Carbon factsheet

What really makes a difference?

GREEN HERITAGE HOMES

Our homes are responsible for 27% of UK carbon emissions, so for many people, **reducing their home's carbon impact** is a key motivation for retrofit work.

Improving energy efficiency can reduce **operational carbon** - emissions that come from home heating. But installing new energy saving equipment has an **upfront carbon** cost, which includes the materials, manufacturing, transport and processing. It's helpful to understand both types of emissions.

This factsheet outlines the carbon implications of different retrofit options, helping you to choose the most effective **measures** and **materials** for reducing carbon emissions.

Carbon payback on common measures

The table below shows carbon impact of different energy measures on a 3-bedroom house over 20 years. It is clear that heat pumps offer the greatest carbon savings, but insulation measures can also have very short carbon payback periods.

Measure	Impact on performance	Estimated Cost	Average carbon payback time[1]	Carbon saved after 20yrs[2]
Top up loft insulation (from 100mm to 300mm)	U-Value improves from 0.5 to 0.16[3]	£1500	1 ½ years (fp)	-2%
Install 100mm insulation on a previously uninsulated solid wall	U-Value improves from 1.5 to 0.4	£10,000	1-5 years (fp)	-10%
Replace old double-glazed windows with new high efficiency units	U-Value improves from 2.8 to 1.4	£8,500	Over 25 years (fp)	+2% (fp)
Replace single-glazed windows with high efficiency double glazed units	U-Value improves from 4.8 to 1.4	£8,500	13 years (sp)	-2% (net increase in carbon) (sp)
Replace a gas boiler with an air source heat pump	Heating fuel changes from gas to electricity, and system efficiency improves from 90% to 350%	£8,500 (after BUS grant)[4]	Under 1 year (fp)	-69% (fp)

Table key - pay back period

- (lp) a long pay back period of more than 20 years.
- (sp) slower pay back period.
- (fp) fast pay back period.

1 Carbon Payback is the length of time before the 'upfront carbon' cost of installation is outweighed by savings in 'operational carbon'.
2 Carbon saved after 20 years is the percentage reduction of the household's total fossil carbon emissions achieved over 20 years.
3 U value is a measure of heat loss - lower values indicate better performance.
4 The heat pump cost of £8,500 is the cost to the householder after the standard £7,500 Boiler Upgrade Scheme subsidy has been subtracted.

The scenarios were modelled for BWCE by People Powered Retrofit using their HRP tool. As shown, heat pumps offer by far the greatest carbon savings. However, insulation measures can also have very short carbon payback periods, and where possible combining both insulation and a heat pump is often best for improved comfort, low running costs, and minimal impact on the grid.

Bath & North East Somerset Council – Improving People's Lives | Bath Preservation Trust | Bath & West Community Energy | Centre for Sustainable Energy | People Powered Retrofit | South West Net Zero Hub

Upfront carbon and material choices

Finding the impact of building materials

Many manufacturers now provide Environmental Performance Declarations (EPDs) for their products, which include data on a product's environmental impacts.

Our upfront carbon figures are based on the A1-A3 reported emissions in EPDs. You can also use EPDs to compare products directly.

Some EPDs for natural materials subtract 'biogenic carbon', resulting in a negative value in A1-A3. However, as explained below, we separate biogenic carbon out instead.

Fossil carbon, the key

Heating your home produces **operational emissions** – from burning gas or other fossil fuels to generate heat and electricity.

Building work adds an **upfront carbon** cost – due to fossil fuels used to extract, produce and transport materials.

Once released into the atmosphere, fossil carbon enters our carbon cycle and is very difficult to remove.

Reducing fossil carbon emissions is key to stopping climate breakdown.

Biogenic carbon, a temporary store

'Biogenic carbon' is the carbon found in natural materials – absorbed from the atmosphere by plants as they grow.

This carbon is only stored temporarily. It's released back into the atmosphere when the material decays or is burned. Using natural materials in buildings can delay that release.

Storing biogenic carbon can help, but it doesn't cancel out fossil carbon. Natural materials are limited, so using them in one building may reduce availability for other projects – which may lead others to rely on high-carbon alternatives.

Choice of insulation materials

The table below shows the upfront carbon of various insulation types, along with their 'K value' (how much heat can pass through the material), and the thickness needed to achieve a specific 'U value' – a measure of heat loss.

You will need specific advice on what's suitable for your project, and there may be trade-off's to consider between embodied carbon and other requirements for your project.

Material	Thermal conductivity (K value)	Thickness to reach U-value of 0.16	Fossil CO_2 (kgCO2e) per 1m2	Bio CO_2 (kg) per 1m2
PIR foam insulation boards (e.g. Celotex, Kingspan etc.)	0.022	200mm	27 (h)	0 (n)
Expanded polystyrene (EPS) insulation boards	0.034	250mm	8 (m)	0 (n)
Glass wool insulation rolls	0.038	280mm	7.6 (m)	0 (n)
Woodfibre insulation rolls	0.038	280mm	14.3 (mh)	16.2 (s)
Loose fill cellulose (e.g. warmcell)	0.038	280mm	1.7 (l)	16.00 (s)

Table key - carbon emissions

- (h) highest
- (mh) moderately high
- (m) midrange
- (l) very low
- (n) no biological carbon is stored by this material.
- (s) significant amount of biological carbon stored.

Of course, upfront carbon and thickness are often not the only factors to consider:

- **Glass wool** is usually the cheapest option where suitable, followed by EPS, then PIR.
- **Older buildings** may need vapour-open material (e.g. woodfibre) to prevent damp buildup.
- **Soild floor insulation** may require load-bearing, vapour-closed slabs (e.g. EPS or PIR).
- **Toxicity, recyclability and source of the materia**l (beyond scope for this factsheet)