Can we deliver carbon positive homes?

Is it possible to build the new homes that we all need and not add to, or even reduce, overall carbon emissions? This is the 'carbon positive' ambition we sought to address in our Positive House approach.

Although there are difficulties with nomenclature (is negative or positive carbon better?) we have to face the reality that to meet global carbon reduction targets – not just the current UK national net zero requirements – we will need to radically reduce consumption and increase carbon removals and the pool of stored carbon. We need to address the legacy of historic emissions by reversing, not just reducing, emissions where we can.

This is the regenerative sustainability ambition we have taken on and our goal of being climate and nature positive.

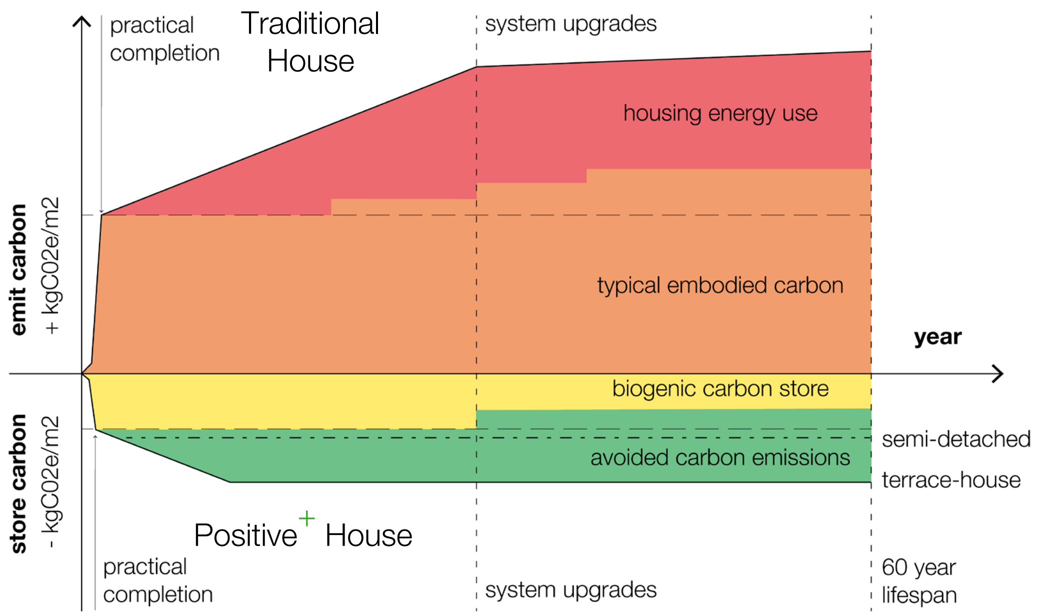
By coupling a Passivhaus approach with a predominately bio-based housing system, we wanted to test if it is possible to generate more energy than a home consumes and store more carbon in use that it took to make.

The attached Lifecycle Analysis (LCA) shows that achieving this positive carbon ambition is going to be hard to achieve, especially when taking future replacements and end of life impacts into account over the whole life of a building.

The assessment is based on a detailed review of energy consumption, grid decarbonisation, and embodied carbon impacts using the newly updated PHPP and PH Ribbon assessment model of our Positive House design.

It uses the same assumptions as the RICS methodology apart from an updated set of end of life values for timber that are based on more accurate industry data for the reuse and recycling of wood based products from DEFRA and Wood Recycling Association: that more accurately represent existing markets. Some of the other assumptions in RICS for material replacement are also a little pessimistic for houses as set out (do you redecorate your home every 10 years for instance? Will PV panels actually need replacing, and won't they have lower EC in 20 years?) but we have kept them for consistency.

Below: Carbon graph over 60-year reference period up until end of life: Typical house compared with a Positive+ House



Others are also theoretical. The pulse of emissions from timber at end of life – the large spike at the end of the graph – are when the CO2 stored in natural materials (biogenic storage) is passed on to the next product or emitted if it is burned or decays. Some of this is therefore for accounting purposes when the wood fibre ends up being reused.

We wanted to make it easier to reuse elements and included an approach for Design for Manufacture Assembly and Disassembly (DfMA+D) promoting methods for a more Circular Economy and reduce consumption in the future.

Although we can achieve our carbon positive aim when considering just the original materials (A1-A3) with the benefits of biogenic carbon storage, when taking cradle to site values (transport and construction) impacts into account (A1-A5) this tips over that zero threshold. Over a full 60 year standard study period the cradle to grave estimate (A1-C) is 270kgCO2e/m2 (GIFA) considering whole life emissions and including a biogenic carbon store of 198kgCO2e/m2. Notably this is still less than half of the revised RIBA 2030 Challenge target for residential buildings of 625kgCO2e/m2 in 2030.

We understand that there were good reasons to revise the benchmarking to make it more consistent across various methods, but we have to question the validity of the targets – for housing at least – and if they are promoting the sort of radical action in the face of the climate emergency that we believe the authors wanted. It is clear that we can do much better, and demonstrated across many of the finalists in the recent Home of 2030 competition.

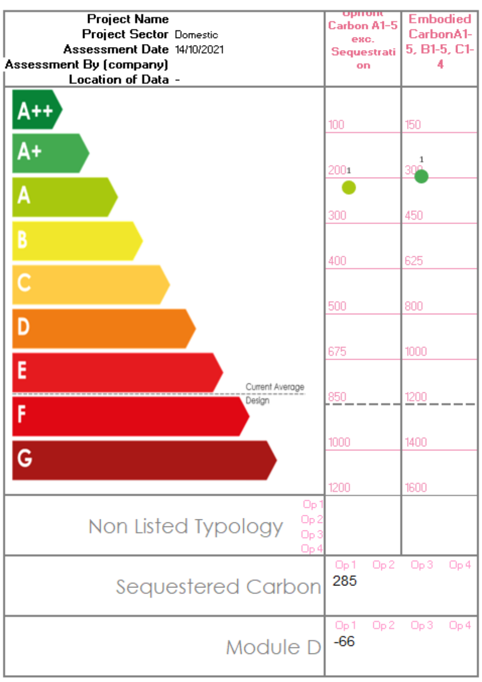
LCA is a useful tool to estimate impacts, not a precise prediction. We are considering impacts over many years and multiple materials with imperfect assumptions. Many of the actual impacts will depend on occupants and how they use and adapt their home. By designing now to anticipate impacts of future climate change and an ageing population, with improved durability of finishes, and by making it easier to adapt and maintain homes, we hope to reduce the actual cumulative impacts over time, not just optimise the accounting.

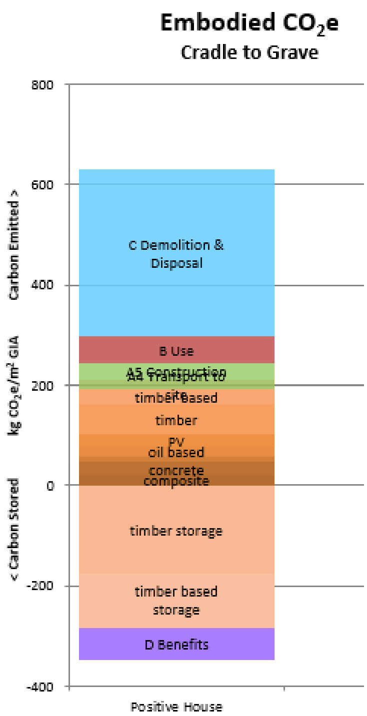
There are many other emissions that aren't covered by these building assessments such as mobility and lifestyles. Just as we have expanded the assessment scope of carbon from regulated operational energy to include all consumption and now embodied carbon, we need to think more clearly about how we might also assess broader impacts in design and encourage healthy and lower impact approaches for communities overall.

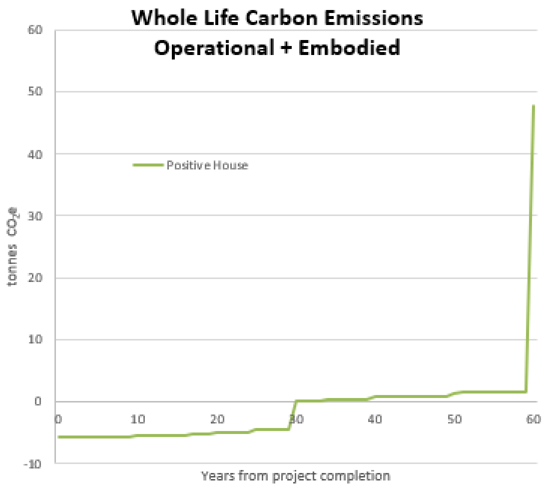
The Positive+ Collective.

Below Left: Embodied Carbon Cradle to Grave including end of life Demolition & Disposal.

Below: Cumulative C02 Emissions graph, both operational and embodied over 60-year lifetime of project highlighting to requirement to re-use, re-cycle at end of life







RIBA CHALLENGE (includes ●)

Building Type: Domestic

Operational Energy	41	kWh/m2.a GIA
RIBA level met	2025 Target	
Embodied Carbon	345	kg CO_2e/m² GIA
RIBA level met	2030 Target	