



UCL

Refurbishment & Demolition of Housing

Embodied Carbon: Factsheet



UCL ENGINEERING
Change the world

What is embodied carbon and how is it estimated?

Embodied carbon means all the CO₂ emitted in producing materials. It's estimated from the energy used to extract and transport raw materials as well as emissions from manufacturing processes.

The embodied carbon of a building can include all the emissions from the construction materials, the building process, all the fixtures and fittings inside as well as from deconstructing and disposing of it at the end of its lifetime.

Who estimates embodied carbon?

- Surveyors, architects or designers at the design stage of a construction.
- Researchers and analysts to provide evidence for policy making.

How is it used in decision-making?

It can be used to compare the environmental impacts of different building materials, designs and construction processes. It can help to identify elements which are carbon-intensive and promote alternative options which reduce the amount of CO₂ released. It can be used to design policies that reduce the CO₂ emissions from the construction sector.

What evidence is there about embodied carbon in the costs and benefits of refurbishment and demolition?

Most studies on retrofit compare "before and after" energy performance, but some assess the potential savings that could be achieved if occupants were rehoused in new low energy houses. Only a few include the embodied carbon of demolishing and retrofitting buildings.

Typical scenarios used to estimate and compare embodied and operational carbon

- Comparing refurbishment and demolition of buildings
- Comparing operational carbon and embodied carbon
- Comparing options for reusing, reprocessing and recycling waste materials
- Comparing different sources and supply chains for materials

Requirements to reduce embodied carbon

- Are there requirements to report on embodied carbon? Yes but they are voluntary e.g. UK government's 'Code for Sustainable Homes' or 'Environmental Profiles' (accreditation scheme for construction products)
- Are there legal requirements to meet reduction targets for embodied carbon? No, none in the UK for the moment.

Strategies to reduce embodied carbon

- Using construction products that are made from locally available raw materials, through energy efficient and low emission processes and by manufacturers local to the construction site.
- Transporting materials with low carbon vehicles.
- Designing the construction process to minimise waste and reuse or recycle products where possible.
- Using systems and products that have long life spans.
- Designing the building to be able to change its use over time to minimise future refurbishments.



Refurbishment: what happens to embodied carbon

Refurbishment improves the energy efficiency of existing buildings by adding insulation or replacing old systems with more energy-efficient ones, such as low energy lighting or better boilers.

Refurbishment means occupants use less energy day-to-day, but it also means more embodied carbon as more material is added to the building and older systems are thrown away.

These additions can extend the lifespan of the building and so they help avoid the embodied carbon needed to replace an old building with a new one.

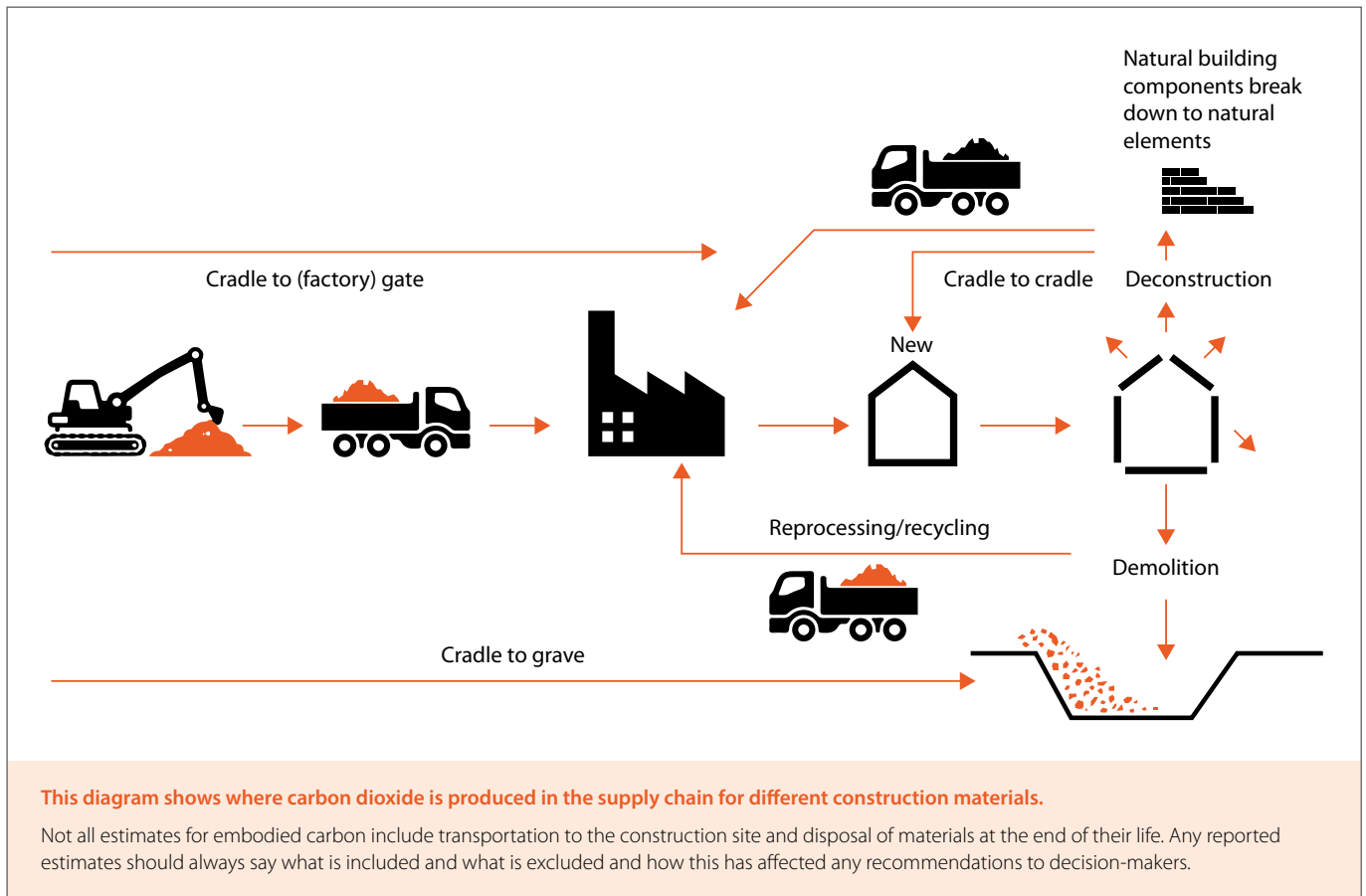
Demolition: what happens to embodied carbon

When a building is demolished energy is used to deconstruct it, and remove, process and dispose of the waste. CO₂ may also be released through associated chemical processes.

Building a new replacement requires more materials and energy, creating more embodied carbon.

When renewable energy is supplied to our homes, it becomes less important to improve our building's energy performance and more important to avoid the embodied emissions of demolition and rebuilding.

Reusing or recycling building materials can reduce the embodied carbon of demolition.



Where can I find out more?

- WRAP: www.wrap.org.uk/resource-efficient-built-environment
- Green Building Council : www.ukgbc.org
- Embodied Water: www.angelamorelli.com/water
- UCL Policy briefing [with hyperlink]
- UCL Technical report [with hyperlink]

This factsheet is one of a series produced by University College London. Other factsheets in the series are:

- 1 Lifespans & Decisions
- 2 Health & Well-being

Example case

Name of Estate	Borough Grove
Location	Petersfield, Hampshire
Local Authority	Drum Housing Association
Year	2009
Developer	Radian
Number of units	14 semi-detached homes
Age and type of building	1950s, precast reinforced concrete
Source of data	Radian

What is included?

- LGV & HGV Deliveries of materials and removal of waste
- Materials (incl. foundations, drainage, excavation of top soil, construction of roads and pavements, external walls, roofing materials, cladding, flooring, insulation, finishes, services)
- Site energy consumption during refurbishment
- Landfilled waste

What is excluded?

- Contractors' travel to and from site to work on the refurbishment
- Replacing systems and equipment within the next 50 years (building life span)
- Decommissioning building at end of life
- Embodied carbon of 1950s construction process

Final totals

- Retrofit cost: £91 900 per building (including decanting residents & staff costs)
- Life time emissions: 140.8 tonnes of carbon dioxide equivalent (tCO₂e) over 50 years
- Life time emissions savings: 230 tons of carbon (compared to non-retrofit)
- Cost per ton of emissions savings: £399

Retrofitting compared to demolition and rebuilding new, low energy homes

- Rebuild cost: £144 700 (£52 800 more than retrofit)
- Life time emissions: 151.2 tCO₂e (emissions 6% more than retrofit)
- Life time emissions savings: 209 tCO₂e (savings 9% less than retrofit)
- Cost per ton of emissions savings: £629 (cost £230 more than retrofit)

These estimates depend on the specific characteristics of this project

– the age and efficiency of the housing. Different projects would have different figures for costs and savings.

