EMBODIED CARBON ASSESSMENT & BENCHMARKING

NEW LIGHT INDUSTRIAL SPACE

THE ARCH COMPANY

Issued by:

Engineering Services Consultancy Ltd

Griffin House, 19 Ludgate Hill, Birmingham, B3 1DW

T: 0121 214 8998 www.escuk.com

Issue date: 12/10/2022

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OUR PROJECT REF: ESC0356

DOCUMENT REF: 0356/ESC/15/ZZ/RP/Z/0015

ENGINEERING SERVICES CONSULTANCY LTD

Griffin House, 19 Ludgate Hill, Birmingham, B3 1DW

Tel: 0121 214 8998
Email: info@escuk.com
Web: www.escuk.com

REV	DATE	ISSUED BY	REVIEWED BY
A	12 October 2022	Vicki Wilson	Nick Gorrie

EXECUTIVE SUMMARY

The Arch Company create new, light industrial space within existing railway arches.

Embodied carbon has been assessed for a typical Arch Company development using a sample project, the completed unit providing 491m² of shell only light industrial space. Project works comprised main substructure (foundations to infill walls and ground floor), superstructure (infill walls and waterproof linings to the arch space), core services, lighting and toilet facilities.

The calculation has followed the methodology in BS EN 15978 and the guidance in the RICS Whole Life Carbon Assessment for The Built Environment.

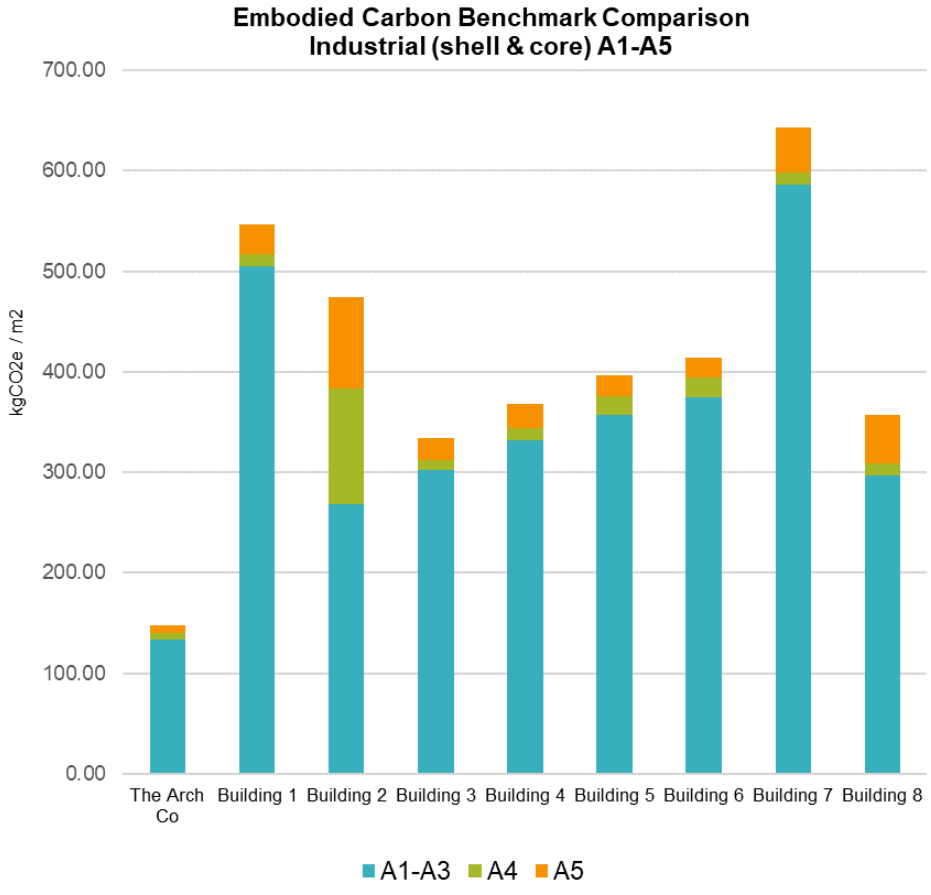
The embodied carbon at practical completion (A1-A5) per m^2 GIA has been calculated as

148 $kgCO_2e/m^2$.

At the time of writing, there are no published, industry-recognised benchmarks for industrial units. We have therefore established a market benchmark range from whole life carbon modelling for recently completed new build light industrial units by multiple different developers around the UK. This benchmark range for embodied carbon at practical completion (A1-A5) per m^2 GIA is:

300 to 700 $kgCO_2e/m^2$

The embodied carbon for a typical Arch Company light industrial arch development is less than half of that for comparative new-build equivalents.



CONTENTS

INTRODUCTION

This document is an Embodied Carbon Assessment of a typical railway arch conversion and refurbishment by The Arch Co.

Engineering Services Consultancy Ltd has been commissioned to undertake an embodied carbon calculation that follows the calculation methodology of BS EN 15978 and the guidelines detailed in the RICS Professional Statement for Whole Life Carbon Assessment for the Built Environment.

The embodied carbon assessment has been completed based up on a typical unit, using as built information from Arch 89 Hemming Street. This report will inform the design team of the typical embodied carbon benchmark performance of a standard railway arch and will make recommendations for the reduction of embodied carbon.

PROPOSED DEVELOPMENT

The development used as a case study and the basis for the assessment is Arch 89 Hemming Street, London, E2 6JG.

The unit has a gross internal area of 491m^2 and provides a shell only space for future fit out, with a core services and toilet facilities.

DEFINING WHOLE LIFE CARBON

Whole Life Carbon (WLC) comprises of two components:

- Carbon in construction (also referred to as embodied carbon)
    - The amount of carbon emissions associated with a building's product and construction stages.
- Carbon in operation (also referred to as operational carbon)
    - The amount of carbon emissions associated with the building's operational energy.

This report includes an assessment of the carbon in construction (embodied carbon) only.

ACHIEVING NET ZERO CARBON

Net Zero Carbon is the term used when the Whole Life Carbon for a building is zero. This is typically achieved using renewable energy supplies to reduce the operational energy to zero and through offsetting to reduce the embodied carbon to zero.

Figure 1 outlines the steps to achieving a net zero carbon building.

At present, in the UK, there is no mandatory requirement to report on Whole Life Carbon. However, the UK Government is committed to achieving Net Zero Carbon by 2050, compared to 1990 levels. As a bid to meet this target and also due to the increasing importance of ESG reporting, the reporting of Whole Life Carbon is becoming more commonplace.

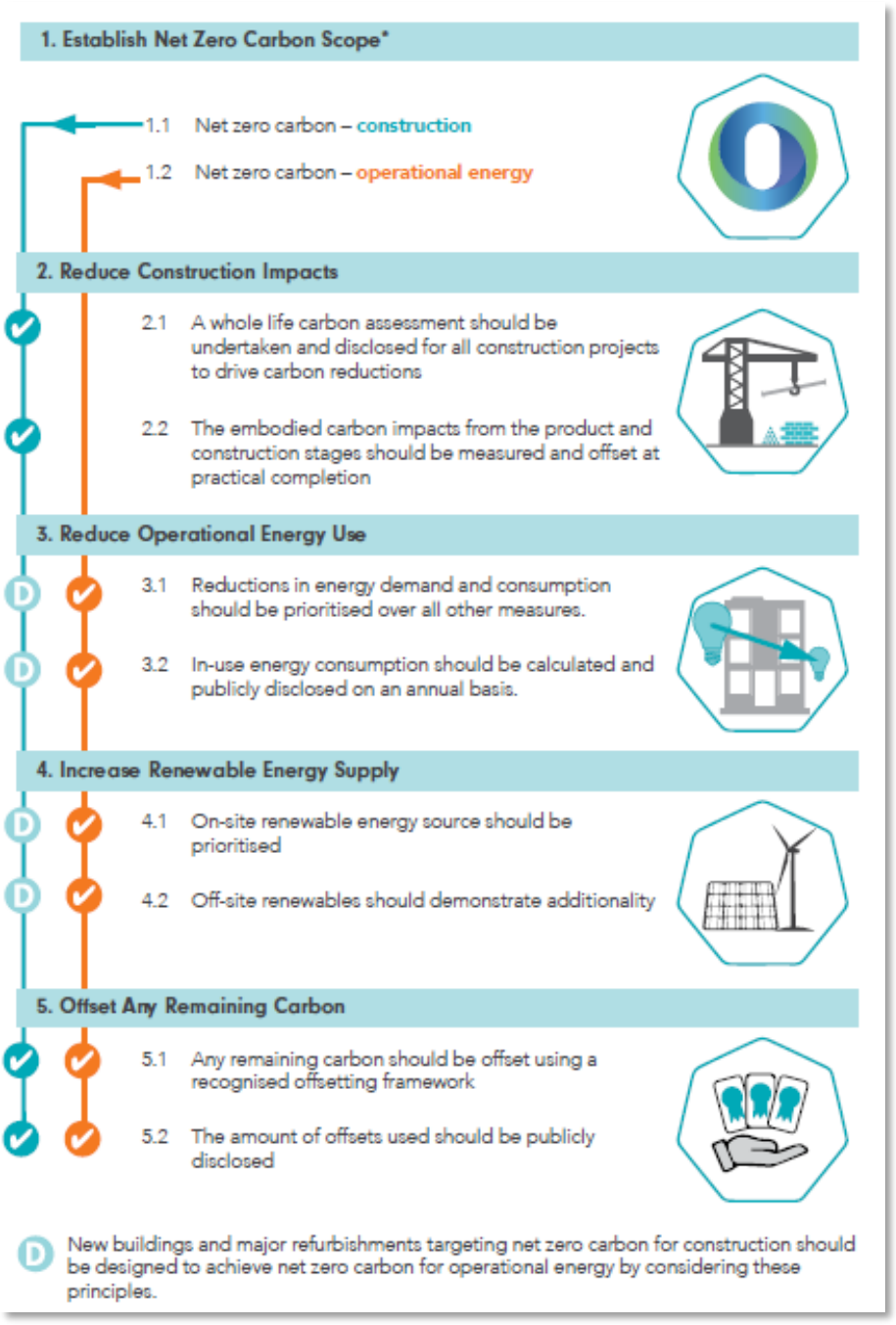


Figure 1 – Steps to achieving a net zero carbon building. Source: UKGBC Net Zero Carbon Buildings – A Framework Definition

BENEFITS OF MEASURING WHOLE LIFE CARBON

There are numerous benefits that result from measuring and reducing WLC emissions, including:

- Encouraging re-use of existing materials and retrofit/refurbishment thereby reducing embodied carbon emissions and offering cost savings;
- Maximising resource efficiency, thereby reducing waste and offering cost savings;
- Maximising durability and also adaptable and flexible design which increases the longevity of the building.
- Promoting the circular economy through designing for end of life and future use;
- Reducing life-cycle costs through the consideration of maintenance, repair and replacement over the building's lifetime;
- Encouraging responsible sourcing of materials and the use of local materials, resulting in environmental, social and economic benefits;
- Closing the performance gap between design and actual operational carbon emissions;
- Demonstrate compliance with planning requirements and environmental assessments such as BREEAM;
- Be ahead of the game by preparing for future carbon legislation and possible taxes.

KEY STANDARDS

There are a number of key standards that provide methodologies for calculating Whole Life Carbon and advice for achieving Net Zero Carbon.

BS EN 15978:2011 Sustainability of Construction Works — Assessment of Environmental Performance of Buildings — Calculation Method is the recognised framework for appraising the environmental impacts of the built environment. The standard outlines the calculation rules for the assessment of the environment performance of new and existing buildings, based on Life Cycle Assessment (LCA) and other quantified environmental information, and gives the means for the reporting and communication of the outcome of the assessment.

RICS Professional Standards and Guidance, UK - Whole Life Carbon Assessment for the Built Environment (2017) provides a standardised interpretation and implementation of the whole life carbon methodology to allow consistent application of the BS EN 15978 standard and enhance comparability of outputs. The document also refers to a number of other standards relevant to calculating whole life carbon. These are outlined in Figure 2.

In addition to the above calculation and methodology documents, there are also framework documents that should be acknowledged that aim to assist with the delivery of Net Zero Carbon by 2050.

UKGBC Net Zero Carbon Buildings: A Framework Definition this report outlines an overarching framework of consistent principles and metrics that can be integrated into policy, but primarily can be used as a tool for businesses to drive the transition to a net zero carbon built environment.

LETI Climate Emergency Design Guide: How new buildings can meet UK climate change targets and *LETI Embodied Carbon Primer: Supplementary guidance to the Climate Emergency Design Guide* provide guidance on defining what good looks like in the context of the climate emergency for new buildings.

The additional standards referred to within BS NE 15978 and in the RICS Professional Standards are listed in Appendix A.

LIFE CYCLE MODULES

BS EN 15978 structures a series of modules that cover all the stages of the life cycle of a project. These modules clearly define the boundaries; where processes influence the building's environmental performance during its life cycle, they shall be assigned to the module in the life cycle where they occur.

The organisation of the different modules used for the assessment of the building are established within BS EN 15978 and correspond to the modular structure of information from EPD for construction products, processes and services according to EN 15804. This is depicted in Appendix B. Table 1 details the boundaries of each stage as per BS EN 15987.

As the assessment is to only consider the embodied carbon, only modules A1-A5 have been included.

Product Stage	**Module A1**	**Raw material supply** This module includes the extraction and processing of raw materials; the reuse of products of materials from a previous product system and the processing of secondary materials used as input for manufacturing the product. It also includes the generation of electricity, steam and heat from primary energy resources (also including their extraction, refining and transport) and energy recovery and other recovery processes from secondary fuels.
	Module A2	**Transport to the manufacturer** This module includes the transportation up to the factory gate and internal transport.
	Module A3	**Manufacturing** This module includes the production of ancillary materials or pre-products, products and co-products and packaging. It also includes processing up to the end-of-waste state or disposal of final residues including any packaging not leaving the factory gate with the product.
Construction Process Stage	**Module A4**	**Transport emissions** This module includes transport emissions from all stages of the journey of the products following their departure from the final manufacturing plant to the project site, taking into account any interim stops at storage depots and/or distribution centres.
	Module A5	**Construction – Installation process emissions** This module includes the carbon emissions arising from any on or off-site construction-related activities. 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.

Table 1 – Boundaries of each module as per BS EN 19578.

METHODOLOGY

This embodied carbon assessment is compliant with the calculation methodology established in BS EN 15978 and the guidelines in the RICS Professional Standards and Guidance, UK - Whole Life Carbon Assessment for the Built Environment (2017).

The RICS Professional Standard for Whole Life Carbon Assessment defines the minimum scope of a WLCA, as shown in Table 2. The items in grey have been excluded from this assessment of the embodied carbon.

Building Parts	Substructure
	Superstructure
Life Stages	Product stage Modules A1-A3
	Construction process stage Modules A4-A5
	Replacement stage for façade Module B4
	Operational energy use Module B6
Assessment Timing	Design stage – prior to technical design stage (RIBA Stage 4)
	As built – after practical completion

Table 2 – Minimum WLCA reporting requirements

REFERENCE STUDY PERIOD

The reference study period used is 0 years and assessed only the carbon in construction at practical completion.

SOURCES OF DATA

The software used to build the WLC model is OneClick LCA. OneClick LCA has a database with over 100,000 different data points. They review, verify, curate and integrate data from a huge range of public and private sources to the One Click LCA database in order to provide access to the largest database of environmental construction data in the world. All data in the database undergoes a rigorous ten-point verification using a process that has been reviewed by Building Research Establishment (BRE).

The operational carbon has been evaluated using IES Virtual Environment, a computational fluid dynamics software which allows us to model the energy performance of the building and analyse the likely energy use and hence carbon emissions from the building.

Material quantities have been ascertained from the following sources:

- Premeasure for Arch 89 Hemming Street (Rev2);
- Handback File for Arch 89 Hemming Street;
- The Arch Co Standard Design Specifications.

Where possible, the following sources of carbon data for materials and products have been used.

- 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.

The sources of data used in each module of the WLCA is detailed in Table 3.

Product Stage	**Modules A1-A3**	Where specific products have been specified and relevant EPDs are available, these have been selected within the OneClick LCA software. Where exact products are unknown at this stage, the best alternative has been selected, for example regional generic data. Discussions were also had with the design team to confirm the recycled content of materials. The main substructure (foundations and ground floor) and superstructure (roof and external walls) are existing and therefore have no resultant embodied carbon emissions.
Construction Process Stage	**Modules A4-A5**	The default data provide within the RICS Professional Standard and within the OneClick LCA software has been used for transport emissions. The construction site operations have been calculated using assessment tool built into the OneClick LCA software.

Table 3 – Sources of data used in the WLCA by module stage

BUILDING COMPONENETS

A minimum of 95 per cent of the cost allocated to each building element category should be accounted for in the assessment, as per the requirements of BS EN 15804.

The building elements included within this WLCA are listed in Table 4.

Building Part/Element Group		Building Element		Included	Coverage %
	Demolition	0.1	Toxic/Hazardous/Contaminated Material treatment	N/A	>95
		0.2	Major Demolition works	N/A	N/A
0	Facilitating Works	0.3 0.5	Temporary/Enabling works	N/A	N/A
		0.4	Specialist groundworks	N/A	N/A
1	Substructure	1.1	Substructure	Yes	>95
2	Superstructure	2.1	Frame	Yes	>95
		2.2	Upper floors incl. balconies	N/A	N/A
		2.3	Roof	Yes	N/A
		2.4	Stairs and ramps	N/A	N/A
		2.5	External walls	Yes	N/A
		2.6	Windows and external doors	Yes	>95
		2.7	Internal walls and partitions	Yes	>95
		2.8	Internal doors	Yes	>95
3	Finishes	3.1	Wall finishes	Yes	>95
		3.2	Floor finishes	Yes	>95
		3.3	Ceiling finishes	Yes	>95
4	Fittings, furnishings & equipment	4.1	Fittings, furnishings & equipment	N/A	N/A
5	Building services & MEP	5.1-5.14	Services	Yes	N/A
6	Prefabricated Buildings & Building Units	6.1	Prefabricated buildings and building units	N/A	N/A
7	Work to Existing Building	7.1	Minor demolition and alteration works	N/A	N/A
8	External Works	8.1	Site preparation works	Yes	>95
		8.2	Roads, paths, pavings and surfacings	N/A	N/A
		8.3	Soft landscaping, planting and irrigation systems	N/A	N/A
		8.4	Fencing, railings and walls	N/A	N/A
		8.5	External fixtures	N/A	N/A
		8.6	External drainage	Yes	>95
		8.7	External services	N/A	N/A
		8.8	Minor building works and ancillary buildings	N/A	N/A

Table 4 – Building element groups considered within the WLCA based on the BCIS Standard Form of Cost Analysis

EXCLUSIONS

Any items excluded each account for less than 1 per cent of the total category cost, as per the requirements of BS EN 15804.

All items in the cost plan have been included in the assessment, none have been excluded.

ASSUMPTIONS

The RICS Professional Standards and Guidance, UK - Whole Life Carbon Assessment for the Built Environment (2017) provides default material data to include in the WLCA where specific data is unknown or unavailable. This default data has been used in the WLCA where necessary. The default material data is listed in Appendix C.

Additional material quantity assumptions have been made where data is absent. The assumptions made in the WLCA are listed in Table 6.

Building Element	Assumption
External walls	Wall ties have been assumed to weigh 0.931kg each.
External walls	Void filler has been assumed to be similar to a Sikaflex product.
External walls	Butterfly wall ties have assumed to weigh 0.01kg each.

Table 5 – Assumptions made in the WLCA

VERIFICATION

The WLCA has been verified by Müge Yüksel of One Click LCA Ltd.

The verification statement is provided in Appendix D.

RESULTS

The results of the WLCA are summarised below. Table 8 summarises the embodied carbon at practical completion (modules A1-A5) by building element.

EMBODIED CARBON BY LIFE-CYCLE STAGE (A1-A5)

Module	$kgCO_2e/m^2$	$kgCO_2e$
A1-A3	133.83	65,712.23
A4	6.29	3,086.88
A5	7.76	3,809.86
Total	**147.88**	**72,608.97**

Table 6 – Embodied carbon by life-cycle stage (A1-A5)

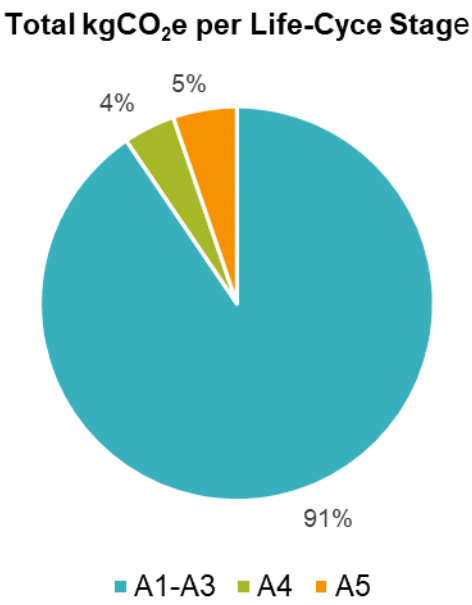


Figure 2 – Embodied carbon by life-cycle stage (A1-A5)

EMBODIED CARBON PER BUILDING PART AT COMPLETION (A1-A5)

Element	$kgCO_2e/m^2$	$kgCO_2e$
Substructure	74.73	36,690.91
Superstructure	61.87	30,378.21
Finishes	0.71	348.03
Services	10.33	5,072.35
External Works	0.24	119.44
Total	**147.88**	**72,608.94**

Table 7 – Embodied carbon per building group at completion (A1-A5)

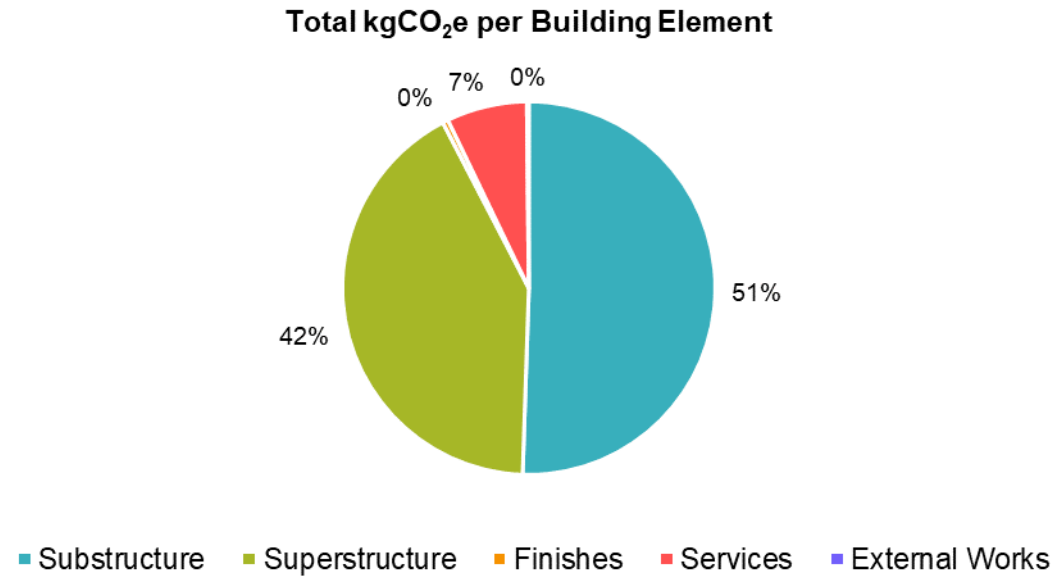


Figure 3 – Embodied carbon per building group at completion (A1-A5)

EMBODIED CARBON PER BUILDING ELEMENT

Building Element	Mass kg	$kgCO_2e$	$kgCO_2e / m^2$	% $kgCO_2e$
Standard foundations	74,360.00	9,027.91	18.39	12.30
Lowest floor	377,236.19	28,254.92	57.55	38.50
Frame	752.72	1,961.38	3.99	2.67
Roofs	3,712.33	14,170.31	28.86	19.31
External walls	58,280.87	10,905.13	22.21	14.86
Windows	723.09	1,600.14	3.26	2.18
External doors	442.57	1,626.36	3.31	2.22
Internal walls	488.42	329.89	0.67	0.45
Internal doors	43.74	24.97	0.05	0.03
Finishes	395.96	278.72	0.57	0.38
Sanitary installations	77.23	373.82	0.76	0.51
Water installations	338.44	971.95	1.98	1.32
Heating	131.80	1,044.45	2.13	1.42
Lighting	85.10	1,321.25	2.69	1.80
Electrical installations	133.07	668.53	1.36	0.91
Other services	67.96	713.62	1.45	0.97
External works	17,280.00	119.44	0.24	0.16
Total	**534,549.49**	**73,392.79**	**149.48**	**100.00**

Table 8 – Embodied carbon per building element at completion (A1-A5)

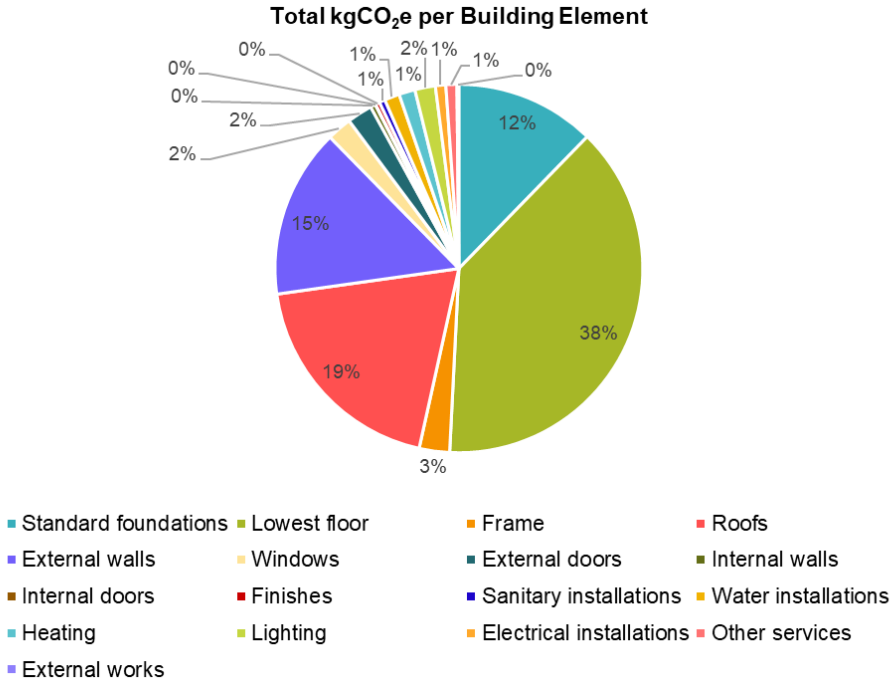


Figure 4 – Embodied carbon per building element at completion (A1-A5)

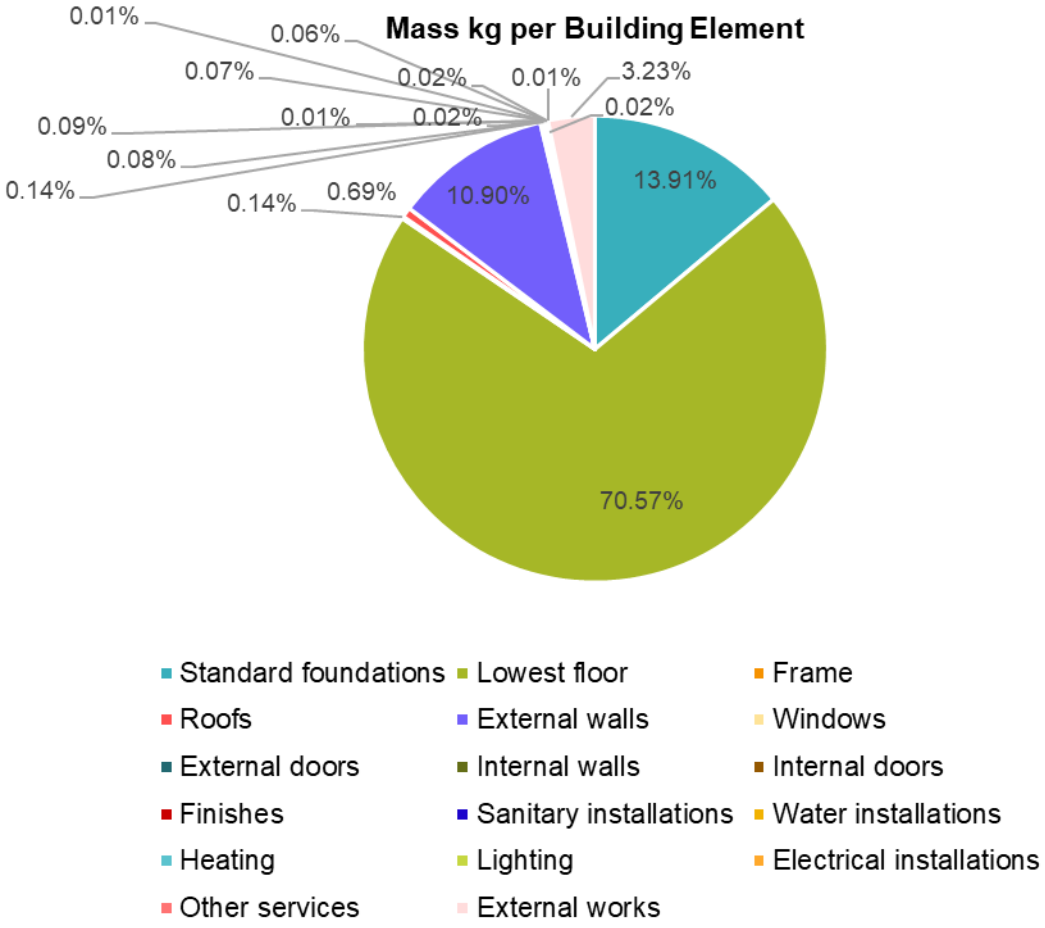


Figure 5 – Mass per building element

COMPARISON WITH BENCHMARKS

PUBLISHED BENCHMARKS

Although the concept of WLC has been around for a long time, there is limited data currently available for benchmarking and comparisons. UKGBC, LETI and RIBA have developed guidance and created benchmarks which should be targeted in order to deliver net zero carbon by 2050.

The UKGBC have modelled the typical breakdown of whole life carbon emissions for new buildings. Figure 5 shows the typical breakdown for a warehouse with office space.

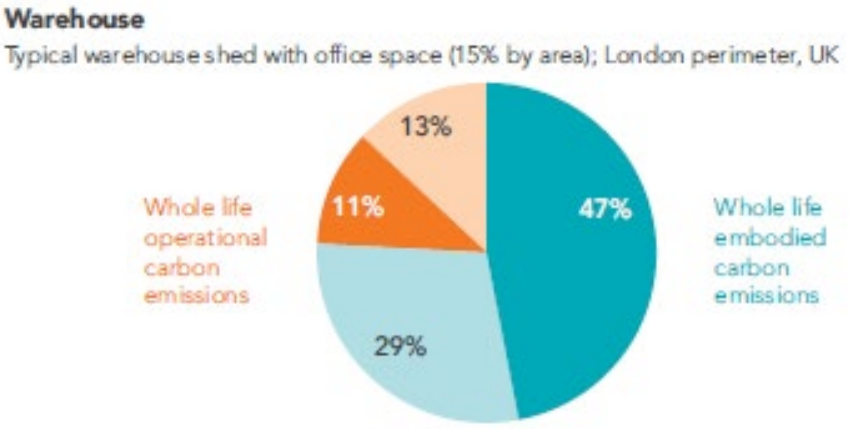


Figure 6 – Total WLC emissions breakdown for a new warehouse. Source: UKGBC Net Zero Carbon Buildings – A Framework Definition

There are currently no recognised benchmarks for industrial developments. The closest building type for which there are industry-recognised benchmarks available is offices.

Table 10 outlines the benchmarks established by LETI in their Climate Emergency Design Guide and their Embodied Carbon Primer.

Table 11 outlines the benchmarks established by the RIBA 2030 Climate Challenge.

Table 12 outlines the benchmarks established in the London Plan Guidance.

LETI Commercial Offices	Business as Usual	2020 Targets	2030 Targets
Operational	Building regs	55 kWh/m^2/yr	
Embodied	1000 kgCO_2e/m^2	600 kgCO_2e/m^2	350 kgCO_2e/m^2

Table 9 – LETI WLC Benchmarks

RIBA 2030 New-build Offices	Business as Usual	2025 Targets	2030 Targets
Operational	130 kWh/m^2/yr	75 kWh/m^2/yr	55 kWh/m^2/yr
Embodied	1400 kgCO_2e/m^2	<970 kgCO_2e/m^2	<750 kgCO_2e/m^2

Table 10 – RIBA 2030 WLC Benchmarks

London Plan Offices	Benchmark	Aspirational
A1-A5	<950 $kgCO_2e/m^2$	<600 $kgCO_2e/m^2$
B-C (excluding B6 & B7)	<450$kgCO_2e/m^2$	<370 $kgCO_2e/m^2$
A-C (excluding B6 & B7)	<1400 $kgCO_2e/m^2$	<970 $kgCO_2e/m^2$

Table 11 – London Plan WLC Benchmarks

ESTABLISHED MARKET BENCHMARKS

As there is a lack of industry-accepted benchmarks for industrial units, ESC have developed their own record based upon whole life carbon modelling undertaken for new build industrial units (B1/B2/B8 usage). These typically comprise of a shell only warehouse and an open plan office area with a Cat A fit out.

The modelling for the comparative units have all been undertaken using the same methodology and are compliant with BS EN 15978 and the guidance in the RICS Whole Life Carbon Assessment for The Built Environment.

It is important to note that the buildings modelled are developments where the whole carbon targets have been driven by the developer and/or the funds voluntarily, i.e. these buildings are typically lower carbon than the norm as they are actively trying to measure and reduce their whole life carbon. These developments are all being developed or funded by UK market leaders and the modelling has been undertaken in 2021-2022 so can be used as direct comparators.

Even so, there is not a vast amount of data available as there is currently no mandatory requirement for the measuring and reporting of embodied or whole life carbon.

The embodied carbon emissions for new build units typically ranges from **300-700 $kgCO_2e/m^2$**. This is based on the product and construction stage carbon (modules A1-A5) up to Practical Completion.

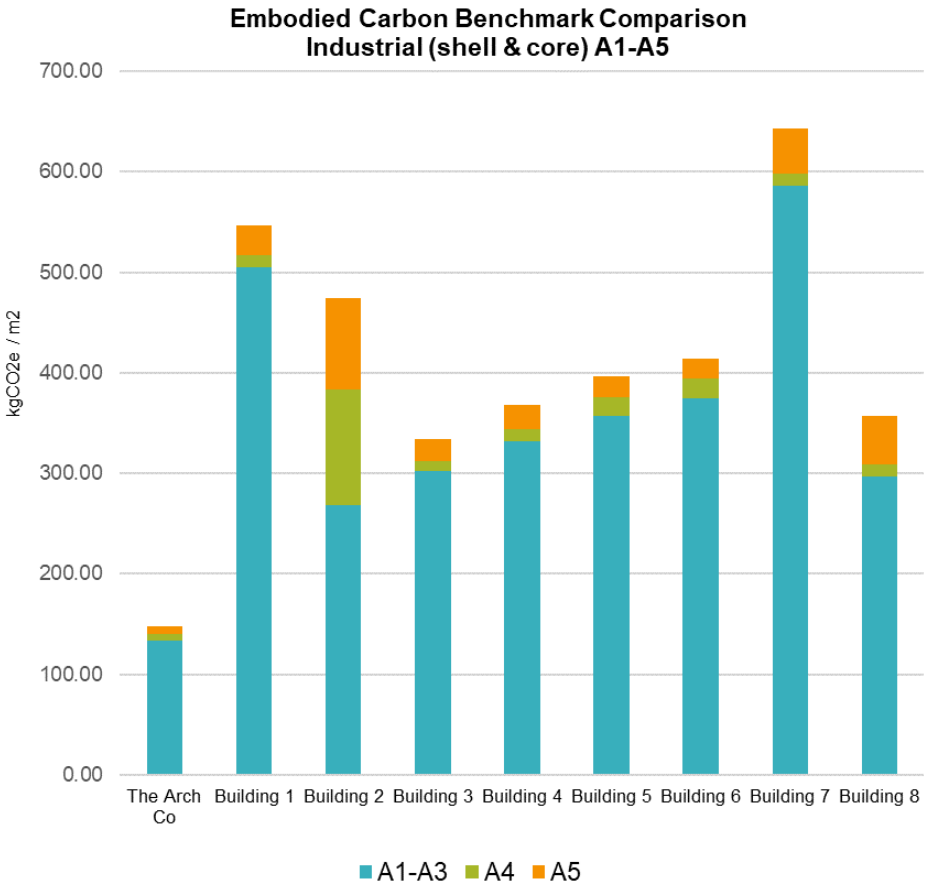


Figure7 – Embodied Carbon Benchmark Comparison (A1-A5)

CONCLUSION

The embodied carbon assessment has been based upon a standard Arch Company design and using a sample project. The project used is Arch 89 Hemming Street. This unit has been used selected as a representative typical unit, recently completed. The unit comprises of 491m^2 of shell only light industrial space with core services and core toilet facilities.

The embodied carbon assessment includes modules A1-A5, as defined by BS EN 15978 and has been calculated following the methodology in BS EN 15978 and the guidance in the RICS Whole Life Carbon Assessment for The Built Environment.

The embodied carbon for an Arch Company railway arch development at practical completion (A1-A5) has been calculated as:

148 kgCO_2e/m^2.

At the time of writing, there are no published, industry-recognised benchmarks for industrial units. We have therefore established a market benchmark range from whole life carbon modelling for recently completed new build light industrial units by multiple different developers around the UK. This benchmark range for embodied carbon at practical completion (A1-A5) per m2 GIA is:

300-700 kgCO2e/m^2.

Arch Company railway arch developments comprise main substructure (foundations to infill walls and ground floor), superstructure (infill walls and waterproof linings to the arch space), core services, lighting and toilet facilities. Benchmark developments provide similar space and comprise similar works but, as standalone buildings, include an internal structural frame to which insulated weatherproof cladding is fixed. Arch developments adopt a simple, standardised design and benefit from the existing viaduct structure to support lining and reduce the need for insulation. This means that the embodied carbon for arch developments is significantly lower than a comparative new build providing similar light industrial space.

The embodied carbon for a typical Arch Company light industrial arch development is demonstrably less than half of that for comparative new-build equivalents.

APPENDIX A

KEY STANDARDS

Key European and international standards referred to in BS EN 15978 and the RICS Whole Life Carbon Assessment for The Built Environment

Standard	Full title	Regional jurisdiction
EN 15978: 2011	Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method	European standard
EN 15804: 2012 + A1: 2013	Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products	European standard
PAS 2050: 2011	Specification for the assessment of the life cycle greenhouse gas emissions of goods and services	UK document
PAS 2080: 2016	Carbon management in infrastructure	UK document
ISO 21930: 2017	Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services	International standard
ISO/TS 14067: 2013	Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification	International standard
ISO 14025: 2006	Environmental labels and declarations – Type III environmental declarations – Principles and procedures	International standard
ISO 14040: 2006	Environmental management – Life cycle assessment – Principles and framework	International standard
ISO 14044: 2006	Environmental management – Life cycle assessment – Requirements and guidelines	International standard
EN 16449: 2014	Wood and wood-based products. Calculation of the biogenic carbon content of wood and conversion to carbon dioxide	European standard
EN 16485: 2014	Round and sawn timber. Environmental Product Declarations. Product category rules for wood and wood-based products for use in construction	European standard
EN 16757: 2017	Sustainability of construction works. Environmental product declarations. Product Category Rules for concrete and concrete elements	European standard

Figure 17- European & Interntional Standards. Source: RICS whole life carbon assessment for the built environment (2017)

APPENDIX B

MODULE STAGES

Display of modular information for the different stages of the building assessment.

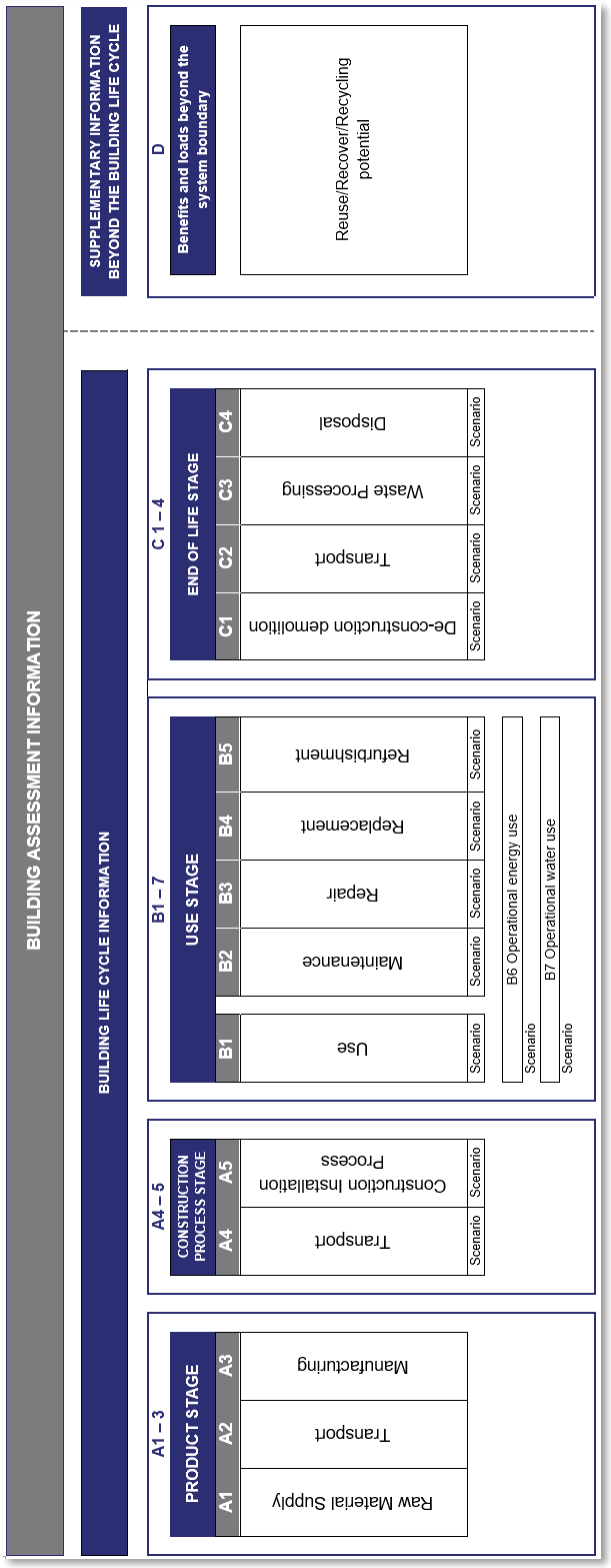


Fig 18 Modular information. Source: BS EN 15978:2011

APPENDIX C

DEFAULT DATA

RICS Professional Standards and Guidance, UK - Whole Life Carbon Assessment for the Built Environment (2017) default data.

	Material	Details	Specification
1.	Concrete	Piling	C32/40 20% cement replacement [1]
		Substructure	C32/40 20% cement replacement [1]
		Superstructure	C32/40 20% cement replacement [1]
		Generic concrete	C16/20 0% cement replacement [1]
2.	Steel	Reinforcement bars	97% Recycled Content [2]
		Structural steel sections	20% Recycled Content [3]
		Studwork/Support frames	Galvanised steel, 15% Recycled Content [4]
3.	Blockwork	Precast concrete blocks	Lightweight blocks for building envelope
			Dense blocks for other uses
4.	Timber	Manufactured structural timber CLT, Glulam, etc.	100% FSC/PEFC [5]
		Formwork	Plywood
		Studwork/Framing/Flooring	Softwood
5.	Aluminium	Cladding panels	Aluminium sheet, 35% Recycled Content [6]
		Glazing frames	Aluminium extrusions, 35% Recycled Content [6]
6.	Plasterboard	Partitioning/Ceilings	Min. 60% Recycled Content [7]
7.	Insulation	To floors, roofs & external walls	PIR

Figure 19. Default Specifications For Main Building Materials Source: RICS Professional Standards And Guidance, UK - Whole Life Carbon Assessment For The Built Environment (2017) Table 6

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]

Figure 20. Default Transport Scenarios for UK Projects Source: RICS Professional Standards And Guidance, UK - Whole Life Carbon Assessment For The Built Environment (2017) Table 7

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]

Figure 21. Site Waste Disposal Scenarios. Source: RICS Professional Standards And Guidance, UK - Whole Life Carbon Assessment For The Built Environment (2017) Table 8

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%

Figure 22. Default Recovery Rates. Source: RICS Professional Standards And Guidance, UK - Whole Life Carbon Assessment For The Built Environment (2017) Table 10

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

Figure 23. Indicative Component Lifespans Source: RICS Professional Standards And Guidance, UK - Whole Life Carbon Assessment For The Built Environment (2017) Table 9

APPENDIX D

VERIFICATION STATEMENT

APPENDIX E

PROJECT ID MATRIX

Date of assessment	August 2022
Verified by	Müge Yüksel, One Click LCA Ltd
Project type	Refurbishment
Assessment objective	Measure and reduce the development's whole life carbon emissions.
Project location	Based on: Arch 89 Hemming Street London E2 6JG
Date of project completion	November 2020
Property type	Light industrial
Building description	Converted railway arch providing shell only light industrial space for future fit out, with core services and toilet facilities.
Size	491 m^2 (Gross Internal Area)
Project design life	60 years
Assessment scope	Refer to Table 4
Assessment stage	Refer to Table 6
Data sources	Refer to Table 3
Assumption and scenarios	Refer to Table

Tble 16. Project ID matrix.

REFERENCES

EN 15978:2011 Sustainability of Construction Works — Assessment of Environmental Performance of Buildings — Calculation Method (November 2011)

Specifies the calculation method, based on Life Cycle Assessment (LCA) and other quantified environmental information, to assess the environmental performance of a building, and gives the means for the reporting and communication of the outcome of the assessment. The standard is applicable to new and existing buildings and refurbishment projects.

EN 15804:202+A2:2019 Sustainability of Construction Works. Environmental Product Declarations. Core Rules for The Product Category Of Construction Products (September 2021)

Provides core product category rules for all construction products and services. It provides a structure to ensure that all Environmental Product Declarations (EPD) of construction products, services and processes are derived, verified and presented in a comparable way.

RICS Whole Life Carbon Assessment for the Built Environment (November 2017)

https://www.rics.org/globalassets/rics-website/media/news/whole-life-carbon-assessment-for-the--built-environment-november-2017.pdf

The fundamental objective of whole life carbon measurement is the mitigation of carbon impact in the built environment. Better understanding and consistent measurement of the whole life carbon emissions of built projects will in turn enable comparability of results, benchmarking and target setting to achieve carbon reductions.

This professional statement is intended to standardise whole life carbon assessment and enhance consistency in outputs by providing specific practical guidance for the interpretation and implementation of the methodology in EN 15978 in carbon calculations. This is to achieve coherent and comparable results that can be used to benchmark the whole life carbon performance of built assets.

UKGBC's Net Zero Carbon Buildings: A Framework Definition (April 2019)

https://ukgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2019/04/05150856/Net-Zero-Carbon-Buildings-A-framework-definition.pdf

The net zero carbon buildings framework sets out definitions and principles around two approaches to net zero carbon, which are of equal importance:

Net zero carbon – construction

When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy.

Net zero carbon – operation

When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset.

UKGBC's Net Zero Whole Life Carbon Roadmap (November 2019)

https://www.ukgbc.org/wp-content/uploads/2021/11/UKGBC-Whole-Life-Carbon-Roadmap-A-Pathway-to-Net-Zero.pdf

The Net Zero Whole Life Carbon Roadmap for the Built Environment (The Roadmap) provides a shared vision and set of actions for achieving a net zero carbon UK built environment by 2050, in relation to the construction, operation, and demolition of buildings and infrastructure.

LETI Embodied Carbon Primer (January 2020)

https://www.leti.london/_files/ugd/252d09_8ceffcbcafdb43cf8a19ab9af5073b92.pdf

This Embodied Carbon Primer offers supplementary guidance to those interested in exploring embodied carbon in more detail. There is lack of knowledge in the built environment industry surrounding embodied carbon reduction strategies and calculations.

Therefore, LETI has produced the 'LETI Embodied Carbon Primer', to support project teams to design buildings that deliver ambitious embodied carbon reduction.

LETI Climate Emergency Design Guide (January 2020)

https://www.leti.london/_files/ugd/252d09_3b0f2acf2bb24c019f5ed9173fc5d9f4.pdf

To help industry understand and deliver net zero carbon new buildings, LETI recently published the Climate Emergency Design Guide. The Guide is specifically targeted towards developers, designers and policy makers. It helps to define 'good' and sets clear and achievable targets. It contains five chapters that provide detail on delivery and implementable solutions, with each chapter addressing a key component towards a zero carbon future. Chapter 2 of the Climate Emergency Design Guide addresses embodied carbon.

RIBA 2030 Climate Challenge (2021)

https://www.architecture.com/about/policy/climate-action/2030-climate-challenge

RIBA has developed voluntary performance targets for operational energy use, water use and embodied carbon. These performance targets form the basis of the 2030 Climate Challenge which the RIBA has been developed in consultation with other professional UK construction bodies. The performance targets align with the future legislative horizon and set out a challenging but achievable trajectory to realise the significant reductions necessary by 2030 in order to have a realistic prospect of achieving net zero carbon for the whole UK building stock by 2050.

Engineering Services Consultancy Ltd

12 October 2022