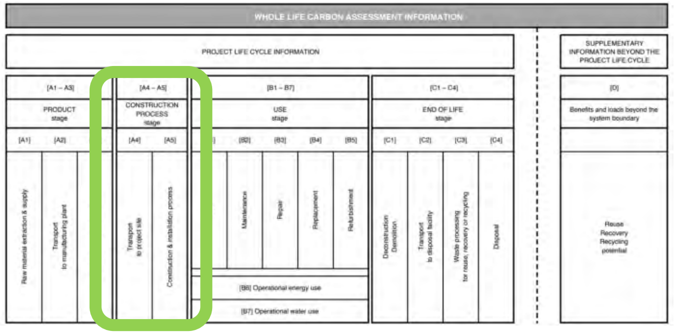

Transport scenario	km by road*	km by sea**
Locally manufactured e.g. concrete, aggregate, earth	50 [1]	-
Nationally manufactured e.g. plasterboard, blockwork, insulation	300 [1]	-
European manufactured e.g. CLT, façade modules, carpet	1,500 [2]	-
Globally manufactured e.g. specialist stone cladding	200 [3]	10,000 [3]

Table 7: Default transport scenarios for UK projects

* Means of transport assumed as average rigid HGV with average laden – average laden as per BEIS carbon conversion factors.

** Means of transport assumed as average container ship.

3.5.2.2 [A5] Construction – installation process emissions

This section refers to EN 15978; 7.4.3.3 and 8.5, EN 15804; 6.2.3.

The carbon emissions arising from any on- or off-site construction-related activities must be considered in [A5]. This includes any energy consumption for site accommodation, plant use and the impacts associated with any waste generated through the construction process, its treatment and disposal.

The following figure can be used as an average for building construction site emissions, in the absence of more specific information: **1400kgCO_2e/£100k** of project value (BRE Meeting Construction 2025 Targets – SMARTWaste KPI p.3, footnote 9). The cost figure is based on the date of the publication, March 2015, and should be adjusted to current value in accordance with CPI. Average data from contractors' site emissions monitoring suggest similar levels of construction emissions. This rate should be refined by substitution with site monitoring data provided by the project contractor as these become available.

The carbon emissions associated with any waste generated during the construction process should be accounted for in accordance with the principles outlined for the product and transport stage [A1–A3] and [A4] – see 3.5.1 and 3.5.2 – and EoL stages [C2–C4] – see 3.5.4.

Depending on the disposal scenarios developed for site waste, the following carbon impacts are applicable to the respective waste quantities. Provided the current high diversion from landfill rates for site waste, a 90 per cent recovery per 10 per cent landfill assumption can be taken as default for site waste disposal– see section 3.5.4. The selection of on-site or off-site reuse or recycling scenarios for the different items should be based on project-specific information.

Site waste disposal scenarios		
Disposal to landfill/incineration	Reuse or recycling on-site	Reuse or recycling off-site
[A1–A3] + [A4] + [C2] + [C4]	[A1–A3] + [A4] + [C3]	[A1–A3] + [A4] + [C2] + [C3]

Table 8: Site waste disposal scenarios

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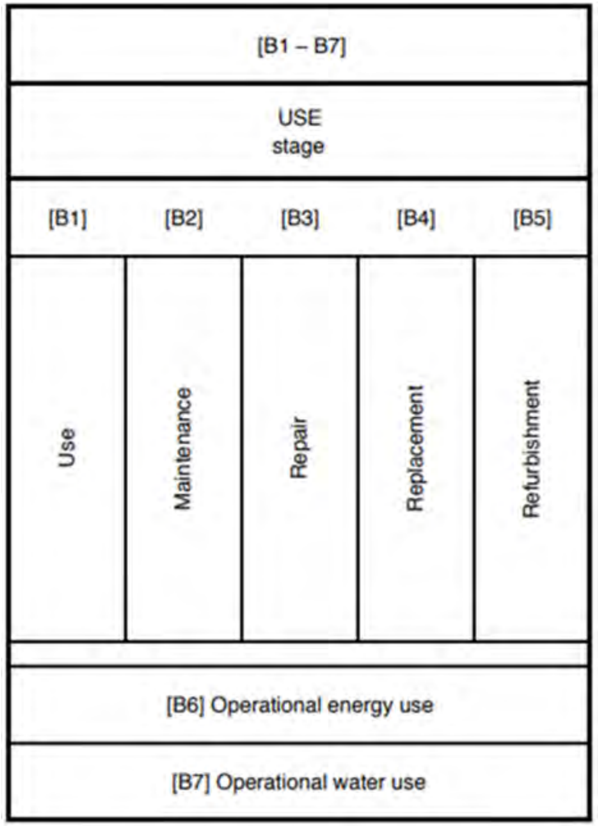
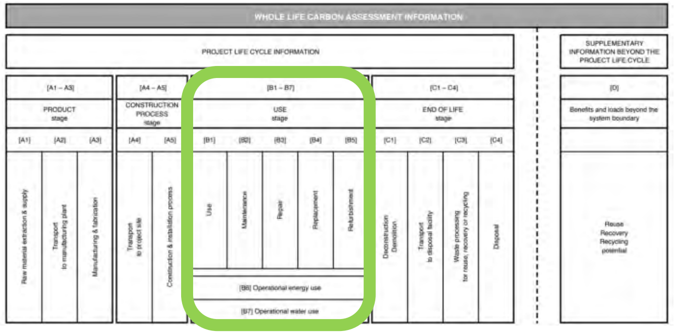


Building part	Building elements/components	Expected lifespan
Roof	Roof coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall finishes: Render/Paint	30/10 years respectively
	Floor finishes Raised Access Floor [RAF]/Finish layers	30/10 years respectively
	Ceiling finishes Substrate/Paint	20/10 years respectively
FF&E	Loose furniture and fittings	10 years
Services/MEP	Heat source, e.g. boilers, calorifiers	20 years
	Space heating and air treatment	20 years
	Ductwork	20 years
	Electrical installations	30 years
	Lighting fittings	15 years
	Communications installations and controls	15 years
	Water and disposal installations	25 years
	Sanitaryware	20 years
	Lift and conveyor installations	20 years
Facade	Opaque modular cladding e.g. rain screens, timber panels	30 years
	Glazed cladding/Curtain walling	35 years
	Windows and external doors	30 years



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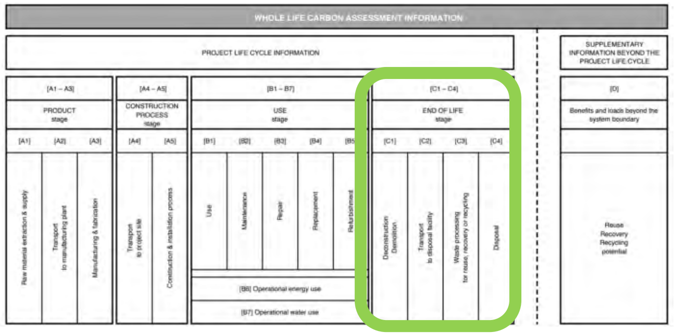

The EoL stage commences when the built asset has reached the end of its life and will no longer be used. For the purposes of the whole life carbon assessment this is assumed to occur at the end of the reference study period of the building as defined in 3.2.3.

Any emissions arising from decommissioning, stripping out, disassembly, deconstruction and demolition operations as well as from transport, processing and disposal of materials at the end of life of the project must be accounted for in module [C].

The EoL stage is considered complete within the scope of whole life carbon assessment when the site is cleared and levelled to the ground plane and is ready for further use.

The assessor should develop suitable project-specific EoL scenario(s) at a building level as well as individual components level where relevant, based on future intentions provided by the project team, precedent and current EoL practices. The EoL scenario(s) should be clearly stated and explained within the whole life carbon assessment report.

In the absence of specific information, scenarios on the proportion of landfilling, reuse and/or recycling each item at the EoL should be developed according to current standard practice.

Metal	Recovery rate Repurposing: reuse or recycling		Disposal Landfill	
	UK	Global	UK	Global
Steel	96% [1]	85% [2]	4%	15%
Aluminium	96% [3]	85% [4]	4%	15%
Copper	65% [5]	65% [5]	35%	35%

Table 10: Default metal recovery rates

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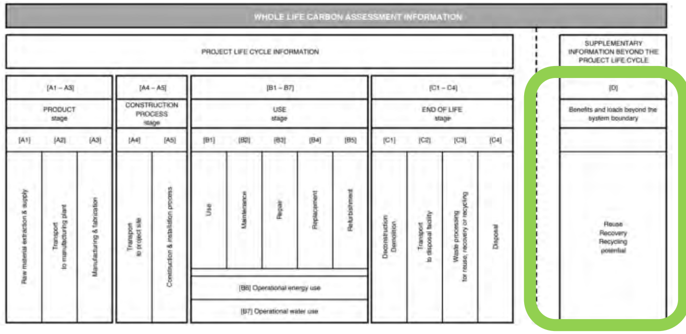

Module [D] includes the potential environmental benefits or burdens of materials and components beyond the life of the project. Module [D] must be reported separately and not aggregated with cradle to grave modules [A–C].

Module [D] is communicated separately as it occurs beyond the life cycle of the project under study and also bears high inherent uncertainty regarding the future treatment of building components. It is, however, important to assess module [D] figures along with cradle-to-grave [A–C] figures to acquire a holistic understanding of the environmental impacts of a built project. This has to take potential future benefits or loads into account and promotes thinking about the future, encouraging connectivity between current and future projects.

SUMMARY

We are in the **biggest fight of our lives** and we all need to be **doing something about it**

Guidance on how to measure the impacts of design choices is available

Data availability is the focus of our next webinar

More data will help sharing, learning and driving future improvement