CASE STUDY 2024

MBC Timber Frame and Passivhaus whole life carbon

Constructing Excellence Midlands





MBC Timber took advantage of an Innovation Voucher at the University of Lincoln School of Architecture and the Built Environment to review the impact of the façade and roof selections made by customers on the overall embodied impact of a home built using our product. Roger Burton provided the case studies utilised in the study conducted by Dr Rosi Fieldson.

What is embodied impact?
Almost everything we do in the built environment releases some carbon emissions. These have been categorised into a standard methodology defined by BS EN 15978:2011 which utilises a modular reporting structure (RICS, 2023);

- **Embodied Impact** rates are based on the gross internal area (GIA defined by RICS) of a home but do not include the annual operation of a home, or the sequestration of biogenic carbon in timber and other biogenic materials. They do include repair and replacement over a reference period of 60 years (A1-5, B1-5, C1-4).
- **Operation emissions** (B6) are based on energy required for the useable area in SAP ratings, these may be slightly different to gross internal floor area for two and three storey designs.
- **Whole life emissions** (All emissions excluding D) assessment considers both the embodied impact and the operational emissions.

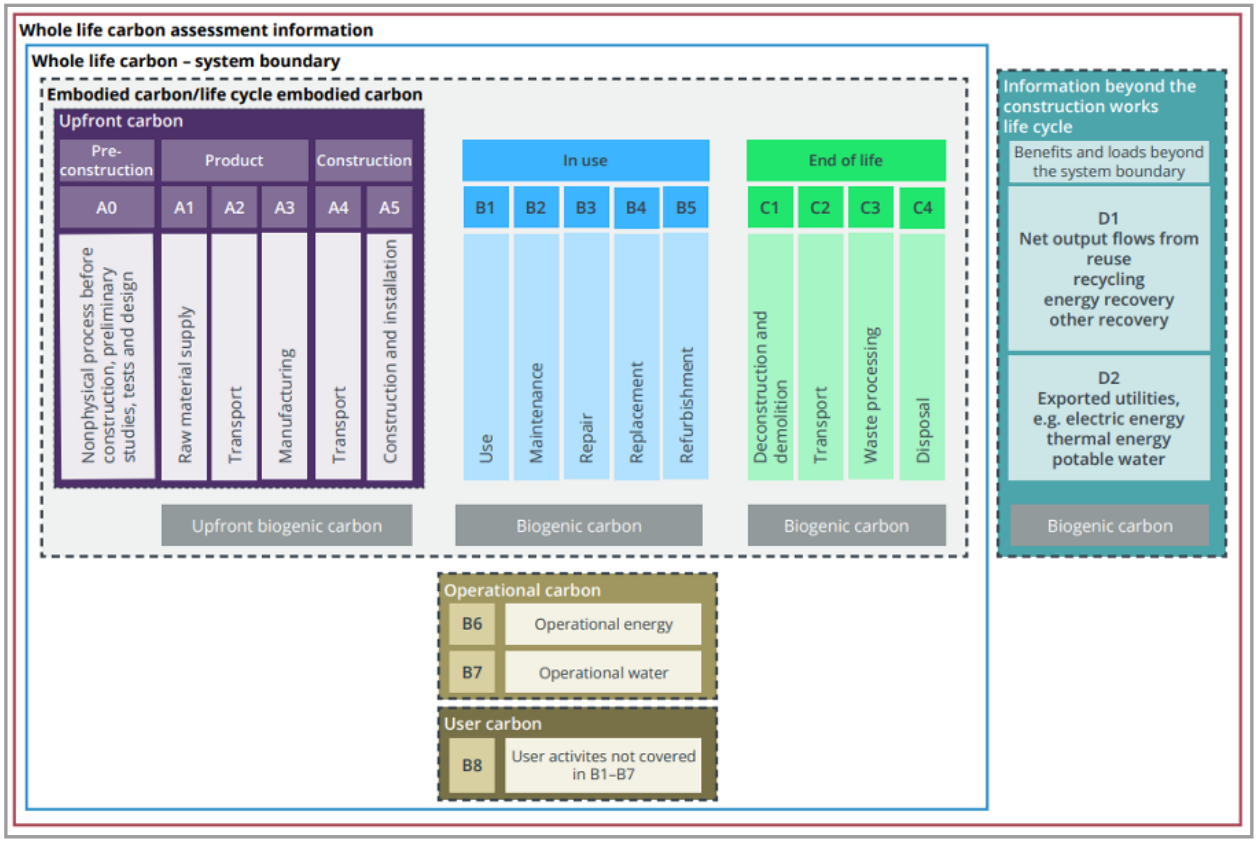
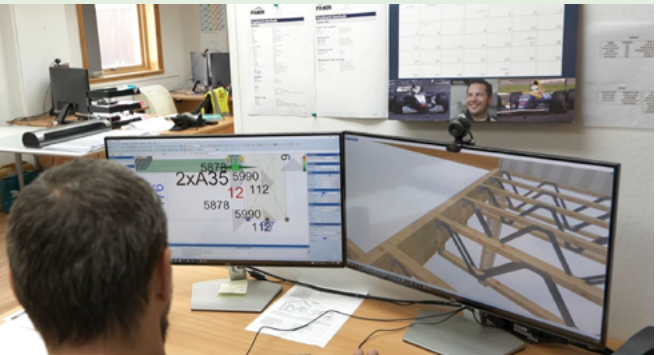


Figure 1 Life cycle stages defined by BS EN 15978:2011 (RICS, 2023)

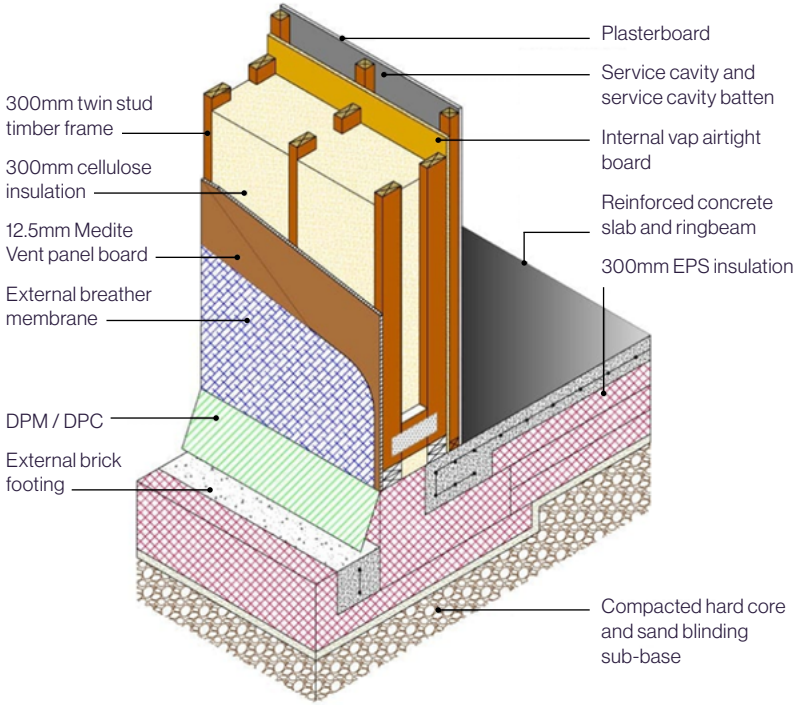
Environmental Product Declarations (EPD) are used in the construction sector to understand the impact from manufacturing, use and disposal at the end of use of the product in a building. EPD are a marker of a manufacturer taking environmental impact seriously as they must appoint a third-party assessor to undertake the assessment and update the documentation at least every five years. EPD can be difficult to interpret and often written in the language of the manufacturer's base nation, using scientific terminology. Lifecycle assessment models for buildings collects the necessary information to consider product when used in a building over a design life of 60 years.

Why is this important? When choosing to develop a highly efficient passivhaus home, the focus for emissions reduction is the envelope design, materials and their manufacture, maintenance, replacement, deconstruction and disposal. Research shows that most highly efficient new homes contribute at least 48% of whole life emissions from the fabric.

What we looked at Two Passivhaus projects with timber external cladding were modelled using life cycle assessment, a completed home and a proposed project at RIBA stage 3 design. The proposed home is calculated to require 7830.0 kwh regulated energy consumption with 2000kwh allowed for unregulated energy use, and roof mounted photovoltaic generation of 4195 kwh per year. Whole life impact is reduced by the sequential reduction of grid emissions negated by installed generation potential representing a negative total for regulated and unregulated energy emissions over 60 years. Options for alternative outer cladding and roof finish on the proposed design were compared to identify how much this increased the embodied and whole life emissions. The cladding alternatives had no impact on U-values and the operational energy(B6).



Passivhaus Woodford. Roger Burton



MBC Timber floor and wall detail for Passivhaus system

Our findings

The completed home had an embodied impact rate of 441 kg CO_2e/m^2 over 173m^2 and proposed project had adopted some design changes as a result of post occupancy evaluation.

The embodied impact of the underlying frame and slab envelope solution supplied by MBC Timber for the proposed house with no external cladding or interior finishes represented 29% at 120kgCO_2e/m^2. A further 24% of embodied emissions were associated with building services.

A4 Transport and A5 construction emissions are included in the overall embodied impact rate. Transport for MBC Timber's works package was estimated at 877kgCO_2e for Woodford and A5 construction process emissions were estimated in the modelling of both houses; 2000kgCO_2e at Woodford and 2343kgCO_2e for Enstone. The general assumptions for the rest of the construction works were estimated as 5 tonnes based on cost of the building but as self-build projects, may have inflated the emissions considerably.

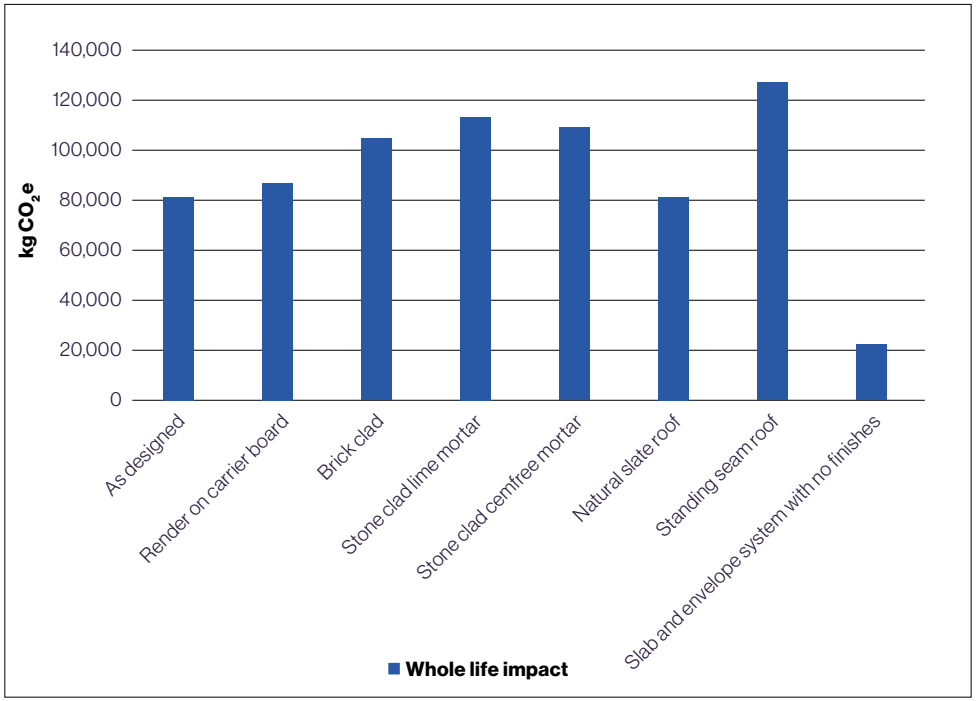
MBC Timber have provided annual data from their scope 1 and 2 business emissions and per unit of measure (m^2 of houses completed). More accurate monitoring of on-site fuel use on projects completed through self-build management would be advantageous. Whilst this data is not published as an EPD, the certainty with which their clients can use it as a basis for technical design stage calculation should be recognised as of benefit.

The study found that timber cladding as an external material causes the fewest upfront and emissions, closely followed by render rainscreen systems. Stone and brick load-bearing external leaf increased the concrete footings required and mortar for bonding. Metal cladding or roofing is the highest impact choice due to the emissions associated with manufacturing metal sheet.

Aside from the necessity of securing planning approval for the visual appearance of materials proposed, it is worth reviewing the Environmental Product Declarations (EPD) of any product being specified with suppliers and installers to seek the best outcome for all design criteria of a new home.

Building area 211m²	Rate kg CO_2e/m² and Absolute emissions kg CO_2e at completion (A1-A5) as figure 1	Embodied impact rate kg CO_2e/m² Absolute kg CO_2e	Whole life impact Annualised rate (60 years) kg CO_2e/m²/year Absolute kg CO_2e
As designed timber cladding and clay tile roof	262 55,282	412 86,932	6.44 81,546
Render cladding	286 60,346	436 91,996	6.85 86,780
Brick facing	370 78,070	523 110, 353	8.28 104,979
Stone facing lime mortar	411 86,721	564 119,004	8.98 113,723
Stone facing low impact mortar	390 82,290	544 114,784	8.64 109,385
Natural slate (Spain)	261 56,377	413 87,143	6.56 81,755
Standing seam zinc	479 101,069	629 132,719	10.06 127,394

Table 1 Embodied emissions findings for alternative wall and roof finishes



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References

RIBA (2021) RIBA 2030 Climate Challenge. London.

BS EN 15978:2011

RICS 2022 Whole life carbon assessment for the built environment RICS PROFESSIONAL STANDARD Global 2nd edition, September 2023 Version 2, November 2023 Effective from 1 July 2024. Royal Institution of Chartered Surveyors London

MBC Timber mbctimberframe.co.uk Accessed 28th February 2024

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If you have a project that provides outstanding benefits and demonstrates best practice to the standards of this case study, why not enter the CE Midlands Awards next year and share your experience to the benefit of the industry?

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