



Improving Consistency in Whole Life Carbon Assessment and Reporting

Carbon Definitions
for the Built Environment,
Buildings & Infrastructure

For inclusion in the update
of the RICS Professional
Statement: 'Whole life
carbon assessment for the
built environment' - 2023



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Contents

1 Introduction

2 Carbon and Net Zero Definitions for Buildings and Infrastructure

- Carbon Definitions
- Net Zero Definitions

3 Achieving Net Zero Carbon

4 Appendix: Documents examined in the preparation of these definitions

1 Introduction

The UK is required to achieve 'Net Zero' by 2050 (Climate Change Act as amended 2019), and 78% Reductions by 2035 (Climate Change Act as amended 2021) and 68% reductions by 2030 (COP26 Nationally declared contribution). The built environment globally is responsible for some 47% of Greenhouse Gas (GHG) emissions (Buildings and Infrastructure) and is therefore making efforts to decarbonize the delivery of buildings and infrastructure across all professions and disciplines.

However there remains significant inconsistency with respect to the basic definitions in use with reference to carbon and net zero carbon terminologies over the life cycle of buildings and infrastructure.

This document provides a common set of definitions for the built environment sector. It has been put together initially by a working group within the Whole Life Carbon Network (WLCN, a group of some 90 built environment professionals) and including detailed discussions between WLCN, LETI, CIBSE, RIBA, RICS, IStructE, ICE, and UKGBC.

The 'Definitions' are structured around CEN TC 350 life cycle modules, (e.g. BS EN 15978:2011 for buildings, BS EN 17472: 2022, PAS 2080:2016 for Infrastructure, BS EN 15643 2021.).

The Working Group for these definitions is as follows:

Jane Anderson	ConstructionLCA
Will Arnold	The Institution of Structural Engineers
Clara Bagenal George	Elementa Consulting/LETI
Louisa Bowles	Hawkins Brown
Matthew Collins	RICS
Karl Desai	UKGBC
Michal Drewniok	University of Leeds
Mark Edwards	Gatwick Airport/ICE
Jannik Giesekam	University of Strathclyde
Julie Godefroy	CIBSE
Louise Hamot	Elementa Consulting
Mina Hasman	Skidmore Owings & Merrill/Climate Framework
Ben Hopkins	Bennetts Associates
Smith Mordak	Buro Happold
Simon Sturgis (<i>chair</i>)	Targeting Zero
Alex Tait	RIBA
Tom Wigg	UKGBC
Simon Wyatt	Cundall

2 Carbon and Net Zero Definitions for Buildings and Infrastructure

There are currently many variations in the terminology used to define carbon emissions (operational, embodied, whole life etc.) which leads to confusion amongst stakeholders. The definitions in this document build on the work of others (see Appendix) but have been altered and developed as a ‘family’ of definitions that work together, with the intention of achieving greater consistency across the built environment industry.

The ‘net zero carbon’ definitions set out below are based on the ‘Paris Proof’ approach which dictates that the Built Environment Industry should only use the limited amount of carbon – including energy and material resources – apportioned to it, in order for the UK economy as a whole to reach net zero emissions by 2050 and ensure best efforts to limit global warming to 1.5 degrees Celsius, a trajectory supported by the Science Based Targets Initiative. This requires reducing global built environment emissions by 50% by 2030, required by reducing global built environment emissions as a priority measure, and a decreasing reliance on offsets over time to achieve a net zero carbon balance.

These Definitions apply to buildings and infrastructure in the following Modular structure:

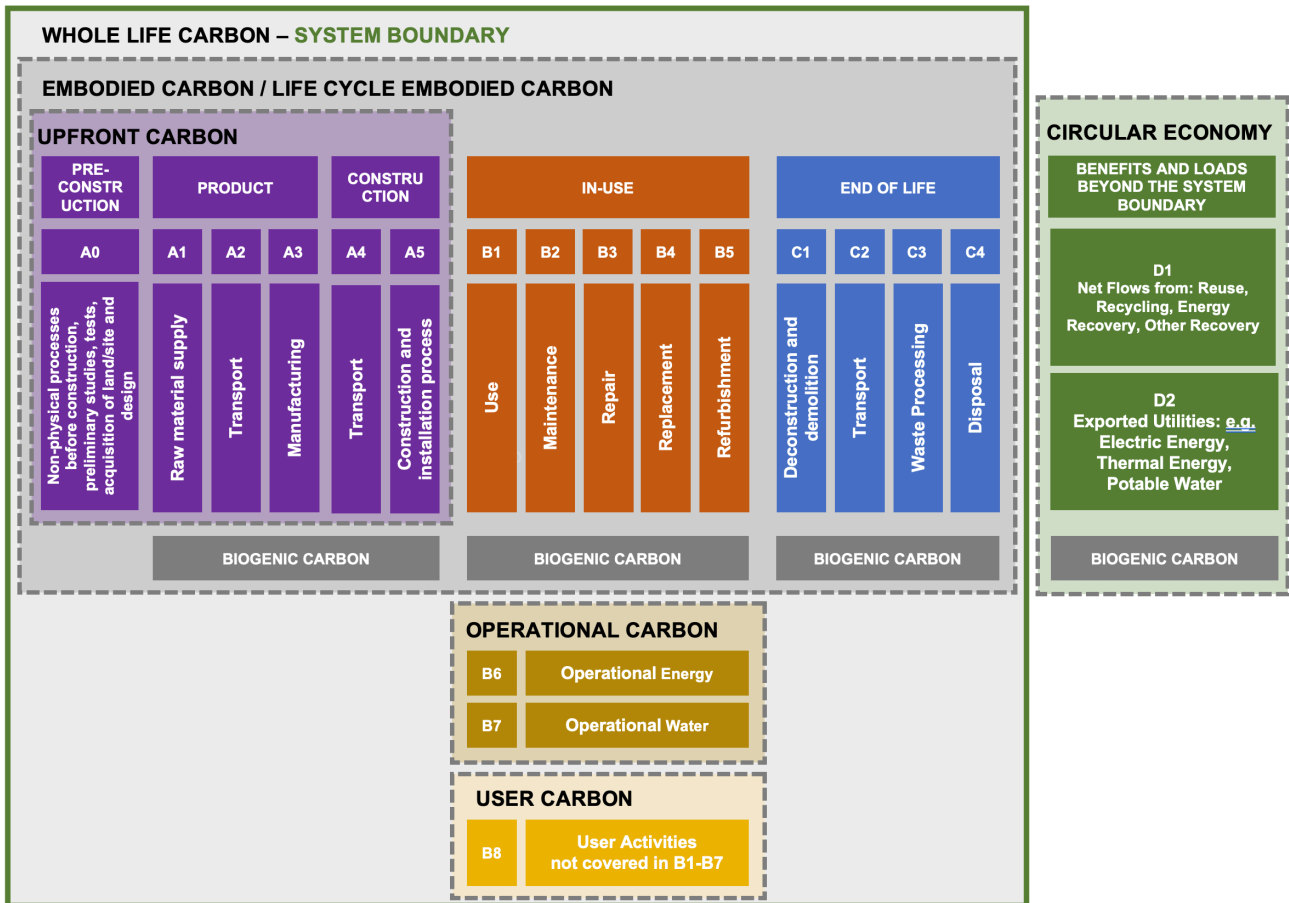


Diagram 1: Showing the Life Cycle Modules adapted from BS EN 15978, BS EN 17472, PAS 2080: 2016 and expected in future updates. NB: A0 is generally assumed to be zero for buildings, however for infrastructure projects A0 can include ground investigations and activities associated with designing the asset.

Carbon Definitions

Greenhouse Gases (GHG)

(Often referred to as 'carbon emissions' in general usage):

'Greenhouse Gases' are constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds.¹

Whole Life Carbon

Whole Life Carbon' emissions are the sum total of all asset related GHG emissions and removals, both operational and embodied over the life cycle of an asset including its disposal (Modules: A0-A5; B1-B7; B8 optional; C1-C4, all including biogenic carbon, with A0² assumed to be zero for buildings). Overall Whole Life Carbon asset performance includes separately reporting the potential benefits or loads from future energy or material recovery, reuse, and recycling and from exported utilities (Modules D1, D2)³.

Embodied Carbon or Life Cycle Embodied Carbon

'Embodied Carbon' emissions of an asset are the total GHG emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset (Modules A0-A5, B1-B5, C1-C4, with A0² assumed to be zero for buildings)³.

Upfront Carbon - Buildings

'Upfront Carbon' emissions are the GHG emissions associated with materials and construction processes up to practical completion (Modules A0-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion³.

Operational Carbon – Energy, Buildings

'Operational Carbon – Energy' (Module B6) are the GHG emissions arising from all energy consumed by an asset in-use, over its life cycle.

Capital Carbon - Infrastructure

The scope of 'Capital Carbon' GHG emissions for an Infrastructure asset are those that align with the scope of Capital Expenditure (or Capex) as determined by the asset owner's preference. Modules A and C must always be included within the scope, with Modules B1-B5 clearly identified as 'Capital' or 'Operational' within the scope.

¹ For these 'Carbon Definitions', we are only addressing the GHGs with Global Warming Potential assigned by the Intergovernmental Panel on Climate Change (IPCC), e.g. carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFC's), perfluorocarbons (PFC's), and sulphur hexafluoride (SF₆).

² A0 is generally assumed to be zero for buildings, however for infrastructure projects A0 can include ground investigations and activities associated with designing the asset.

³ Demolition of existing structures or buildings must be separately identified and included within Module A5.

Operational Carbon - Infrastructure	The scope of 'Operational Carbon' GHG emissions of an infrastructure asset are those that align with the scope of Operational Expenditure (or Opex) as determined by the asset owner's preference. Modules B1-B5 must each be clearly identified as 'Capital Carbon' or 'Operational Carbon' within the scope. Module B8 must be clearly identified as 'Operational Carbon' or 'User Carbon' within the scope. Modules B6 and B7 are always 'Operational Carbon' within the scope.
Operational Carbon - Water	'Operational Carbon – Water' (Module B7) are those GHG emissions arising from water supply and wastewater treatment for an asset in-use, over its life cycle.
Carbon Sequestration	'Carbon Sequestration' is the process by which carbon dioxide is removed from the atmosphere and stored within a material – e.g. stored as 'Biogenic Carbon' in 'Biomass' by plants/trees through photosynthesis and other processes.
Biogenic Carbon	'Biogenic Carbon' refers to the carbon removals associated with carbon sequestration into biomass as well as any emissions associated with this sequestered carbon. Biogenic carbon must be reported separately if reporting only upfront carbon but should be included in the total if reporting embodied carbon or whole life carbon.
Biomass	'Biomass' is material of biological origin excluding material embedded in geological and/or fossilized formations.
User Carbon	'User Carbon' (B8) are those GHG emissions associated with user's utilisation of the buildings or infrastructure during the use stage excluding B6 and B7. These must be clearly identified as 'Operational Carbon' or 'User Carbon' within the scope if addressed.

Net Zero Definitions

<p>Net Zero (whole life) Carbon</p>	<p>A 'Net Zero (whole life) Carbon' Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A0-A5, B1-B8, C1-C4) are minimized, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero⁴.</p>
<p>Net Zero Embodied Carbon or Net Zero Life Cycle Embodied Carbon</p>	<p>A 'Net Zero Embodied Carbon' asset is one where the sum total of GHG emissions and removals over an asset's life cycle (Modules A0-A5, B1-B5 and C1-C4) are minimized, which meets local carbon targets or limits (e.g kgCO₂e/m²), and with additional 'offsets', equals zero.</p>
<p>Net Zero Upfront Carbon</p>	<p>A 'Net Zero Upfront Carbon' asset is one where the sum total of GHG emissions, excluding 'biogenic carbon', from Modules A0-A5 is minimized, which meets local carbon targets or limits (e.g kgCO₂e/m²), and with additional 'offsets', equals zero.</p>
<p>Net Zero Capital Carbon - Infrastructure</p>	<p>A 'Net Zero Capital Carbon' infrastructure asset is one where the sum total of GHG emissions, as aligned with the scope of Capital Expenditure (or Capex) as determined by the asset owner's preference but always including Module A and C, is minimized, meets local carbon targets or limits (e.g. kgCO₂e/m²), and with additional 'offsets', equals zero.</p>
<p>Net Zero Operational Carbon – Energy</p>	<p>A 'Net Zero Operational Carbon – Energy' asset is one where no fossil fuels are used, all energy use (Module B6) has been minimized, meets the local energy use target or limit (e.g. kWh/m²/a) and all energy use is generated on- or off- site using renewables that demonstrate additionality. Direct emissions from renewables and any upstream emissions are 'offset'.⁵</p>
<p>Net Zero Operational Carbon - Infrastructure</p>	<p>A 'Net Zero Operational Carbon' infrastructure asset is one where the sum total of GHG emissions, as aligned with the scope of Operational Expenditure (or Opex) as determined by the asset owner's preference, has been minimised and meets local carbon, energy and water targets or limits, and where no fossil fuels have been used for operational energy use (Module B6), and which, with additional 'offsets', equals zero.</p>

⁴ To meet the requirements of 'Net Zero (whole life) Carbon' the definitions for 'Net Zero Upfront Carbon', 'Net Zero Embodied Carbon', 'Net Zero Capital Carbon', 'Net Zero Operational Carbon – Energy', 'Net Zero Operational Carbon – Infrastructure', 'Net Zero In-Use Carbon Asset' and 'Net Zero Operational Carbon – Water' must also be individually met as applicable.

⁵ Note: Direct emissions must include CH₄ and N₂O emissions from the combustion of biomass and biodiesel fuels. Upstream emissions include: direct and indirect emissions from energy generation and distribution, WTT emissions for energy consumed in the building and from energy generation and distribution.

Net Zero Operational Carbon - Water

A 'Net Zero Operational Carbon - Water' asset is one where water use (Module B7) is minimized, meets local water targets or limits (e.g. litres/person/year) and where those GHG emissions arising from water supply and wastewater treatment are 'offset'.

Net Zero In-Use Asset

A 'Net Zero In-Use Carbon Asset' is one where on an annual basis the sum total of all asset related GHG emissions, both operational and embodied, (Modules B1-B8) are minimized, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero.

Additionality⁶

Procurement of renewable energy for the asset's use which results in new installed renewable energy capacity that otherwise would not have occurred had the intervention not taken place.

Carbon Neutral

All carbon emissions are balanced with offsets based on carbon removals or avoided emissions.

Absolute Zero Carbon

Eliminating all carbon emissions without the use of offsets.

⁶ See UKGBC's 'Renewable Energy Procurement and Carbon Offsetting – Guidance for Net Zero Carbon Buildings' - March 2021. Section 2 p14/15.

3 Achieving Net Zero Carbon

Calculating Whole Life Carbon over the life cycle to achieve Net Zero Carbon

The table below sets out how to achieve net zero carbon at each project stage. It also illustrates the type of assessment (e.g. prediction based on generic or specific values, or calculated or estimated based on as built values) that must be carried for each life cycle stage, and the relationship to achieving net zero through the use of carbon offsets for residual offsets.

Calculating Whole Life Carbon over the life cycle to achieve Net Zero Carbon								
Whole Life Carbon								Assess Separately
Project Stage	RIBA Stage	Pre-Construction (A0)	Upfront Carbon (A1-A5)	In-Use Embodied Carbon (B1-B5)	In-Use Operational Carbon - Energy, Water and other uses (B6-B7)	User Carbon (B8)	End of Life (C1-C4)	Module D
Early Concept Design	0-3	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values	Prediction based on generic values
Technical Design & Construction	4-5	Calculated on actual values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values	Prediction based on specific values
Post Completion	6		Calculated on actual values	Prediction updated using as built values	Prediction updated using as built values	Prediction updated using as built values	Prediction updated using as built values	Prediction updated using as built values
Use Stage	7			Calculated on actual usage	Calculated on actual metered consumption	Calculated on actual measured use	Prediction updated using as built values from B3-B5	Prediction updated using as built values from B3-B5
End of life							Calculated on actual values	Prediction updated using as deconstructed values
Future Projects (A1-A3)								Calculated on actual values
Residual Offsets to achieve 'Net Zero'		At Practical Completion based on third party verified assessment	At Practical Completion based on third party verified assessment	Annually in use based on third party verified assessment	Renewable energy with annual offsets for residual indirect emissions from energy and water	Annually in use based on third party verified assessment	End of Life based on third party verified assessment	N/A
KEY:								
Net Zero Carbon in design		Designed to be 'Net Zero Carbon', but which does not have actual embodied or operational performance data to allow verification of 'Net Zero Carbon' status						
Net Zero Carbon enabled		Designed to be 'Net Zero Carbon' 'In-Use', but which does not have actual 'In-Use' or 'End of Life' performance data to allow verification of 'Net Zero Carbon' status						
Net Zero Carbon		Verified as 'Net Zero Carbon', using actual measured data and a third party verified assessment. Net Zero 'Upfront Carbon' can be claimed at Practical Completion, and 'Net Zero' 'In-Use' can be claimed annually.						

Diagram 2: This table sets out how to achieve net zero carbon at each project stage. It also illustrates the requirements across project life cycle modules through to Module D and the relationship to achieving net zero through residual carbon offsets.

Explanatory Notes for Diagram 2: (see UKGBC’s ‘Renewable Energy Procurement and Carbon Offsetting – Guidance for Net Zero Carbon Buildings’ - March 2021 for a comprehensive explanation of Offsetting).

- **‘Carbon offsets’** are emissions reductions or removals achieved by one entity and can be used to compensate (offset) emissions from another entity.
 - Offsets must be verified and retired in line with the GHG protocol.
 - Carbon emissions must be minimized as indicated in the definitions above before offsetting.
 - Offsets should be purchased in advance where possible and retired as indicated in the table above.
 - Exported renewable energy generated cannot be used to account for embodied carbon.
 - *The potential loads and benefits of recovery of material from the asset beyond the system boundary must not be used to offset the whole life carbon of the asset at any project stage.*
 - The potential benefit of renewable energy generated and exported from the asset must not be used to offset the whole life carbon of the asset at any project stage.

- **‘Generic values’** assessed using estimated quantities, and typical appropriate national*** carbon factors from accepted industry databases (source and the territorial scope must be stated).
- **‘Specific values’** values assessed using estimated quantities and appropriate national*** carbon factors (from accepted industry databases), adapted to the project location*, or actual EPD values (adapted to the project location*), if materials or systems have already been purchased-
- **‘Actual values’** or **‘as built values’** values assessed using actual quantities and carbon factors from EPD for the actual products / systems used (adapted to the project location**). If EPDs are not available, values assessed using actual quantities and appropriate national*** carbon factors (from accepted industry databases), adapted to the project location**,

* Transport, including predicted waste quantities, predicted on-site waste transportation and predicted waste treatment

**Transport, including actual on-site waste quantities, actual waste transportation and actual waste treatment)

*** If national carbon factors are not available regional or global carbon factors may be used instead.

For example;

- At the concept design stage the asset can be predicted to be net zero, based on generic values.
- At Project Completion an asset can be net zero upfront carbon based on actual values, subject to verification and residual offsets.
- At Project Completion, an asset is also potentially net zero carbon enabled to allow the occupier to achieve a net zero occupation subject to actual usage data, and actual metered consumption plus residual associated offsets.

4 Appendix

Documents examined in the preparation of these definitions:

DGNB: German Sustainable Building Council	https://www.dgnb-system.de/en/index.php
UKGBC: Zero Carbon Buildings	UKGBC Zero Carbon Buildings: A Framework Definition: https://www.ukgbc.org/wp-content/uploads/2019/04/Net-Zero-Carbon-Buildings-A-framework-definition.pdf
LETI: Climate Emergency Design Guide	https://www.leti.london/cedg
LETI: Embodied Carbon primer	https://www.leti.london/ecp
WGBC: Bringing Embodied Carbon Upfront	WorldGBC Net Zero: https://www.worldgbc.org/advancing-net-zero/what-net-zero
CCC - Net Zero- The UK's contribution to stopping Global Warming	https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/
Office for National Statistics (ONS): Net zero and the different official measures of the UK's greenhouse gas emissions	https://www.ons.gov.uk/economy/environmentalaccounts/articles/netzeroandthedifferentofficialmeasuresoftheksgreenhousegasemissions/2019-07-24
RIBA 2030 Challenge	https://www.architecture.com/about/policy/climate-action/2030-climate-challenge
IPCC: The Carbon Cycle and Atmospheric carbon Dioxide	https://www.ipcc.ch/site/assets/uploads/2018/02/TAR-03.pdf
RICS Professional Statement: Whole life carbon assessment for the built environment	https://www.rics.org/globalassets/rics-website/media/upholding-professional-standards/sector-standards/building-surveying/whole-life-carbon-assessment-for-the-built-environment-1st-edition-rics.pdf
Greater London Authority- Policy S12 Whole Life Carbon Draft Detailed Guidance	https://www.london.gov.uk/what-we-do/planning/implementing-london-plan/planning-guidance/whole-life-cycle-carbon-assessments-guidance-pre-consultation-draft

BS EN 15978: 2011	https://shop.bsigroup.com/ProductDetail/?pid=00000000030256638
BS EN 15643:2021	https://shop.bsigroup.com/products/sustainability-of-construction-works-framework-for-assessment-of-buildings-and-civil-engineering-works/standard
BS EN 15804:2012+A2:2019	https://shop.bsigroup.com/products/sustainability-of-construction-works-environmental-product-declarations-core-rules-for-the-product-category-of-construction-products-2/standard
BS EN 17472:2022	https://shop.bsigroup.com/products/sustainability-of-construction-works-sustainability-assessment-of-civil-engineering-works-calculation-methods/standard
PAS 2080: 2016	https://shop.bsigroup.com/products/carbon-management-in-infrastructure/standard
Climate Change Act Amendment 2019	https://www.legislation.gov.uk/ukdsi/2019/9780111187654
CIBSE TM65 Embodied Carbon Methodology	https://www.cibse.org/knowledge/knowledge-items/detail?id=a0q3Y00000IPZOhQAP
IStructE How to Calculate Embodied Carbon (2nd Ed)	https://www.istructe.org/resources/guidance/how-to-calculate-embodied-carbon/
UKGBC Renewable Energy Procurement and Carbon Offsetting	https://www.ukgbc.org/wp-content/uploads/2021/03/Renewable-Energy-Procurement-Carbon-Offsetting-Guidance-for-Net-Zero-Carbon-Buildings.pdf
UN Race to Zero Lexicon	https://unfccc.int/climate-action/race-to-zero-campaign