The Business Case for Managing and Reducing Embodied Carbon in Building Projects
Making zero carbon buildings a reality

Managing and reducing the embodied carbon impact of a project can be achieved by building less, building clever and building efficiently. Effective leadership, innovation and procurement is essential to enable the management and reduction of embodied carbon.

Why take action

Embodied carbon is the emissions (CO\textsubscript{2}e) created from all the activities of the creation and demolition of a building. It is the total life cycle carbon less the operational carbon impact\textsuperscript{1}. It covers the emissions that arise from the energy and industrial processes used in the processing, manufacture and transportation of the materials, products and components required to construct, maintain and refurbish a building.

- It is becoming widely recognised that the balance between operational and embodied carbon emissions needs to be considered to understand the true carbon impact of new and refurbished buildings.
- Embodied carbon impacts are becoming increasingly significant\textsuperscript{2}, as operational emissions fall in response to building regulations and more efficient operational processes and technologies, see Figure 1.
- Studies suggest embodied carbon in domestic buildings may be equivalent to 10 times annual operational energy use; and for complex commercial buildings, the ratio can be as high as 30:1\textsuperscript{3}.
- Industry stakeholders generally agree there is a high chance that the measurement, management and reduction of embodied carbon in construction projects could soon become a mandatory requirement.
- Rising energy and material costs are the third most significant threat to growth identified by CEOs in the engineering and construction sector\textsuperscript{4}.
- Buildings with low embodied carbon credentials can be more desirable to blue chip clients and tenants alike.

Benefits of taking action

Reducing the embodied carbon impact of a building can realise a number of benefits:
- cost savings associated with a reduction in material use, increased use of secondary and recycled materials, and lower wastage rates;
- a reputation for good environmental management;
- being ‘ahead of the curve’ with regards to future legislation;
- being resilient to resource price rises and resource scarcity risks; and
- being less reliant on energy-intensive manufacturing routes.

Modelling by the Green Construction Board (GCB) predicts that in 2050 embodied carbon will represent around 32% of the built environment’s emissions versus 18% in 2010\textsuperscript{2}.

**Figure 1: Changing significance of embodied carbon: 2010 and 2050\textsuperscript{2}.**
Good practice
Construction clients, contractors, designers and investors have a key role to play in reducing the embodied carbon impact of buildings as their decisions ultimately influence what gets designed and constructed, and how. Considering embodied carbon and undertaking an assessment of a project early in the design process will allow for the most significant embodied carbon reduction opportunities to be identified.

There are a number of key principles which can be used to reduce the embodied carbon impact of a building. These include:

- establishing and implementing good practice waste reduction, reuse and segregation policies and processes;
- setting requirements within procurement documents for the measurement and reduction of embodied carbon impacts;
- optimising material use; and
- considering alternative materials.

Optimise material use by:
- exploring options for reusing or reconfiguring existing structures;
- increasing overall building design efficiency;
- designing out waste;
- designing for future adaptability, reuse and deconstruction; and
- prefabricating components off site to reduce waste and transport emissions.

Consider alternative materials with:
- lower carbon intensities, such as:
  - cement replacement such as pulverised fuel ash (PFA); and
  - biogenic materials.
- lower transport related emissions through utilising locally sourced materials;
- higher recycled content;
- higher levels of durability and low through-life maintenance; and
- the ability to sequester carbon.

Box 1: Opportunities to reduce embodied carbon.

CEN/TC 350
A suite of new European Standards is being developed for assessing the sustainability of construction products and the built environment, by the CEN Technical Committee (TC) for the sustainability of construction works (CEN/TC 350). This includes a framework and guidance for calculating the embodied carbon impacts of construction to help ensure new buildings are designed from a whole life perspective.

Specific standards include EN 15978 (Sustainability of construction works – Assessment of environmental performance of buildings) and EN 15804 (Sustainability of construction works – Environmental product declarations).

Box 2: CEN/TC 350.

Image 1: WRAP and UK-GBC Embodied Carbon Database.
**Industry activity**

Major clients and contractors taking action to measure and manage the embodied carbon impacts of their projects include:

**BAM Construct** has worked with clients and suppliers to measure and reduce embodied carbon impacts, often whilst reducing costs (through use of alternative or secondary materials). Embodied impacts and life cycle performance are being integrated within Building Information Modelling (BIM) to allow assessments and tracking of impacts to be carried out more easily and to work towards life cycle ‘management’ models for buildings.

**British Land** is working with its supply chain to fully understand the embodied carbon impacts of its developments. British Land has found that embodied carbon savings of 3-4% can be achieved without making any significant changes to a project’s design or programme. British Land now ask contractors on all of their major projects to measure the embodied carbon impact of substructures, foundations, frames and façades.

**Derwent London** has developed a brief for projects which sets out its requirements for embodied carbon assessment and has, to date, conducted embodied carbon assessments for several of its developments. This has shown that a 70% reduction in embodied carbon can typically be achieved when selecting refurbishment and regeneration over a new build solution.

**Land Securities** is increasingly conducting embodied carbon assessments on its developments and include the measurement and management of embodied carbon as a requirement within procurement and contract documentation. Land Securities want to be better informed as a client and able to respond to future legislation.

**Sainsbury’s** is taking action to address embodied carbon and has committed to a four year research partnership with the University of Reading’s TSBE Centre to understand the opportunities, challenges and business benefits of tackling embodied carbon in its store development programme. The research is looking at issues around setting reduction targets, measurement of embodied carbon using BIM and innovations in construction materials and techniques to reduce emissions.

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**Quick wins**

The largest components of a construction project in terms of mass, carbon, energy and cost need to be determined, as they provide the greatest opportunity for achieving embodied carbon savings.

**Image 2: 1 New Street Square, London.**

Land Securities appointed Sturgis Carbon Profiling to undertake a carbon life cycle assessment at the pre-tender stage of its 1 New Street Square development in London. The project involves the demolition of existing buildings on the site, retaining but increasing the depth of the basement across the site, and the development of one new building, with retail and office use on the ground floor levels and offices above. It was found that embodied carbon could account for around 70% of the development’s total whole-life carbon impact.

A series of opportunities have been identified which have the potential to reduce the development’s embodied carbon impact by over 30% at no extra cost to the project. The key opportunities include specifying a higher rate of recycled content for the aluminium cladding, raised access flooring and plasterboard, the use of light-weight blockwork and the use of ground granulated blast-furnace slag (GGBS) as a cement replacement.
Case studies

Case study summaries are shown below. These and additional case studies can be found on the Green Construction Board¹⁰ and WRAP¹¹ websites.

London 2012 Olympic Stadium
Embodied carbon savings were achieved by using:
- concrete with 100% recycled aggregate; and
- surplus steel from a local gas pipeline.
This approach reduced embodied carbon by 38% in the final scheme compared to the concept design¹².

5 Broadgate
Achieved an estimated 5% reduction in the base build embodied carbon footprint of the building¹³. Savings were achieved through a variety of methods including:
- reducing the façade skin thickness;
- using low carbon concrete (by including PFA); and
- using double primary beams in the steel floor.

Scunthorpe Sports Academy
Delivering a building with low embodied carbon was a core requirement of the project¹⁴. A number of measures were implemented to realise this, such as:
- using Glulam timber as a core structural element. This presented a negative embodied carbon of 517.38 tonnes CO₂e;
- a green Sedum roof to help sequester carbon over the lifetime of the building; and
- minimising travel associated with construction by using local workforce and sourcing local materials.

Box 4: Case study examples.

References

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