UK Net Zero Carbon Building Standard

A demonstrator project

August 2025

MAX FORDHAM

PRICE & MYERS

Buttress

Contents

Front cover image: Greenhaus by Buttress
with Max Fordham

Foreword

In response to the emergence of the UK Net Zero Carbon Building Standard (NZCBS) in late 2024, Buttress, Price & Myers and Max Fordham have collaborated on a study which focuses on the embodied carbon impact on the residential sector and the means of which compliance with The Standard could be achieved.

Credits

Title: Net Zero Carbon Building Standard - a demonstrator project

Date: August, 2025

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MAX FORDHAM PRICE& MYERS Buttress

Contributors

Paul Nelson, Senior Architect, Buttress

Paul joined Buttress in late 2019, bringing with him experience gained across the residential, education and healthcare sectors. This included a number of significant projects involving the restoration of large mill complexes into residential-led, mixed use developments. He is passionate about expanding the use of BIM in the delivery of such projects and is experienced in the implementation of Revit as a tool for coordinated design and surveying. Paul is involved in the implementation of our in-house carbon calculator, having done high-level exercises on several projects looking at different massing to the effect on the embodied carbon.

Alison Haigh, Associate, Buttress

Alison has 20 years' experience as an architect and specialises in the design and delivery of sustainable residential schemes. She has led multi-disciplinary teams on all stages in the design and development of medium and tall buildings for registered social landlords, private developers and contractor clients. Alison is also a certified Passivhaus consultant, evidencing the skill and experience she brings to Buttress' residential portfolio.

Marcus Rogers, Architectural Technologist, Buttress

Marcus is an Architectural Technologist working within the new-build residential team, contributing to several affordable housing and Passivhaus schemes. A highly proficient Revit user, Marcus provides technical support across the studio, offering training and guidance to colleagues on best practices and complex queries. He is deeply committed to sustainability, having played a key role in achieving Buttress's B Corp certification and leading the company's efforts in our Planet Mark certification. Having conducted several Whole Life Carbon Assessments, Marcus now teaches these skills to others within the practice.

Certified B Corporation

Tomasz Lukaszewicz, Associate, Price & Myers

A chartered structural engineer with more than a decade's experience, Tomasz leads the Price & Myers Manchester studio. His project portfolio includes the design of complex structures across a multitude of sectors including commercial, education, residential, event and retail.

Tomasz is passionate about breathing new life into existing buildings. He's been leading some of the most sustainable adaptive reuse schemes in the Nort-West, including Mayfield Park and Mayfield Depot in Manchester, Tileyard North (regeneration of Seven Mills complex in Wakefield) and Rochdale Town Hall.

Ben Gholam, Associate, Price & Myers

With over 15 years' experience across a broad spectrum of structural engineering work – from small domestic refurbishment to hyperscale data centres, and everything in between – Ben brings with him a wealth of knowledge. He has always had a keen interest in improving the sustainability of structural designs, and was a driving force behind the implementation of the Climate Action Group within Price & Myers – an internal task group enacting structural change in the way engineers design by promoting climate-first principles, and developing internal systems to reduce embodied carbon in everyday practice.

Ben is responsible for the production and management of the Price & Myers Embodied Carbon Database, and has been collaborating with professional institutions, academia and other consultancies and disciplines to better co-ordinate this work across the industry since 2016. He also led the team responsible for the development of our Structural PANDA software in collaboration with the University of Cambridge, which is used by design teams across the industry to significantly reduce the embodied carbon of their designs at an early stage.

Hero Bennett, Director, Max Fordham

Hero is Max Fordham's Sustainability Director and leader of the 'MF: Beyond Net Zero' strategy group. Joining the practice in 2008 with a background in engineering and physics, Hero has since set and delivered pioneering sustainability strategies on leading projects across a wide range of sectors including education, residential, and workplace, new build and refurbishment. Hero has recently been exploring how low embodied carbon principles can be incorporated at masterplan level through massing considerations. Hero currently sits on the RIBA Awards Group as a sustainability advisor and is a member of the Greater Cambridgeshire and Suffolk Design Review Panels.

Chris Price, Senior Sustainability Consultant, Max Fordham

Chris joined the practice in 2021 and is a Senior Sustainability Consultant at Max Fordham, specialising in driving down embodied carbon emissions and developing meaningful circular economy initiatives. With over six years' experience as a structural engineer, Chris has broad technical expertise in structural systems, materials, and the construction process. Chris' experience as a structural engineer, combined with his work evaluating embodied carbon on countless projects, makes him an expert in the field. Utilising this specialist knowledge, Chris effectively engages with design teams, advising and strategising on embodied carbon across all elements of a project, not only MEP. Chris is currently working on five UK Net Zero Carbon Building Standard pilot projects.

Chris' project portfolio includes mixed-use high-rise residential buildings, offices, hotels, student accommodation, an underground station, and refurbishments of historic structures. This eclectic mix allows him to quickly understand the constraints of a scheme and identify the main high-carbon targets that might be present in a 'business-as-usual' approach. Chris has been appointed to the UK Green Building Council (UKGBC) Task Group for whole life carbon reductions through circular economy principles. He is also a member of the London Energy Transformation Initiative (LETI) Circular Economy team, drafting content for an upcoming publication.

1

What is the UK NZCBS?

Ancoats Mobility Hub by Buttress

1.0 What is the NZCBS?

The UK Net Zero Carbon Building Standard (NZCBS) is a set of guidelines and criteria developed to help the built environment in the UK achieve net-zero carbon emissions. The Standard focuses on reducing carbon emissions associated with both the operational and embodied carbon of buildings. It provides a framework to guide developers, designers, and construction professionals towards creating buildings that contribute to the UK's carbon reduction targets, specifically aiming to minimize the environmental impact of new and existing buildings.

1.1 Key elements of the standard

1.1.1 Operational Carbon

This includes carbon emissions from energy use within the building, such as heating, cooling, lighting, and other utilities.

1.1.2 Embodied Carbon

This refers to the carbon emissions associated with the building materials, construction process, and any maintenance or refurbishment that occurs throughout the building's lifecycle.

1.1.3 Upfront Embodied Carbon Measurement

Embodied carbon is measured by accounting for the carbon footprint of each material used in a building. This includes:

- Extraction - The carbon emitted from obtaining raw materials.
- Manufacturing - The carbon emissions from processing and producing building materials.
- Transportation - The carbon footprint of transporting materials to the construction site.
- Construction - The carbon emissions from the building process itself.

The measurement involves assessing each of these stages (from cradle to site) and using carbon calculations to estimate the carbon emissions. Various certifications, like the Environmental Product Declarations (EPD), help provide more accurate measurements of embodied carbon for specific materials.

1.2 Targets and limits

The UK Net Zero Carbon Building Standard typically sets the following key targets:

1.2.1 Operational Carbon:

For new buildings, the aim is for them to be net-zero in terms of operational carbon emissions, often relying on renewable energy sources and energy-efficient building designs.

1.2.2 Upfront Embodied Carbon

The standard aims to minimize embodied carbon throughout the life cycle of the building. For many projects, limits are set on how much upfront embodied carbon is allowed per unit area or volume of the building, typically quantified in kilograms or tonnes of CO2e per square meter (kg CO2e/m²).

1.2.3 Target Limits

Depending on the type and purpose of the building, limits can vary. For example, a typical target for embodied carbon might be 500 kg CO2e/m² for a building's structure and materials, though this can vary by specific project type or building category. The Standard is applicable to parties involved in the construction of existing and/or new buildings in the UK across 13 sectors and provides requirements for: new build, retrofit in one go, retrofit step by step, and office fit-out scenarios. Targets are dependent on the year of commencement, combining top-down carbon and energy budgets with a bottom-up analysis of what the industry can practically achieve (based on in-use industry data).

Table 1: Table EC-1

Building Type	2025 Limit (kgCO2e/m2 GIA)	2030 Limit	2040 Limit	2050 Limit
Flats	565	380	160	40
Higher Education	475	450	250	60
Commercial Office	475	350	200	50
Residential (New Build)	430	300	150	40
Retail	450	375	250	50
Hotel	475	400	250	60
Industrial	500	400	300	70
Science & Technology	500	400	250	50
Data Centres	550	400	250	50
Retrofit Works	300	300	200	100
Reportable Works	350	300	150	40

From the UK NZCBS showing upfront embodied carbon limits for new works by building type

1.3 Why The Standard is important

1.3.1 Climate Change Mitigation

Buildings contribute significantly to global carbon emissions, both through operational energy use and embodied carbon. The NZCBS is critical for helping the built environment reduce its overall carbon footprint in line with the UK's commitment to achieve net-zero carbon by 2050.

1.3.2 Regulatory Compliance

With increasing climate regulations, adopting the NZCBS can help ensure that buildings meet both current and future legal requirements.

1.3.3 Market Demand and Sustainability

More developers, tenants, and investors are focusing on sustainability. Adhering to NZCBS helps meet the growing demand for green buildings, which can lead to reduced operating costs, improved reputation, and better marketability.

1.3.4 Long-Term Environmental Impact

By addressing both operational and embodied carbon, the NZCBS contributes to more sustainable building practices, which have long-term benefits for the environment and reduce the overall impact of construction on the planet.

In essence, the UK Net Zero Carbon Building Standard helps create buildings that not only minimise their direct carbon emissions but also take full responsibility for their entire lifecycle, contributing to the broader goal of mitigating climate change.

Categories measured under the UK NZCBS

Limits are set for:

- Up-front carbon
- Operational energy
- Fossil fuel free
- District heating and cooling networks
- Refrigerants
- Heating delivered

Targets are set for:

- On-site renewable electricity generation

There is an optional reporting requirement for:

- Off-setting

There are reporting requirements for:

- Life cycle embodied carbon
- Operational water use
- Electricity demand
- Heating and cooling delivered to the building

2 Executive summary

Greenhaus by Buttress with Max Fordham

2.0 Executive summary

2.1 Methodology

2.1.1 Architectural Elements

The embodied carbon assessment was calculated using a range of tools and indices, varying between disciplines.

One Click LCA was used as the primary method of assessment for all architectural elements encompassing embodied carbon emissions and providing a holistic view of the project's environmental impact.

The assessment has been based on the methodology set out according to the British Standard BS EN15978:2011 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method), and the RICS Professional Statement 'Whole Life Carbon Assessment for the built environment 2023'.

2.1.2 Structural Elements

The structural carbon assessment was carried out based on 'How to Calculate Embodied Carbon, 3rd Edition (2025) form the IStructE, in line with current Royal Institution of Chartered Surveyors (RICS) methodology. This includes the default carbon factors for concrete and steel reinforcement, based on a 25% Ground Granulated Blast-furnace Slag (GGBS) replacement for concrete and UK Certification Authority for Reinforcing Steels (CARES) reinforcement with 100% recycled content.

2.1.3 MEP

The Building Services benchmark figure was taken from a range of appropriate data-points, including comparable Max Fordham projects and the embodied carbon evidence base produced by WSP (reviewed by Max Fordham) for Westminster Councils' Retrofit First Policy. The figure chosen was deemed to be appropriate for the scale of the project, achievable by a number of servicing strategies and representing an viably-low figure. The underpinning data was all produced using the second edition of the aforementioned RICS professional standard. As noted elsewhere, Building Services carbon data is less mature than other areas of construction with natural risks of change as the industry develops.

2.1.4 Purpose

The demonstrator project provides a complete view of the upfront embodied carbon impact associated with the building case study for the purpose of establishing which 'target year' set by the NZCBS can be achieved using the tools, materials and methods used in current construction and manufacturing frameworks.

2.1.5 Comparison with Targets

The result in this study will be benchmarked against the Net Zero Carbon Building Standard (NZCBS) (Pilot Version) for new build 'flats' Table EC-1. The current 2025 limit is set at **565 kgCO2e/m2** GIA for reference (refer to figure 1 for further detail).

Architecture: **119.7kgCO2e/m²**

Structure: **162.0 kgCO2e/m²**

MEP: **120.0 kgCO2e/m²**

Construction Site Activities: **40 kgCO2e/m²**

Total: 441.7 kgCO2e/m²

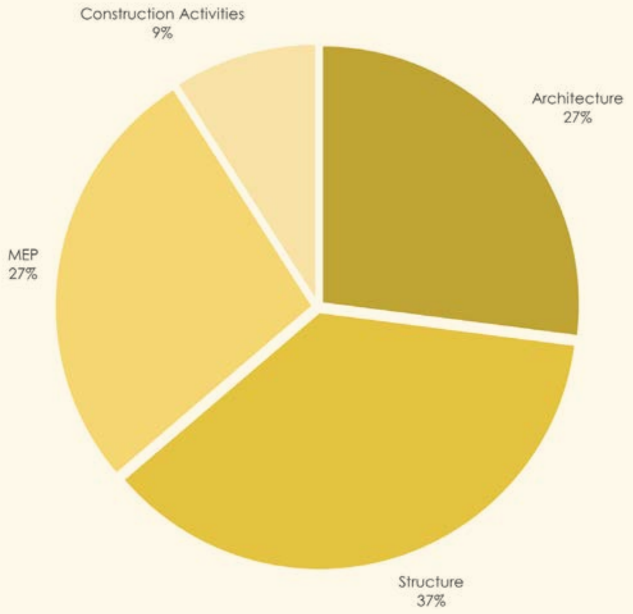
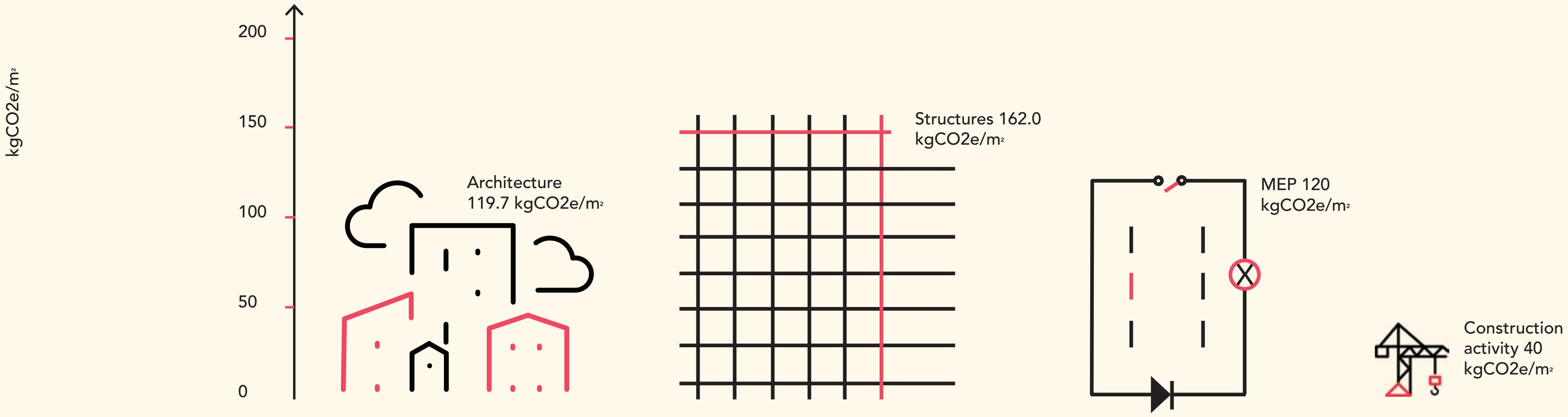


Figure 1 Total Upfront Embodied Carbon by discipline

2.2 Key findings

The total embodied carbon for the building study excluding sequestered carbon comes to **441.7 kgCO2e/m²**. When measured against the limits set within the UK NZCBS this figure meets the 2028 target which is set at **450 kgCO2e/m².** The report aims to dissect this figure further and try and understand how we could further improve this result given we are only three years away from this limit when measuring new build residential developments against it.

It is widely acknowledged that there is no 'magic bullet' for resolving the issues facing the construction industry as the shift towards net zero carbon design begins to pick up speed. The Standard's targets simply extrapolate back from 2050 when true 'zero upfront carbon' is expected to be met. The process that is needed to get there is not necessarily a linear one with a neat depreciation year on year. There are known obstacles to driving down stubborn embodied carbon and there are likely to be as yet unforeseen hurdles along the way too. However, there are also likely to be opportunities arising from new building technologies and material innovation to amendments in legislation which make it easier to achieve the goals set out.



Total Upfront Embodied Carbon by discipline

	Global Warming Potential (GWP)	kgCO2e/m²
Architecture	A1-A5 (Exc. Construction Site Activities A5.2)	119.7
Structure	A1-A5 (Exc. Construction Site Activities A5.2)	162.0
MEP	Site Impact Emissions (Excl. Construction Site Activities A5.2)	120.0
Construction Activities	Using RICS methodology based on GIA	40.0

Case study: Greenhaus

Greenhaus by Buttress with Max Fordham

Greenhaus

Buttress' Greenhaus is one of the UK's first medium-rise Passivhaus certified apartment schemes and one of the north west's largest. It provides 96 energy-efficient apartments, at affordable rents, in the heart of Salford's vibrant Chapel Street.

To achieve Passivhaus standards within a budget, we needed to create a compact build form and simplify the thermal envelope, thus reducing the exposed surface area for heat loss. Maintaining the integrity of the thermal line and avoiding thermal bridges is imperative and by concentrating on the design of every element of the envelope and building construction we have maintained a simple form that makes it easier to meet Passivhaus' stringent airtightness requirements.

The majority of heat demand is met by internal gains from people and equipment and as a result, the heating plant is far smaller. In turn, these cost savings can be spent on triple glazing, openable windows, and highly efficient ventilation systems that add back to the experience of the new residents.

Buttress: Architect

Hannon: MEP | Alan Johnston Partnership: Structural Engineer

Max Fordham: Passivhaus Designer and post occupancy review

3 Aims

3.0 Aims of the project

With the emergence of the UK Net Zero Carbon Building Standard in late 2024, Buttress, Price & Myers and Max Fordham agreed to collaborate on a demonstrator project which would focus on the embodied carbon impact on the residential sector and the means of which compliance with the standard could be achieved.

3.1 Summary

The study aims to establish the extent to which, the targets set for Embodied Carbon within the UK NZCBS can be applied to a typical multi-storey residential development under 18m in height.

This building typology will be tested through a lean yet realistic structural design utilising modern methods of construction with an average dataset applied to Environment Product Declarations (EPDs) for architectural elements. Structural elements have been calculated through Price & Myers' in-house Panda software. Figures for the mechanical and electrical design have been extrapolated from previous building studies completed by Max Fordham. An explanatory note around this has been provided under Section 6.

The UK NZCBS will be used as a means of understanding:

a) What a realistic embodied carbon figure is, utilising today's technology, materials and methods for construction.

b) How this figure sits against the limits set by The Standard and which year projected by the standard is currently achievable.

c) How much headway this gives the wider construction industry in aligning to the future limits and whether the targets are aspirational without a fundamental shift in material technology, specification and manufacturing processes.

3.2 Defining the boundaries

From the outset, it was established that the study would have to be undertaken based on a building of less than 18m in height. With the changes arising from the most recent iteration of Approved Document B it has now been established that the need for an additional stair core and the associated structure around it would result in an embodied carbon figure exceeding that of the current limits set by the UK NZCBS.

Price & Myers undertake embodied carbon studies across all their projects and the average across 100 data sets is currently around 324kg CO2e/m2. Given that structure is typically around 60% of the total embodied carbon, any uplift associated with additional structural elements is going to make achieving the targets quite difficult. This in itself warrants potential further discussion around the opening gulf between compliance with The Standard and the trade-off in aligning with Building Regulations. A further appraisal of this is given under section 8.

3.3 Assumptions

Given that this is a hypothetical case study it was important to establish what assumptions would be made as a way of guiding the building form, siting and material specification.

3.3.1 Location

The building location was chosen as being within Salford, Greater Manchester predominantly due to the familiarity for all disciplines in developing residential buildings within this conurbation. This helped guide the technical aspects associated with location specific foundation design as well as guiding other design decisions related to comparable architectural features of developments within the area.

3.3.2 Architectural

Balconies - traditional balconies were not included within the design based on the limited inclusion of them in schemes across the area. We have, however allowed for a Juliet arrangement incorporated as part of the external window/ door configuration.

Photovoltaic (PV) Provision - previous studies undertaken by Buttress have typically shown a relatively high embodied carbon associated with the manufacture of mono-crystalline panels. This may be due in part to lack of reliable up-to-date datasets and EPD availability. Given that operational energy returns are outside of the scope of this project, it is difficult to quantify the net benefit associated with their incorporation.

The NZCBS has a separate target for the inclusion of PV into a design and this is quoted as **750 kgCO2e/kWp.** Current Environmental Product Declaration (EPD) data suggests that mono crystalline panels sit closer to **1250 kgCO2e/kWp** which essentially means that embodied carbon associated with their production and manufacture needs to come down over the coming years in order to align with the standard.

It is recognised that an approximate 63% saving in embodied carbon using CdTe panels is possible but as yet, such technology is limited in availability.

Ground floor layout - we have not allowed for any mixed use development and have opted for a full residential development. The ground floor therefore comprises apartments with ancillary spaces such as bin/ bike store and plant room. This helps with alignment to the sectors contained within the NZCBS.

Basement inclusion - it is assumed that the building is developed on a flat site with limited retaining structures or need for excavation works to form a basement or sub-basement level.

3.3.3 Structural

The design was based on the method most typically used to construct similar buildings in the UK - namely an in-situ flat-slab reinforced concrete (RC) frame.

In order to demonstrate the leanest realistic design, column spacings were set to allow for 200mm slabs working with minimal levels of reinforcement. This was achieved by carefully positioning columns within the approximate centre of each residential unit (usually in a bathroom or cupboard space).

Masonry support angles at every level were assumed in order to deal with the large cavities required for Passivhaus design, and RC downstand beams around the slab perimeters were also utilised to help minimise deflections and keep the slabs as efficient as possible.

Stability was provided by 200mm thick RC walls around the lift and stairs, which also serve as an inherent fire barrier to the circulation spaces. As required by the ground conditions, a piled foundation solution was utilised.

Reinforcement quantity rates were based on real as-built data from similar scale projects recently completed to a similar standard.

We assume a 25% GGBS replacement based on current IStructE guidance. We note that this is not necessarily reflective of global resource availability, where GGBS production is around now only 10% of cement demand and (probably) falling. This 25% figure is therefore utilising a higher ‘fair share’ percentage than maybe it should be.

Similarly, reinforcement is based on IStructE guidance whereby UK CARES reinforcement can be taken. Whilst this is reflective of the market, it should be noted that this assumes a recycled steel percentage roughly three times what the global availability is, again meaning that this is overstating the amount of recycled material that is fairly available. It may be that a separate assessment should be provided to compare the ‘fair’ values against the calculated ones.

3.3.4 Mechanical / Electrical

The evaluation of embodied carbon in building services is an evolving area, with industry data and methodologies still maturing relative to structural and architectural components.

Despite the challenge of MEP systems’ inherent complexity and the high number of discrete components involved, each requiring detailed carbon information, the field is progressing rapidly.

Significant efforts are being made to collect, interpret, and apply emerging data by those leading the field, and more robust analysis and informed design decision-making is emerging.

Experience shows that MEP systems are highly responsive to the unique constraints and functions of each building, and outcomes of carbon optioneering exercises tend to be highly project-specific. As such, care must be taken when interpreting generalised findings, which may not translate directly across different contexts.

The approach taken therefore for this report is cautious, utilising the lower end of the range of upfront carbon for a generic residential typology. This assumes a lower risk dataset for the purposes of this project. The lower end represents a good estimate of achievable scores when:

- Undertaking effective MEP carbon optioneering
- Opting for low-energy designs requiring less, and smaller, MEP equipment

The source of this information was the high-quality data set produced by WSP in Westminster Council’s Embodied Carbon Evidence Base published September 2024, review by Max Fordham. This data set assumed a heating, cooling and ventilation strategy that utilised Mechanical Ventilation with Heat Recovery (MVHRs), 4-pipe heat pumps (R32), Ambient loop distribution and fan-coil units.

4 Scope

Agar Grove, Phases 1A,B,C by Max Fordham,
1C by Price & Myers

4.0 Scope of study

4.1 Architecture

The total Gross Internal Area (GIA) for the case study building is 3,054sqm spread over 6 storeys including ground level. The total height from internal ground level to the highest occupied floor is 15.5m. The building is predominantly brick clad utilising a structural framing system (SFS) and masonry support angles set at two levels. The ground floor comprises of 150mm of insulation with a 75mm floating screed applied above. Punched windows are timber framed, triple glazed units incorporating louvres at the head for connection to mechanical vent and heat recovery ductwork internally. Areas of aluminium framed curtain walling have been incorporated to ground floor communal spaces and a full height curtain wall is positioned within the stair core. Mineral wool insulation has been specified within the external walls with a total cavity width of 200mm. Internal partitions and ceilings are based on typical build-ups anticipated with a residential building typology of this scale. The study does not account for internal fixtures and fittings or external landscaping.

4.2 Structure

The scope of the structural carbon assessment includes all permanent elements of the superstructure and substructure. In this case this includes the entire reinforced concrete (RC) frame above ground, and the foundations and piles below ground. Any load-resisting secondary elements not within the structural scope were not included in the assessment – most notably this includes stairs, SFS panels and masonry support angles. These have instead, been accounted for as part of the architectural elements.

4.3 MEP

The scope of this data set is all the building services within the building. As previously stated no allowance for photovoltaics is included.

Best practice targets very low operational demand which therefore requires the minimum size and quantity of MEP equipment i.e. lean design.

The data corresponds to a heating, cooling and ventilation strategy that utilised MVHRs, four-pipe heat pumps (R32), Ambient loop distribution and fan-coil units.

Figure 2 Visual of Building form used in the study to quantify material data

4.4 Assessment framework

Buttress has selected One Click LCA as the primary tool for this study. Structural elements have been calculated through Price & Myer's 'in house' Panda software. Figures for the mechanical and electrical design will be tested against a recent study by Westminster City Council titled Embodied Carbon Evidence Base.

This software offers a comprehensive framework for assessing the project's upfront embodied carbon footprint. It is acknoweldged however, that the scope of this report does not extend to a whole life carbon assessment. Where possible the Upfront Embodied Carbon Assessment adheres to industry standards, ensuring credibility and accuracy.

4.5 Compliance with standards

BS EN 15978:2011 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method) is complemented by the RICS Professional Statement (PS): Whole Life Carbon Assessment for the built environment (referred to as the RICS PS in this document). The RICS PS serves as a guide for implementing the principles outlined in BS EN 15978:2011, providing technical details and specifying calculation requirements.

Adherence to RICS guidance and BS EN 15978:2011 is paramount to maintaining consistency and reliability in our assessment. These standards provide a structured approach that ensures our calculations are transparent, comparable, and credible and whilst the report is limited to Stage's A1-A5 - the methodology for extracting this data is in line with RICS guidance.

4.6 Life cycle stages

BS EN 15978: 7.4 presents a series of modules which cover all stages of the life-cycle of a typical project. Those stages included within this report are highlighted in bold for clarity (See table 2).

4.7 Reference study period

The reference study period, which represents the assumed building life expectancy for assessment purposes, is typically set at 60 years but is not relevant for the purpose of calculating upfront embodied carbon.

4.8 Carbon metrics and units

CO2e (carbon dioxide equivalent) is a preferred metric for assessing the impact of building construction and operation due to its ability to comprehensively account for various greenhouse gases, provide consistency for comparisons, offer a long-term perspective on emissions, align with climate policies, and facilitate clear communication of a building's environmental impact. The results of this embodied carbon assessment will be communicated in kilograms of carbon dioxide equivalent (kgCO2e).

4.9 Data collection and sources

In this assessment, we gathered data from a variety of sources. For the "Product Stage" (A1-A3), we relied on supplier data sheets and Environmental Product Declarations (EPDs). Where product specific EPDs are not available in the database, or where the material manufacturer and product types are not currently known, the closest matching product has been selected.

Where practical, the scope of materials have been derived directly from Revit models made available across the design team. Using this method for establishing material quantities provides an accurate and live take-off but is reliant on the consistency and accuracy of modelling across the design team. The requirements and conventions for material naming and modelling protocols are set out and defined with the design team during the pre-assessment period.

Specifications are used as a supplemental source for identification of product/ system particulars and these are mapped/ assigned to Environmental Product Declarations (where available).

4.10 Assumptions and limitations

In some cases it will be necessary to input data manually in order to capture elements of the building not modelled directly within a Revit setting. These may include landscaping, ancillary services or secondary fixings, fittings and furniture items.

Table 2: Whole Life Cycle Stages
[A0] Pre-Construction
[A1-A3] Product Stage
[A4] Transport
[A5] Site Activity
[B1] In Use Impacts (Materials)
[B2] Maintenance
[B3 - B4] Repair & Replacement
[B5] Operation Energy Use
[B6] Operational Energy Use
[B7] Operational Water Use
[B8] User Activities
[C1] Deconstruction and Demolition Processes
[C2] Transport
[C3] Waste processing for reuse, recovery or recycling
[C4] Disposal
[D] Benefits & loads beyond the system boundary

(Scope of project highlighted in bold)

Case study: Agar Grove

Agar Grove

Max Fordham's Agar Grove led the way in large scale Passivhaus certified homes. The redevelopment of the estate helped to set a new standard for social housing.

The first Passivhaus development of its kind in the UK, it has meaningfully tackled fuel poverty by reducing residents' fuel bills by 70% and has influenced changes to the London Plan in relation to district heat networks.

With each building having a standalone heating system, each phase has been able to take advantage of the latest technology available at the time.

With three blocks now delivered, and the fourth under construction, the masterplan was designed before embodied carbon came to the forefront of sustainability.

The latest phase, Phase 2A, uses in-apartment exhaust air heat pumps, and no communal network. This is an appropriate technology for Passivhaus certified homes where certainty over heat loss gives confidence that heating demands will be met with this technology.

Max Fordham carried out embodied carbon design optioneering on different heating strategies, and this latest phase solution was demonstrated to have the lowest embodied carbon heating strategy out of all the phases so far.

Max Fordham: M+E Engineer 1A, 1B, 1C

Price & Myers: Structural Engineer Phase 1C

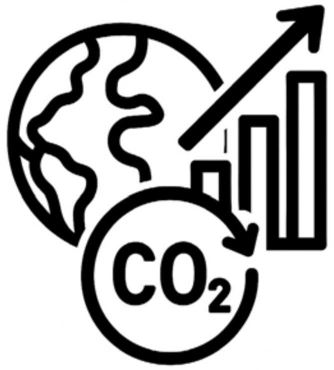
Architects: Mae 1A, 1B, Hawkins Brown 1A, Architype 1A

5 Data Collection

Central Somers Town Community Facilities and Housing by Price & Myers and Max Fordham

5.0 Data collection and analysis

This section sets out the inputs used in the embodied carbon assessment.



5.1 Life Cycle Stages

5.1.1 A1-A3: Material Extraction, Transport, & Product Manufacture.

A1-A3 are influenced by the carbon factors quantified within an Environmental Product Declaration (EPD). This design information and primarily drawings have informed the EPD selection which determines the A1-A3 carbon emission factor applied to each material. A total emission factor for each material is generated when applying the EPDs carbon factor to the total rates of materials.

Buttress acknowledge that the EPD selection and carbon emission factors have significant bearing on the final upfront A1-A5 results, and the building's performance against industry benchmark. We understand the importance of selecting suitable and representative embodied carbon factors (EPDs) to the given elemental material specifications and quantities.

Table 16 of RICS PS provides default specifications for main building materials, where designs are in concept stages and specification detail is not available.

We have set out our approach to EPD selection further on in this section and detailed confidence and quality testing the data for the top 10 materials which have the greatest bearing on the A1-A3 emissions.

5.1.2 A4: Transport to Site

For the purpose of this assessment, default transport distances have been used as supply chain data and production locations are not fully quantifiable. Use of default distances is the approach to take where information is not available. Defaults used are listed in Appendix B.

We assume the distances also account for return journeys which the RICS methodology requires.

5.1.3 A5: Site Impact Emissions

Site impact data inclusive of temporary facilitating works, energy and water consumption, plant fuel consumption have been estimated by using the building GIA. This will be rounded up to 40 kgCO2e/m2 in line with the RICS method.

Site Wastage factors (Lifecycle stage A5.3) have been predicted using RICS default values and applied to architectural elements using One Click LCA. For structural elements, these have been calculated using Price & Myers' in-house Panda software.

Materials that do not form part of the asset such as formwork or hoardings and additional trips to site have not been included at this stage. Estimates on this data are not available.

5.2 Building Elements

The building element groups outlined in Table 2 align with the BCIS Elemental standard form of cost analysis, 4th edition, promoting consistency and interoperability between Bills of Quantities (BoQs), cost plans, and carbon assessments. The RICS Professional Statement has adjusted the category reporting breakdown to tailor it to the specific requirements of whole life carbon assessment, identifying building elements that are particularly significant in terms of carbon emissions.

In our assessment, specific building elements assume a crucial role in determining carbon emissions. These elements were scrutinised due to their significant contribution to the project's carbon footprint. For instance, structural components or particular materials may exert a disproportionately substantial influence. Our methodology gives precedence to these elements allowing us to concentrate on reducing the emissions which hold the greatest value.

5.3 Building Information Modelling (BIM)

A key aspect of our assessment involves the use of Building Information Modelling (BIM), specifically through Revit software, to generate a highly accurate and detailed data set. This data-driven approach includes the project materials, components, and systems, significantly enhancing assessment precision. BIM, especially Revit, allows us to catalogue every project element, from structural components to material specifics, providing a comprehensive understanding of the project's carbon profile.

6 Results

The Depot by Buttress

6.0 Results

6.1 Architectural

Table 3.1 - Summary of results

Upfront embodied carbon (kgCO2e)		Global Warming Potential - kgCO2e (A1-A5, excl. A5.2)
1. Substructure	1.2.1. Lowest slab	25,374
	1.2.2. Suspended slabs	622
2.2. Upper floors		14,327
2.3. Roof		14,920
2.4. Stairs and ramps	2.4.1. Stairs	3,734
	2.4.3. Safety and access ladders, chutes, slides and guarding	4,262
2.5. External envelope, including roof finishes	2.5. External envelope including roof finishes	5,946
	2.5.1. External - opaque envelope	96,412
	2.5.2. External - full height glazing systems	6,426
	2.5.3. External - roof finishes/coverings	6,014
2.6. Windows and external doors	2.6. Windows and external doors	28,397
	2.6.1. Windows - vertical	36,457
2.7. Internal walls and partitions	2.7.1. Internal walls - solid	60,195
2.8. Internal doors		16,989
3. Finishes	3.1. Wall finishes	7,510
	3.2.3. Floor finishes	16,843
	3.3. Ceiling finishes	5,227
4.1. General fittings, furnishings and equipment		971
Not classified		87
Site wastage (A5.2)		17,442
Total upfront embodied carbon (kg CO2e)		**368,157**
Total upfront embodied carbon (tonnes CO2e)		**368**

6.2 Structural

Table 3.2 - Summary of results

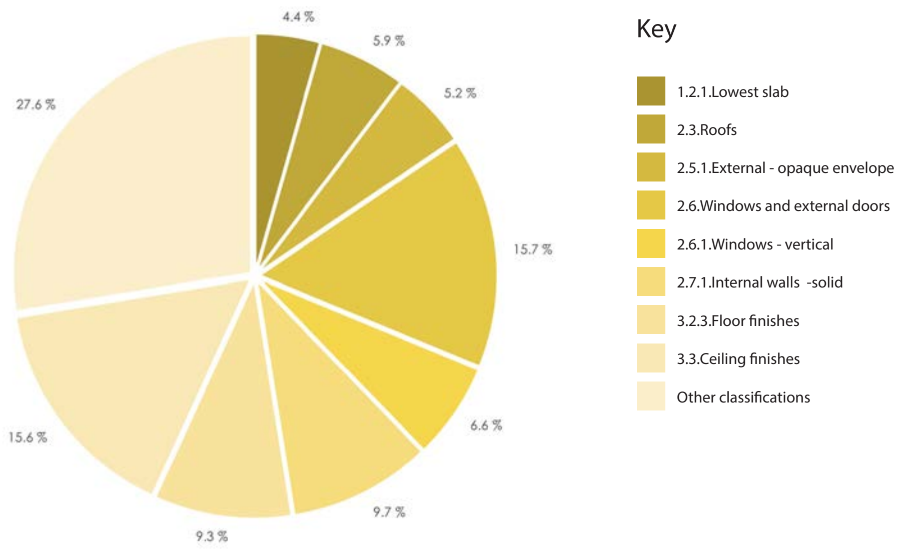
Upfront Embodied Carbon (kgCO2e)		Global Warming Potential - kgCO2e (A1-A5, excl. A5.2)
1. Substructure	1.1 Foundations & Piling	95,484
	1.2.1. Lowest Slab	35,790
2.1 Frame	2.1.1 Vertical Frame	101,957
2.2. Upper floors		248,563
Total Upfront Embodied Carbon (kg CO2e/m^2)		**481,794**
Total Upfront Embodied Carbon (tonnes CO2e/m^2)		**481**

6.3 Mechanical, Electrical & Plumbing

Table 3.3 - Summary of results

Upfront Embodied Carbon (kgCO2e)	Global Warming Potential - kgCO2e (A1-A5, excl. A5.2)
5. Services	366,480
Total Upfront Embodied Carbon (kg CO2e/m^2)	**366,480**
Total Upfront Embodied Carbon (tonnes CO2e/m^2)	**360**

Architectural Total Kg CO2e - Classifications



Architectural Total Kg CO2e - Life Cycle Stages

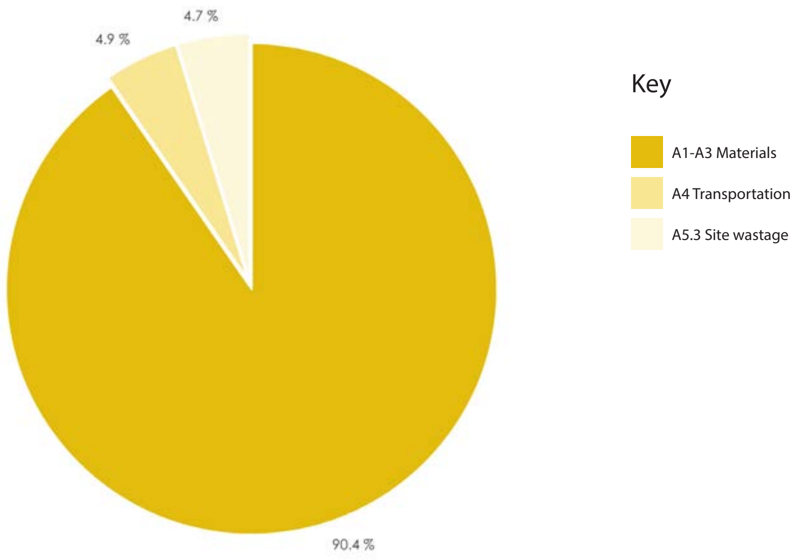


Figure 3 Architectural total Kg CO2e

Table 4 - Total Kg CO2e - Classifications

Item	Value	Unit	Percentage %
1.2.1.Lowest slab	32,776	kg CO2e	4.4 %
2.3.Roofs	38,930	kg CO2e	5.2 %
2.5.1.External - opaque envelope	117,268	kg CO2e	15.6 %
2.6.Windows and external doors	48,970	kg CO2e	6.5 %
2.6.1.Windows - vertical	72,343	kg CO2e	9.7 %
2.7.1.Internal walls -solid	69,632	kg CO2e	9.3 %
3.2.3.Floor finishes	116,590	kg CO2e	15.6 %
3.3.Ceiling finishes	53,697	kg CO2e	7.2 %
Other classifications	199,385	kg CO2e	26.6 %

Table 5 - Total Kg CO2e - Life cycle stages

Item	Value	Unit	Percentage %
A1-A3 Materials	332,632	kg CO2e	90.4 %
A4 Transportation	18,083	kg CO2e	4.9 %
A5.3 Site wastage	17,442	kg CO2e	4.7 %

Case study: Citizens House

PRICE&
MYERS

Citizens House

Price & Myers' Citizens House is the result of a campaign by local people to build Community Land Trust (CLT) homes on surplus council-owned land.

It is a new development of eleven affordable homes for third sector housing developer London Community Land Trust. The first purpose-built community land trust homes to be completed in London.

Sustainability and low-carbon performance were key considerations in the design and delivery of Citizens House. The building achieves a 39% reduction in carbon emissions against the 2013 Part L notional baseline, equating to a projected saving of 5.4 tonnes of CO^2 per year.

A 12.7kWp solar PV array was installed on the main roof, contributing to 10.5% on-site energy generation. Operational energy use is reduced by 37.2%, with total energy demand at 100.8 kWh/m²/year and heating and hot water loads at 74.4 kWh/m²/year.

The building fabric has been designed for thermal efficiency and long-term performance. U-values are 0.23 W/m²K for the walls, 0.14 W/m²K for the roof, and 0.12 W/m²K for the floor. Airtightness was measured at 5 m³/hr/m² @ 50Pa, and the overall thermal bridging Y-value is 0.08 W/m²K. The structure is compact and carefully detailed to reduce heat loss, with balconies providing solar shading to mitigate overheating. The building has a predicted design life of 100 years.

Natural daylight and water efficiency are also well considered. 94.2% of the floor area achieves a daylight factor over 2%, with 9.3% achieving more than 5%. Annual mains water consumption is below 38.3 m³ per occupant.

> **'We drew on our wealth of experience of these types of projects to be able to deliver a quality design that has resulted in a building quality well above its cost.'**
>
> Jack van Zwieten, Structural engineer/Associate.

The building's location supports a low-carbon lifestyle. It's a short walk from Sydenham Overground station and local amenities, which enabled a reduction in car parking provision from eleven spaces to five. Secure cycle parking is provided for each home, along with visitor cycle stands and pram storage at ground level. A previously unsafe cut-through route on the site was replaced with a well-lit public path, improving access and safety for the wider neighbourhood.

Durability and ease of maintenance informed material choices. External materials were selected with a view to minimising future upkeep, and careful attention was paid to the parapet and junction details to reduce thermal bridging and improve fabric resilience. Thermal blocks and Damp Proof Course (DPC)s were used to maintain performance without the need for proprietary thermal breaks, keeping the construction cost-effective while meeting environmental targets.

Price & Myers: Structural Engineer

Architects: Archio

7

Most contributing materials

Downley Drive by Buttress

7.0 Most contributing materials

7.1 Most Contributing Architectural Materials

Materials have been chosen based on an average dataset for any particular product specified. The aim with this was to eliminate any bias in material selection, giving a realistic interpretation of the range of EPD's currently available. It should be acknowledged that in so doing we have discounted any emerging or new products which may have the capacity for driving down embodied carbon in the years to come. Section 7.2 considers this in further detail and offers a hypothetical 'what if' scenario.

Overall the top 10 contributing materials make up a total of:

65.8%

of the upfront embodied carbon (A1-A3) associated with the architectural materials. It is therefore of benefit to source alternative products with a focus on these materials.

For the baseline study, we aimed the majority of our datasets on the average EPD for any given building element in order to reduce any bias and also to give a more accurate interpretation of where we stand in terms of real world specification and data availability. Table 6 illustrates the materials which contributed the most to the architectural elements along with the corresponding carbon weighting expressed in tonnes and as a percentage of Cradle to Gate (A1-A3) impacts.

Table 6 - Top 10 Most Contributing Materials (Architectural)

No.	Resource	Cradle to gate impacts (A1-A3)	Percentage of Cradle to Gate (A1-A3)
1.	Timber Framed Windows	64,855 kgCO2e	18.5 %
2.	Brickwork	45,217 kgCO2e	12.9 %
3.	Gypsum Plasterboard	20,456 kgCO2e	5.8 %
4.	Metal Framing	16,900 kgCO2e	4.8 %
5.	Masonry Support Angles	16,237 kgCO2e	4.6 %
6.	Self Levelling Screed	14,644 kgCO2e	4.2 %
7.	Suspended Ceiling System	14,194 kgCO2e	4.1 %
8.	Internal Wooden Doorleaf	13,782 kgCO2e	3.9 %
9.	*PIR Insulation Roof Boards	13,550 kgCO2e	3.9 %
10.	PIR Insulation Floor Boards	10,730 kgCO2e	3.1 %

Polyisocyanurate (PIR)

8 Opportunities & Further Consideration

Greenhaus by Buttress with Max Fordham

8.0 Opportunities & further consideration

8.1 Potential Reductions

The following table looks at emerging products/manufacturing techniques which offer a realistic opportunity within the coming years to reduce the embodied carbon of the top ten contributing materials outlined in the previous section. Some of these are based on products currently available with real world data and others are based on industry estimates for the given product represented. A detailed appraisal of each material is then given in the following pages (overleaf).

Table 7 - Top 10 Most Contributing Materials (Architectural)

No.	Resource	Cradle to gate impacts (A1-A3)	Percentage of Cradle to Gate (A1-A3)	Typical Carbon per unit (kg/t/ m2/lm)	Potential Reduction
1.	Timber Framed Windows	64,855 kgCO2e	18.5 %	60.6 kg CO2e / m2	42%
2.	Brickwork	45,217 kgCO2e	12.9 %	0.213 kg CO2e / kg	108%*
3.	Gypsum Plasterboard	20,456 kgCO2e	5.8 %	1.7 kg CO2e / kg	47%
4.	Metal framing	16,900 kgCO2e	4.8 %	2.52 kg CO2e / m2	80%
5.	Masonry Support Angles	16,237 kgCO2e	4.6 %	84.6 kg CO2e / m	n/a
6.	Self Levelling Screed	14,644 kgCO2e	4.2 %	0.18 kg CO2e / kg	72%
7.	Suspended Ceiling System	14,194 kgCO2e	4.1 %	0.81 kg CO2e / lm	42.4%
8.	Internal wooden doorleaf	13,782 kgCO2e	3.9 %	20.8 kg CO2e / m2	65%
9.	PIR Insulation Roof Boards	13,550 kgCO2e	3.9 %	7.15 kg CO2e / m2	20%
10.	PIR Insulation Floor Boards	10,730 kgCO2e	3.1 %	9.54 kg CO2e / m2	32%

8.2 Opportunities for reducing embodied carbon

8.2.1 Material Selection Commentary

This summary and the emerging products column in Table 7 represent a ‘brakes off’ hypothetical scenario which looks at materials which have the potential to tackle the embodied carbon challenge when it comes to specification of materials which typically contribute the highest proportion of building elements.

Brickwork

We acknowledge there are emerging opportunities to specify bricks with a lower embodied carbon footprint or in some examples a negative footprint. Given that brick is one of the predominant building materials in terms of the external envelope, any reduction in embodied carbon could lead to significant reductions overall. Pressed bricks, especially unfired and minimally stabilized, have significantly lower embodied carbon than standard kiln-fired bricks. Building on this trend, innovative advancements such as CO2-negative facing bricks are offering huge savings in upfront embodied carbon. The figure expressed in Table 7 makes use of anticipated figures from leading manufacturers and their claimed reductions with a full EPD anticipated later this year (2025).

The current assessment acknowledges and makes use of Kiln-fired bricks, which remain widespread due to their strength and durability, but their carbon footprint is higher due to energy-intensive production. Any substitution to a pressed alternative must ensure that a compressive strength equal to that of kiln fired bricks is achievable.

Plasterboard

Perhaps one of the most common building materials used across all sectors; any opportunity to unlock the potential of embodied carbon reduction would be of huge benefit to the industry as a whole. Whilst still within the pilot testing stages, there is a promising alternative in the form of Breathaboard which is a low-carbon alternative to plasterboard, designed to improve indoor air quality and moisture regulation. It’s usually made with natural materials like clay, recycled aggregates, or plant fibers. Current estimates suggest that a c.50% reduction is possible compared with standard plasterboard. Such gains are made possible through low energy processing and avoidance of high temperature calcination.

Studwork

Coupled with the use of plasterboard as a partition system, standard metal studs (typically made from cold-formed galvanized steel) are used extensively and have an embodied carbon of around 2,000–2,500 kg CO2e per tonne. They are usually galvanised too which also adds to the emissions profile. Hemp-based studs on the other hand have some encouraging figures which suggest a low or even negative embodied carbon depending on binder type and lifecycle. A possible range between -0.2 to +0.5 kg CO2e per kg certainly provides a level of optimism about it’s potential future use and roll out.

Ground Floor Construction

The use of Geocell in combination with Limecrete offers an alternative build up to a traditional floating screed on PIR insulation system. Foamed glass aggregate made from recycled glass; used as a sub-base (replaces hardcore or insulation) and the Limecrete (e.g. NHL or hydraulic lime + lightweight aggregates) is laid on top as a slab. Limecrete + Geocell systems can offer a 40–60% lower embodied carbon footprint compared to PIR-based floating screed systems.

Limecrete systems also bring benefits in moisture regulation, use of recycled/renewable materials, and potential carbon sequestration (from lime carbonation).

Floating screed + PIR is more conventional, but contributes significantly more embodied CO2, especially due to PIR insulation.

Inverted Roof Construction

Typically used as a roof build up on buildings of this size and typology they are often specified because they resist moisture and compressive loads effectively. The trade off usually being the specification of PIR or Extruded polystyrene (XPS) as the primary insulation layer. Both of these are closed-cell plastic insulations and are non-renewable. Foamglass offers a comparable alternative without the integration of plastic foam as well as a potential embodied carbon reduction of 80-90%. The trade off and slower take-up is usually prohibited by cost which tends to be 35% higher. Unless embodied carbon is mandated by planning authorities or limits and targets brought into the Building Regulations, it’s use is likely to be restricted. As such we have opted to use Bauder’s eco range in our comparisons table.

Masonry Support

Although there is no direct substitution for masonry support angles, there are potential alternatives to the build up of external walls which could have a positive impact on the embodied carbon by reducing the load requirements that the angles support. Using a lightweight backing system (e.g., glass-fibre reinforced concrete (GRC), clay boards, or wood-fibre cement) with thin brick slips is one such method. The benefits to this are that it eliminates or drastically reduces steel supports, reduces brick quantity (less material volume) and prefabrication can reduce waste and site emissions. If traditional brick cladding must be retained:

a. Optimised Support Brackets
Use leaner designs with thermal breaks (e.g., Halfen HIT, Ancon Thermal)
Some offer LCA-verified lower carbon steel or recycled content

b. Aluminium or Hybrid Supports
In select applications, aluminium or composite supports can reduce weight and carbon, though aluminium has a mixed carbon profile (high unless recycled).

Timber Door Leaves

While solid timber is renewable and often lower in carbon than metals or plastics, there are even lower embodied carbon alternatives, especially when considering volume use across a whole apartment block such as this. Standard options are typically solid timber or timber composite/veneer on MDF core. Fire-rated versions often include additional boards, glue, fillers, and intumescent strips. MDF cores are resin-bound (often urea-formaldehyde-based)

Fire-rated doors may include steel, glass, or high carbon mineral cores and high material use across 100+ units tends to add up to a significant total carbon; demonstrated by its placement as seventh in table six.

In place of conventional timber door leaves in mid-rise apartment schemes, several low embodied carbon alternatives are emerging. One of the most promising options is agricultural waste-core doors, which use compressed materials such as wheat straw, hemp hurds, or bagasse, bound with bio-resins. These doors maintain similar performance to standard timber doors, including fire-rating capability when properly skinned, but offer a significantly lower embodied carbon footprint, often in the range of 10–25 kg CO2e per door.

Another lightweight option is recycled paper honeycomb core doors, which are ideal for internal, non-loadbearing applications and can achieve embodied carbon as low as 10–20 kg CO2e per door, though fire performance may be limited.

Additionally, hemp-lime composite or wood fibre core doors offer very low-carbon solutions with natural finishes, though these are more experimental and best suited to eco-focused or small-scale projects.

Compared to conventional solid timber or MDF-core doors, which typically range from 30–60 kg CO2e per door, these alternatives offer substantial reductions in embodied carbon while supporting circular, bio-based construction practices.

Windows

While timber is already a low-carbon option, alternatives like natural fibre composites, recycled aluminium-clad timber hybrids, and engineered wooden frames offer potential reductions in embodied carbon or improve material efficiency.

For wide-scale adoption in mid-rise apartment schemes, hybrid timber-aluminium frames currently provide a good balance of durability, compliance, and embodied carbon reduction, while natural fibre composites represent a promising next-generation solution for deep green or net-zero projects.

The latter, natural fibre composite window frames offer a highly sustainable alternative to traditional timber in mid-rise apartment schemes. These frames are made from plant-based fibres such as flax, hemp, or straw, combined with bio-resins or low-impact binders to form strong, lightweight, and insulating profiles. Because the fibres sequester carbon during growth and the materials are often derived from agricultural by-products, the resulting embodied carbon can be exceptionally low - potentially even carbon-negative. Natural fibre composites provide good thermal performance and can be factory-finished for durability against moisture and UV exposure.

Whilst not yet widely available commercially, especially at scale, they show strong potential for future use in low-carbon construction, particularly for projects targeting net-zero or circular economy principles.

8.2.1 MEP design

Optioneering the MEP design will identify strategies to minimise building services.

- Heat-source option study that engages in whole life carbon balancing of upfront carbon, refrigerant leakage and operational carbon associated with heating and cooling energy use.
- Whole-sale energy strategy carbon comparison finding the lowest whole life carbon solution (e.g. Ambient Loop w/WSHPs vs Exhaust Air Heat Pumps vs HIUs /Underfloor Heating etc.)
- Targeting very low operational demand which therefore requires the minimum size and quantity of MEP equipment i.e. lean design.
- Optimising exercise looking at riser and equipment locations, aiming to minimise duct and pipe runs.
- Careful consideration of electrical design to minimise the length, and diameter, of the largest sub-mains cables.
- Factoring in knock-on effects of building services options to ensure comparisons are holistic (i.e. floor-zone depths and allowable structural systems. raised access floors and plenum distribution, storey heights and façade/structural impacts etc
- Enable reuse of MEP equipment both existing and specify products designed with circularity in mind for refurbishment/upgrade.

8.2.2 Design for Disassembly (DfD)

Designing buildings with disassembly in mind allows for the reuse of materials and components at the end of the building's life cycle. This can reduce the need for new materials in future downstream carbon emissions but is worthy of consideration nonetheless, despite it's immediate impact on A1-A3 carbon.

8.2.3 Minimising Waste

Waste reduction during the construction process can also improve embodied carbon. The less material wasted during construction, the less carbon is emitted in producing and transporting that material.

8.2.4 Early Collaboration

Early-stage collaboration between architects, structural engineers, and sustainability consultants is key. By integrating sustainability targets from the outset, the team can ensure that materials and designs align with embodied carbon reduction goals.

8.2.5 Form factor

Early massing decisions can affect not just the heat loss of the building but also the embodied carbon with roof, foundations and external walls all large contributors. Optimising height and an efficient form factor can help reduce the overall embodied carbon per m2.

8.2.6 Use of Building Performance Software

Using advanced building performance software like Tally, One Click LCA, or Revit with sustainability plugins can allow designers to model and assess the embodied carbon of materials early in the design process. This enables data-driven decisions on material selection and design.

8.2.7 Optimization of the Building Envelope

Focusing on reducing the size and weight of the building envelope (walls, floors, roofs) can help reduce the materials required. For example, using lightweight materials or optimizing the structural frame can reduce the amount of concrete or steel needed.

8.2.8 Industry Support and Role

The role of manufacturer's in reviewing their own existing product lines and carbon emissions cannot be understated. The cumulative effect and impact that such reductions could induce is significant and will play a major role in hitting the limits within the NZCBS.

8.2.9 Standardizing and Sharing Embodied Carbon Data

One of the major hurdles in improving embodied carbon is a lack of reliable data. The industry can play a crucial role in developing standardised tools for calculating and reporting embodied carbon in buildings. This will make it easier for professionals to make informed decisions and track performance.

8.2.10 Certification and Incentives

Governments and industry bodies can create certifications or offer incentives for buildings that meet or exceed net zero carbon standards. This can encourage architects, engineers, and developers to adopt low-carbon strategies in their designs.

8.2.11 Material Innovation and Supply Chain Integration

Suppliers and manufacturers can help improve embodied carbon by investing in low-carbon alternatives, optimizing production processes, and providing transparent carbon data for their products. Manufacturers should also explore circular economy models to promote re-use and recycling of materials.

8.2.12 Education and Training

Architects, structural engineers, and other stakeholders should be provided with continuous training on embodied carbon reduction strategies. This includes access to up-to-date research, carbon-reduction technologies, and best practices to incorporate into their projects.

8.2.13 Government Policy and Regulations

Governments can aid this process by establishing stronger regulations that enforce minimum embodied carbon limits, as well as offering subsidies or tax breaks to those developing low-carbon or carbon-neutral buildings. Public policies could also encourage or mandate lifecycle carbon assessment tools to be used in planning.

8.3 Approved Document B Integration

Part B of the UK Building Regulations focuses on fire safety, covering the materials and construction methods used to ensure buildings are safe in the event of a fire. Incorporating embodied carbon reduction strategies within the context of Part B involves finding a balance between sustainability goals and maintaining fire safety standards.

At present there is a clear opening gulf between Part B and the NZCBS in so much that the two aren't fully compatible with the other creating an either/ or situation. It is recognised that residential buildings over 18m, requiring two stair cores are unlikely to achieve the upfront embodied carbon limits set by The Standard. This makes sense when considering that the additional structure and increased building footprint tend to go hand in hand with an uplift in embodied carbon. This was also the reason why our study was limited to a residential development under 18m.

Considering alternative lower carbon materials goes some way to compensate for this but it only gets the industry so far. Ultimately there needs to be a two pronged approach between regulatory reform and technological advancements in order to maintain compliance with Part B whilst also reducing our carbon footprint.

1. Reduction of carbon within structural systems. This could be through technological innovation such as the introduction of graphene as an alternative reinforcing additive. Graphene can help reduce embodied carbon in structural concrete primarily by improving the mechanical performance of the concrete, which allows for a reduction in the volume of cement used, and since cement production is a major source of CO2 emissions, this leads to a significant carbon saving.

2. Introduction of timber / CLT as a viable structural solution. Improving performance testing to permit the use of timber in high-rise residential developments involves addressing regulatory concerns around fire safety, especially under Part B of the UK Building Regulations. Current testing frameworks often don't fully reflect how mass timber performs in real fires or under real building conditions. Enhancing these methods would allow for more accurate risk assessment and potentially greater acceptance of timber structures.

Since 2018, Regulation 7(2) of the Building Regulations bans the use of combustible materials in the external walls of residential buildings over 18m.
CLT and other structural timbers are classed as combustible (Class D/E) under the Euroclass system. Timber chars rather than melts or collapses, and while this provides predictable fire performance, ensuring adequate fire resistance (typically 90–120 minutes for high-rises) requires:

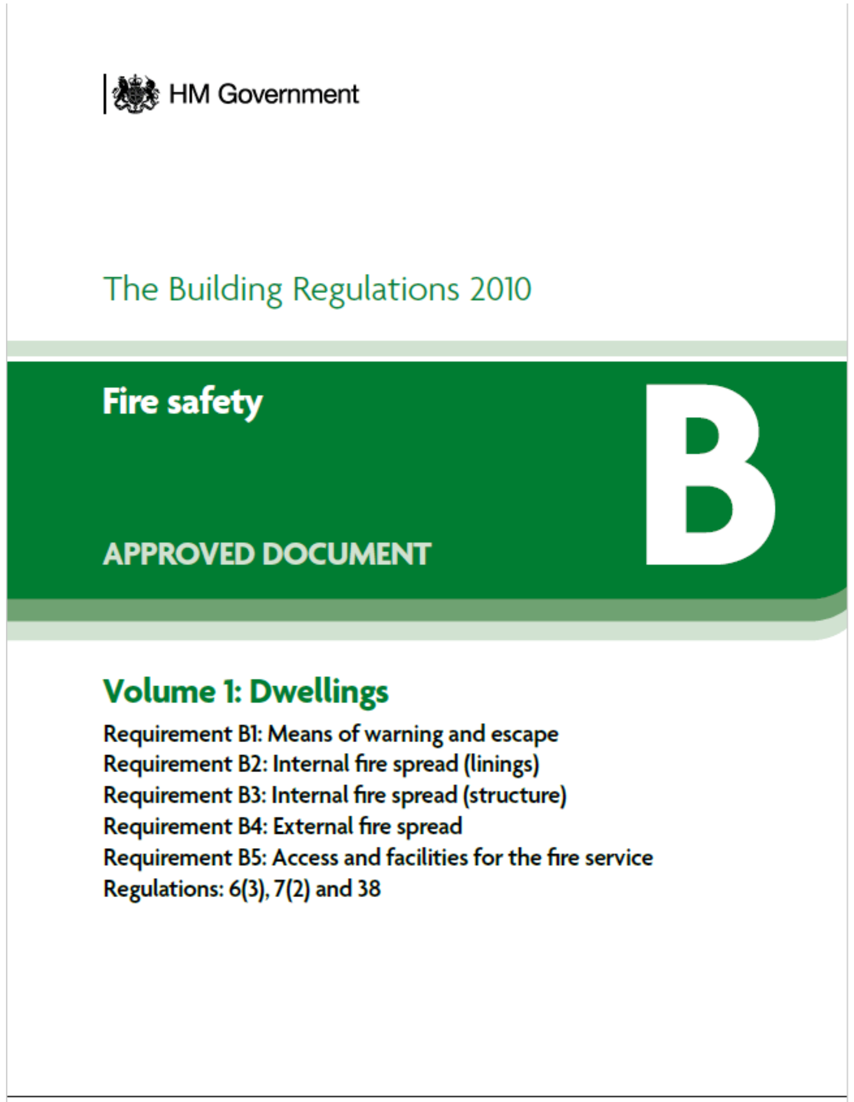
- Sufficient thickness to allow sacrificial charring.
- Encapsulation with fire-resistant boards or plasterboard. Demonstrating this performance can be difficult, especially in complex geometries.

3. Regulatory consultation and research. Building regulations should encourage ongoing collaboration between carbon standards and fire safety experts to ensure that innovative low-carbon solutions (such as timber frame buildings or new low-carbon concrete alternatives) can be safely implemented while maintaining compliance with Part B.

4. Testing and certification. Any new materials or building systems that claim to reduce embodied carbon must undergo fire safety testing and certification to demonstrate compliance with Part B requirements. This ensures that sustainability measures do not compromise safety.

5. Parallel compliance. Buildings would need to demonstrate compliance with both sets of regulations. For example, a building may meet NZCBS' embodied carbon limits while also ensuring that all materials meet the fire safety standards outlined in Part B. This would likely involve submitting documentation and evidence to show that both criteria are being met

6. Cross-disciplinary collaboration. Architects, structural engineers, and fire safety consultants would need to collaborate from the outset of the design process. By considering both embodied carbon and fire safety requirements simultaneously, they can optimize the building design for both sustainability and safety.



HM Government

The Building Regulations 2010

Fire safety

APPROVED DOCUMENT

B

Volume 1: Dwellings

Requirement B1: Means of warning and escape
Requirement B2: Internal fire spread (linings)
Requirement B3: Internal fire spread (structure)
Requirement B4: External fire spread
Requirement B5: Access and facilities for the fire service
Regulations: 6(3), 7(2) and 38

9 Conclusion

9.0 Conclusion

This project has demonstrated that achieving the UK Net Zero Carbon Buildings Standard (UKNZCBS) limits for upfront carbon in residential developments is both technically feasible and strategically beneficial.

As the results illustrate, with current construction methods and specifications the 2025 limit of **565 kgCO2e/m2** can be surpassed by approximately **3 years**. Having knowledge of this is crucial if the industry as a whole is to progress forward with viable alternative strategies and techniques for reducing upfront carbon beyond 2028.

What the report perhaps best demonstrates is that there is not one single solution to achieving a low carbon design but rather a host of tools and techniques that will be required to realise the iterative and sequential annual improvements that the standard calls for.

The study into the top 10 most contributing materials and their corresponding 'low carbon' alternatives provides a promising insight into the direction of travel. It is clear that manufacturers are starting to respond with positive and workable solutions which offer real, practical and alternative options. In most instances such products can be readily substituted against their higher carbon based counterparts.

On this project alone, we found that an approximate **12%** improvement could be achieved if, and when, EPD's are readily available for those components listed in table 6. Figure 4 illustrates this cumulative improvement per material type.

Such a percentage reduction moves us towards the **2030** limit set by the UK NZCBS with a potential figure of **393 kgCO2e/m2**. This in itself is important as it illustrates that even with some fundamental shifts in material specification, the most stubborn carbon sits within the structural and MEP items.

In order to reduce these emissions beyond 2029 and into the new decade a number of other solutions will be needed, some of which may not yet be quantifiable or perceptible. Technology will undoubtedly play a key part in this but so too will the de-carbonisation of the grid.

As the national grid shifts from fossil fuels to renewable energy sources (wind, solar, hydro), the emissions per kWh of electricity decrease, making electrically powered manufacturing processes far cleaner.

Switching from grid electricity at ~200 gCO2/kWh to renewable electricity at <50 gCO2/kWh reduces indirect emissions by over 75%.

Electric Arc Furnaces (EAF) in steel making, when powered by renewable electricity, drastically reduce emissions compared to blast furnace methods for instance. As the grid de-carbonises, the relative embodied carbon of materials shifts - for example, low-carbon steel may become more viable than high-cement concrete in some applications. Architects and engineers can also select materials from suppliers in countries or regions with cleaner grids (e.g., Nordic countries for aluminium or steel).

The future energy scenarios 2023 report envisions a reduction in grid emissions outward to 2050 with a series of scenarios modelled, ranging from a worst case 'falling short' to a more optimistic 'leading the way' scenario. The outcome of this will have a huge bearing on the upfront A1-A3 emissions associated with product processing and manufacturing.

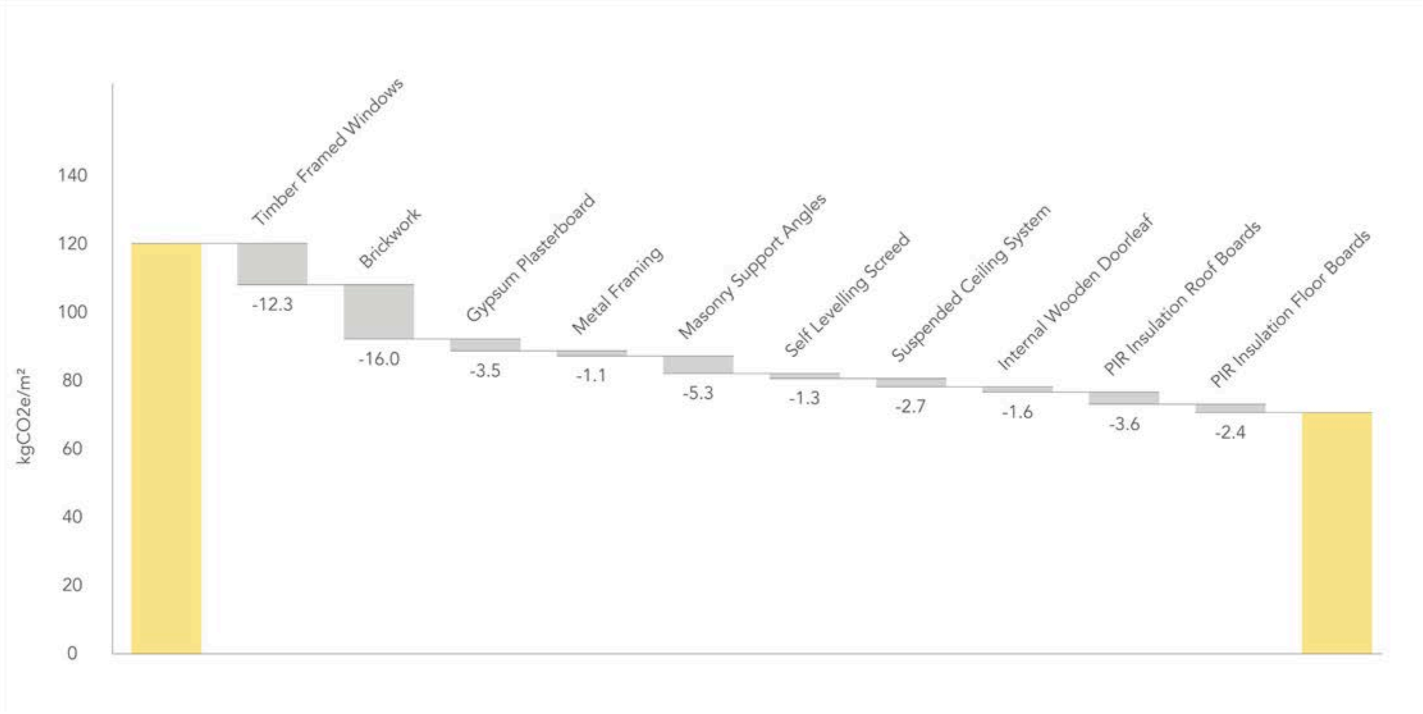


Figure 4 Cumulative improvement when substituting low carbon alternatives (See Table 7)

In summary while challenges remain - particularly around regulatory compliance, material sourcing, and fire safety - this study concludes that with an integrated design approach, rigorous specification, and commitment to continual carbon monitoring, residential projects can align with the UK NZCBS upfront carbon targets and contribute meaningfully to the de-carbonisation of the built environment.

10 Appendices

Valette by Buttress

10.0 Appendices

10.1 Appendix A: Life-cycles (in detail)

BS EN 15978:2011 and the RICS PS define a series of life stages that collectively cover the entire life-cycle of a typical project. Each of these stages plays a crucial role in assessing the project's environmental impact, particularly in terms of carbon emissions:

Pre-construction Stage (A0):

This stage includes non-physical processes such as feasibility studies, design development, and planning approvals. While no materials are physically used, emissions from office operations, digital modelling, and professional services contribute to the project's overall carbon footprint.

Product Stage (A1-A3):

This phase accounts for the environmental impact associated with the extraction, production, and transportation of building materials and components.

Construction Process Stage (A4 and A5):

This encompasses the transportation of materials to the construction site and the subsequent installation processes, both of which contribute to emissions during the construction phase.

Use (B1):

The operational phase of the building, including energy use and occupancy patterns, is a significant contributor to the project's carbon footprint.

Maintenance (B2):

Regular maintenance activities impact the building's energy efficiency and longevity, influencing emissions over time.

Repair and Replacement (B3 and B4):

The need for repairs or component replacements can introduce emissions, affecting the building's life cycle.

Refurbishment (B5):

Major refurbishments or renovations can substantially alter a building's environmental profile, warranting assessment.

Operational Energy Use (B6):

Specific focus on the energy consumption during the building's use phase, which is often a significant part of its life-cycle emissions.

Operational Water Use (B7):

Water-related energy consumption and its associated emissions are considered in this stage.

User Activities (B8):

This accounts for emissions generated by occupant activities beyond standard operational energy and water use. It includes factors such as plug loads, equipment use, and behavioural patterns that influence the building's total environmental impact.

Deconstruction and Demolition Process (C1):

The process of dismantling or demolishing the building at the end of its life involves emissions related to deconstruction and waste management.

Transport (C2):

Emissions resulting from transportation activities, including materials and waste transport, are accounted for here.

Waste Processing for Reuse, Recovery, or Recycling (C3):

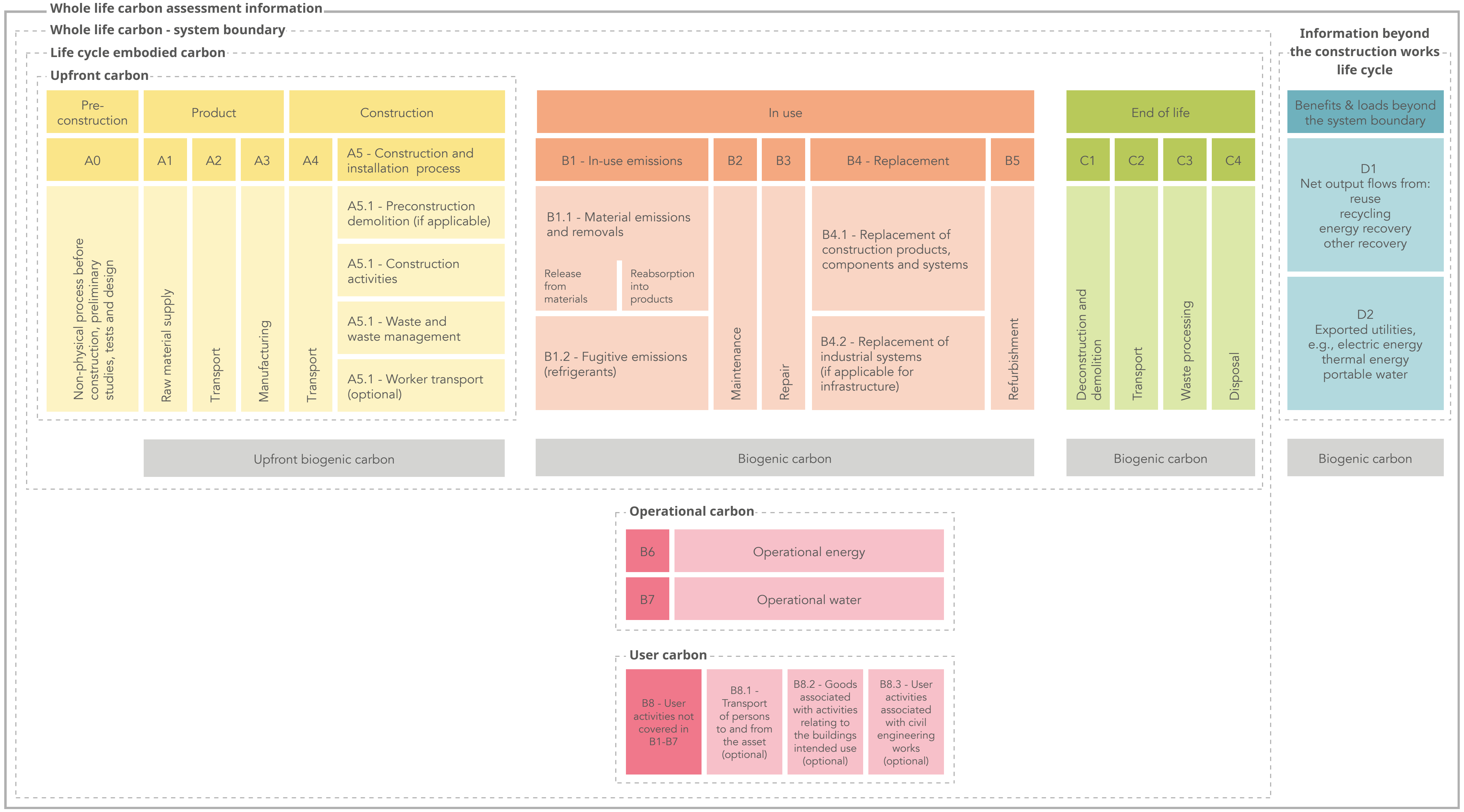
The management of waste materials affects a project's environmental impact.

Disposal (C4):

This stage addresses the environmental consequences of waste disposal.

Benefits and Loads Beyond the System Boundary (D):

Consideration of external factors and indirect impacts that may influence the project's life-cycle emissions.



Building and infrastructure life-cycle stages and information modules (adapted from EN 15978, EN 17472, and EN 15643, with additions to illustrate biogenic carbon). Taken from the UK Net Zero Carbon Buildings Standard (UKNZCBS) April 2025 pilot and further adapted to include additional sub-categories.

10.2 Appendix B: Default transport distances

Transport scenario (both road and sea to be used)	km by road	km by sea
Locally manufactured (ready-mixed concrete)	20	-
Locally manufactured (general) e.g. aggregate, earth, asphalt	50	-
Regionally manufactured e.g. structural timber, blockwork, insulation, carpet, glass	80	-
Nationally manufactured e.g. structural timber, structural steelwork, reinforcement, pre-cast concrete	120	-
European manufactured e.g. cross-laminated timber (CLT), facade modules	1500	100
Globally manufactured e.g. specialist stone cladding	500	10,000

10.3 Appendix C - Default waste rates

Material/product	WR (waste rate)
Concrete in-situ	5%
Concrete pre-cast (floor, beams, and frames)	1%
Concrete (sprayed)	10%
Steel reinforcement	5%
Steel frame (beams, columns, braces)	1%
Concrete blocks (lightweight AAC)	10%
Concrete blocks (dense/medium density)	5%
Brickwork (clay)	6%
Stone (cladding)	5%
Stone (landscaping)	10%
Mortar and render (internal and external)	4%
Screed	8%

Material/product	WR (waste rate)
Floor finish (tile)	6%
Floor finish (carpet)	6%
Timber frames (beams, columns, joists, braces)	2%
Timber floors (boards)	10%
Timber formwork	10% in addition to end of life usage rates
Aluminium sheet	1%
Aluminium extruded profiles/frames	1%
Plasterboard	4%
Insulation	7%
Aggregate	10%
Glass	1%
Coatings (paint, intumescent coatings)	6%

10.4 Appendix D - Glossary of terms

Carbon Accounting: The process of measuring, reporting, and managing carbon emissions to track and reduce an entity's carbon impact.

Carbon Footprint: The total amount of greenhouse gas emissions, primarily carbon dioxide, associated with a specific product, service, or entity.

CO2e (Carbon Dioxide Equivalent): A standardised unit for measuring and comparing the climate impact of various Greenhouse Gases (GHGs), expressed in terms of their equivalent Global Warming Potential (GWP) to carbon dioxide (CO2) over a specific time period. It simplifies the comparison of different greenhouse gas emissions.

Carbon Intensity: A measure of carbon emissions per unit of a product or service, often expressed in kilograms of CO2-equivalent per unit (kg CO2e).

Carbon Neutrality: A state in which an entity's carbon emissions are balanced by carbon removal or offset activities.

Net Zero Carbon: Achieving a balance between carbon emissions and carbon removal or offsets, resulting in no net increase in atmospheric carbon.

Absolute Zero Carbon: Eliminating all carbon emissions without the use of offsets.

Carbon Offset: A mechanism for compensating for carbon emissions by investing in projects that reduce or capture an equivalent amount of carbon elsewhere.

Carbon Sequestration: The capture and long-term storage of carbon dioxide from the atmosphere, often through natural processes like afforestation or carbon capture and storage (CCS) technologies.

GHG (Greenhouse Gas): GHGs are gases in the Earth's atmosphere that can trap heat, contributing to the greenhouse effect and global warming. Common GHGs include carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O).

GWP (Global Warming Potential): GWP is a measure that quantifies the relative warming effect of a greenhouse gas over a specific time period, compared to carbon dioxide (CO2). It helps assess the climate impact of different gases, with values typically expressed in CO2-equivalents.

Embodied Energy: Embodied energy quantifies the total energy consumed throughout a product's life cycle, including its manufacturing, transportation, and use. It assesses energy consumption without specific reference to carbon emissions.

Embodied Carbon: Embodied carbon, on the other hand, focuses specifically on the carbon dioxide (CO2) emissions associated with a product's entire life cycle, providing a measure of its carbon impact on climate change.

Operational Energy: Operational energy represents the energy consumed by a building or system during its everyday use, including heating, cooling, lighting, and electrical equipment. It measures the energy usage without specifying carbon emissions.

Operational Carbon: Operational carbon (Life Cycle Stage B6), in contrast, quantifies the carbon dioxide (CO2) emissions generated during the regular operation of a building or system. It focuses specifically on the carbon emissions resulting from energy use, providing insight into its carbon footprint.

Whole-Life Cycle Assessment (WLCA or WLC Assessment): A comprehensive evaluation of the environmental and carbon impacts of a product, process, or system throughout its entire life cycle. It considers all stages, from raw material extraction and manufacturing (A1-A5) to use & maintenance (B1-B7), and end-of-life disposal or recycling (C1-C4 & D).

Life-Cycle Assessment (LCA): A systematic method for evaluating the environmental impacts of a product, process, or system throughout its life cycle. This assessment considers various stages, including raw material acquisition, production, transportation, use, and disposal (ISO 14040: 2006). A LCA may focus on specific stages or boundaries defined in its scope, for example, Cradle to Gate.

Life-Cycle Inventory (LCI): The process of collecting and quantifying data related to the resource inputs, emissions, and environmental impacts associated with a product or system throughout its life cycle.

Environmental Product Declaration (EPD): A standardised document that communicates the environmental performance of a product, based on LCA data.

BREEAM (Building Research Establishment Environmental Assessment Method): BREEAM is a widely recognized sustainability certification system used to assess and rate the environmental performance of buildings and construction projects.

BCIS: Building Cost Information Service, provides construction-related data, cost information, and industry guidance.

LETI: The London Energy Transformation Initiative. Their primary focus is to advocate for and provide guidance on sustainable and environmentally conscious building practices. LETI plays a crucial role in promoting energy-efficient and environmentally responsible approaches within the construction industry.

RICS: The Royal Institution of Chartered Surveyors. They provide guidance, standards, and professional qualifications.

MEP: Mechanical, Electrical and Plumbing equipment.

Environmental Impact Categories: Specific environmental factors or impacts considered in an LCA, including energy use, water consumption, and air pollution.

Scope 1 Emissions (Direct Emissions): Scope 1 emissions refer to direct greenhouse gas emissions produced by an organization or facility. These emissions result from activities within the organization's control, such as burning fossil fuels for heating or operating company-owned vehicles.

Scope 2 Emissions (Indirect Emissions from Energy): Scope 2 emissions encompass indirect greenhouse gas emissions associated with purchased or imported energy, such as electricity and heat. These emissions occur outside the organization's facilities but are linked to its energy consumption.

Scope 3 Emissions (Other Indirect Emissions): Scope 3 emissions include all other indirect greenhouse gas emissions that result from an organization's activities but occur along its entire value chain. This category covers emissions from sources like supply chain, transportation, employee commuting, and product use by customers.

Upfront Carbon Emissions: 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 completion.

Biogenic Carbon: Biogenic carbon refers to carbon dioxide (CO2) emissions that result from the combustion or decay of biomass, such as wood, plants, or organic waste. These emissions are considered part of the natural carbon cycle and are often considered carbon-neutral because they are balanced by the carbon absorbed by growing plants.

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11.0 References

11.1 References

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Thank you

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