KNOW YOUR HOME, KNOW YOUR CARBON

Reducing carbon emissions in traditional homes

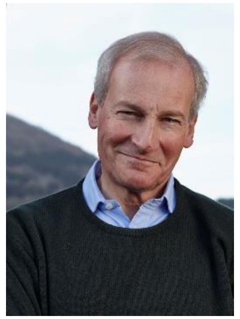
HERITAGE COUNTS 2020
By Historic England
on behalf of the Historic Environment Forum

Most people accept that climate change threatens the fundamental welfare of our planet and that excessive carbon emissions have contributed to this. What is less understood is that our historic environment can play an important role in securing our low carbon future and in providing a means whereby significant emissions can be reduced.

This edition of Heritage Counts provides the evidence:

- That repair and re-use of historic buildings is materially less carbon intensive than either demolition and rebuild or new build on open land
- That existing heritage can be adapted to improve energy efficiency and reduce overall carbon footprint whilst preserving historic significance
- That all the many thousands of custodians who care for our nation's remarkable heritage can make an impact, even through minor changes in their approach.

This research is being published during the year when the UK will be hosting the COP-26 conference. It is timely and practical, demonstrating very clearly how the heritage sector can assist in addressing the greatest challenge facing the world today. It is a call for action.



Sir Laurie Magnus, Chairman of Historic England

Our heritage is one of our greatest national assets, from our rich architectural tradition to our ancient and distinctive landscapes, from exquisite objects, archaeological sites and historic vehicles to stunning religious buildings, museums and preserved ships.

The role of heritage in contributing to a low carbon, green future is seriously underestimated and undervalued. Caring for and conserving our heritage must include living sustainably and avoiding carbon emissions. By conserving and regularly repairing and maintaining historic buildings, we extend the lifespans of existing resources and of our homes. This reduces the pressures on limited natural resources by reducing demand for raw materials whose production involves new high carbon emissions. By conserving historic homes, we eliminate the need for huge amounts of new carbon emissions and reduce needless waste by recycling and re-using existing materials.

This year's Heritage Counts research produced by Historic England on behalf of the Historic Environment Forum, comes at a critical time, as nationally and internationally we look for ways to cut carbon and to implement new carbon reduction strategies. Achieving sustainable and sympathetic conservation of historical buildings is a real challenge. This research shows that our existing heritage buildings, are and can continue to be a critical part of our sustainable future if we invest in caring for them properly. This research provides a firm foundation to develop effective and sustainable futures for historic buildings: Looking after the past is a key part of our battle with climate change and essential to securing our future.

Dr Adrian Olivier MCIfA, Chair of the Historic Environment Forum

“Don’t waste electricity, don’t waste paper, don’t waste food. Live the way you want to live but just don’t waste.”

Sir David Attenborough [1]

This year's Heritage Counts is dedicated to historic homeowners and occupiers

Buildings, including homes, are the 3rd largest carbon emission producers in the UK today[2]. We urgently need to reduce the carbon emissions from our homes.

There are so many options for reducing carbon emissions from homes available to homeowners and occupiers, and they can be catered to suit individual lifestyles, priorities and circumstances. And while there is plenty of information about these different options, our previous Heritage Counts research found that the information is complex, technical and often inconclusive[3].

This can make it both daunting and difficult for homeowners and occupiers to work out what they should be doing to reduce carbon emissions from their homes.

Climate change is such an enormous and complicated issue, but we can all contribute towards our carbon reduction goals. The aim of this report is to use case studies to present some of the carbon reduction options and to demonstrate the impact these are estimated to have on the carbon footprints of case study homes.

There is no "one size fits all" solution to reducing the carbon footprints of traditional homes[4]. The best low carbon solution for each home depends on many different factors. While some are *not* in the control of homeowners and occupiers, many others are.

> ***There is no one complete pathway to a low carbon home, but a road each homeowner can safely take is to avoid wasting energy and carbon.***

Avoid wasting energy and carbon, begins by keeping on top of repair and maintenance at home – this will improve the condition and lifespan of the building and the comfort and health of occupants.

Avoid wasting energy and carbon means reusing and recycling our buildings and building materials where possible, reducing the use of new materials and materials with large carbon footprints.

Avoid wasting energy and carbon also means retrofits that are well planned, high quality and low carbon whilst maintaining the heritage value and natural benefits of traditional homes.

Station Row, Wath Road, Elsecar, Barnsley.
DP175872 © Historic England Archive

This report presents findings about how carbon emissions have been reduced in case studies and modelled examples

This report shows that we can reduce the carbon footprints of our traditional homes by taking both small and large measures. In the report we share a few of the many carbon reduction options available to homeowners and occupiers, using real world and modelled case studies, to show what effect different actions have had on the carbon emitted by the case study homes.

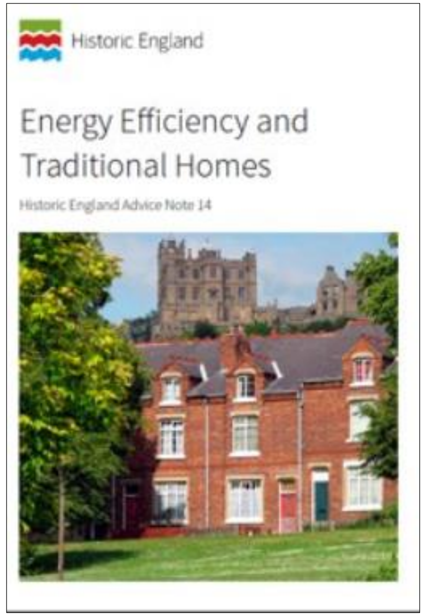
More details about the case studies, the model assumptions and the technical details underlying this summary report can be found in the technical reports.

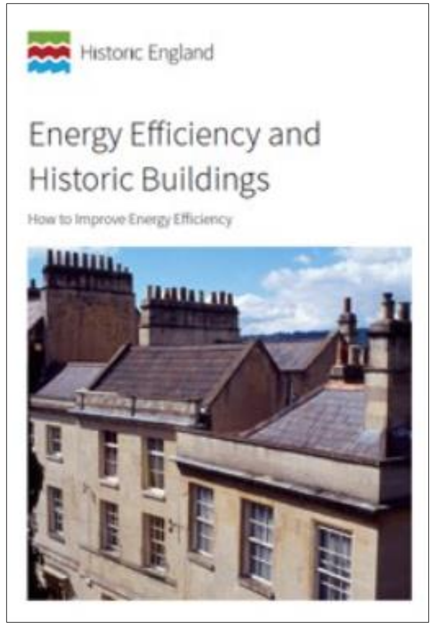
- University of the West of England (2020) **Carbon reduction scenarios in the build historic environment**
- Carrig Conservation International (2021) **Understanding carbon in the Historic Environment – Case Study Extension**
- Parity Projects (2021) **Retrofit case study data**

These supporting reports are available on the Historic England's website – Heritage Counts.

This report is designed to provide evidence and not guidance. Historic England's guidance is freely available online.

For detailed guidance on how to reduce carbon in traditional homes and buildings see:





The guidance includes planning advice and links to detailed planning information for retrofitting historic homes. Click on the documents and follow the links to Historic England's website.

What's included in this report

Ophirton House, Boston, Lincolnshire. DP161477 © Historic England Archive

Climate change is the biggest challenge we face

"Climate change impacts every country on every continent. It disrupts national economies and affects lives. Weather patterns are changing, sea levels are rising, and weather events are becoming more extreme.[5]

Climate change is not on pause. Although the pandemic has prompted a fall in emissions, once the global economy begins to recover then they are expected to return to even higher levels." [5]

Howick Terrace, Berwick-Upon-Tweed, Tweedmouth, Northumberland.
DP065659 © Historic England Archive

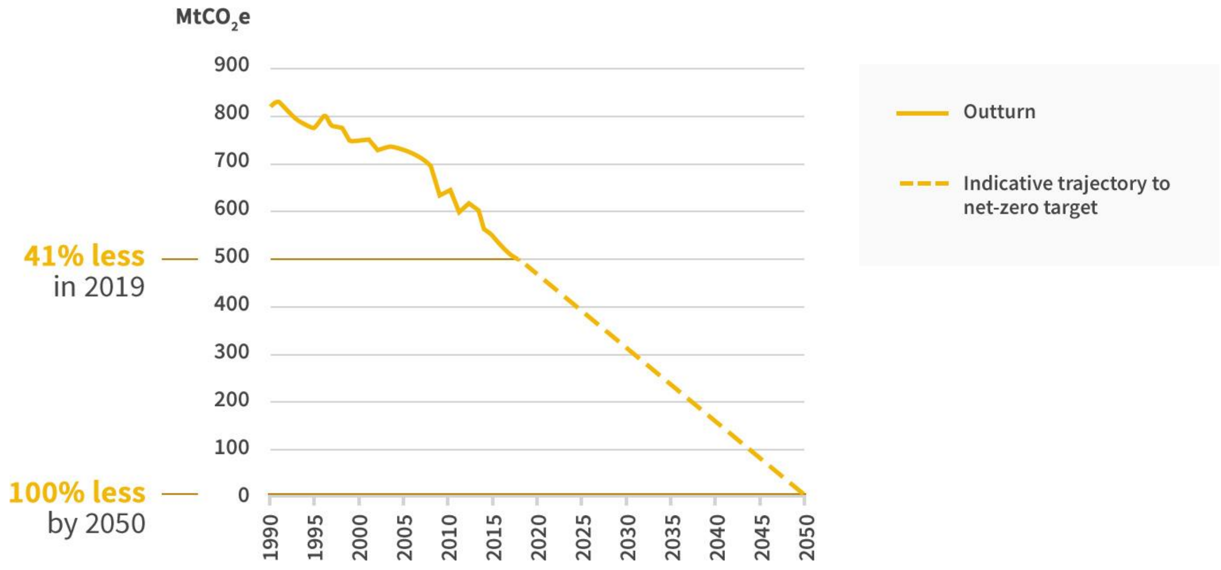
“Humanity faces an urgent choice. Continuing down our current path – where our demands on Nature far exceed its capacity to supply …(or) Choosing a sustainable path (which) will require transformative change”

Dasgupta,P., 2021 [6]

The UK has made a legal commitment to reducing carbon emissions

The UK government has committed to reducing net carbon emissions by 100% by 2050 compared to 1990. **This is our net zero target.**

By 2019 the UK had reduced emissions by 41% compared to 1990.[7]

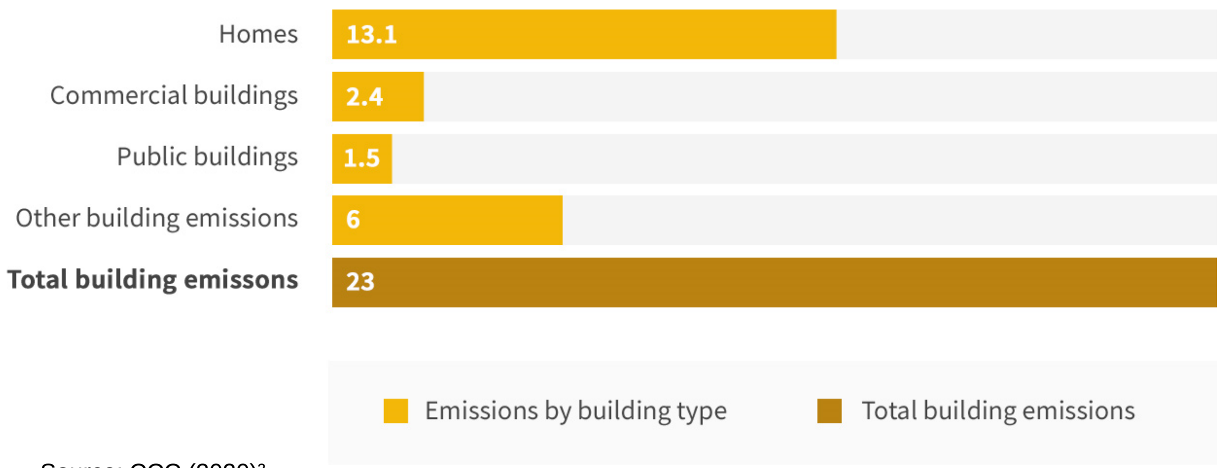


Source: BEIS (2020)[7]

Buildings are the third largest carbon emission producers in the UK after transport and industry.

As much as 17% of the UK's greenhouse gas (GHG) emissions are from buildings. In fact, our homes, shops, theatres, schools etc. account for nearly a quarter (23%) of all UK emissions when including factors such as the emissions from electricity use.[2]

Homes alone account for 13% of all the UKs Green House Gas emissions.



Source: CCC (2020)[2]

See the glossary on pg.63 for some information on terms such as greenhouse gases, carbon emissions, climate change

How is carbon emitted from buildings?

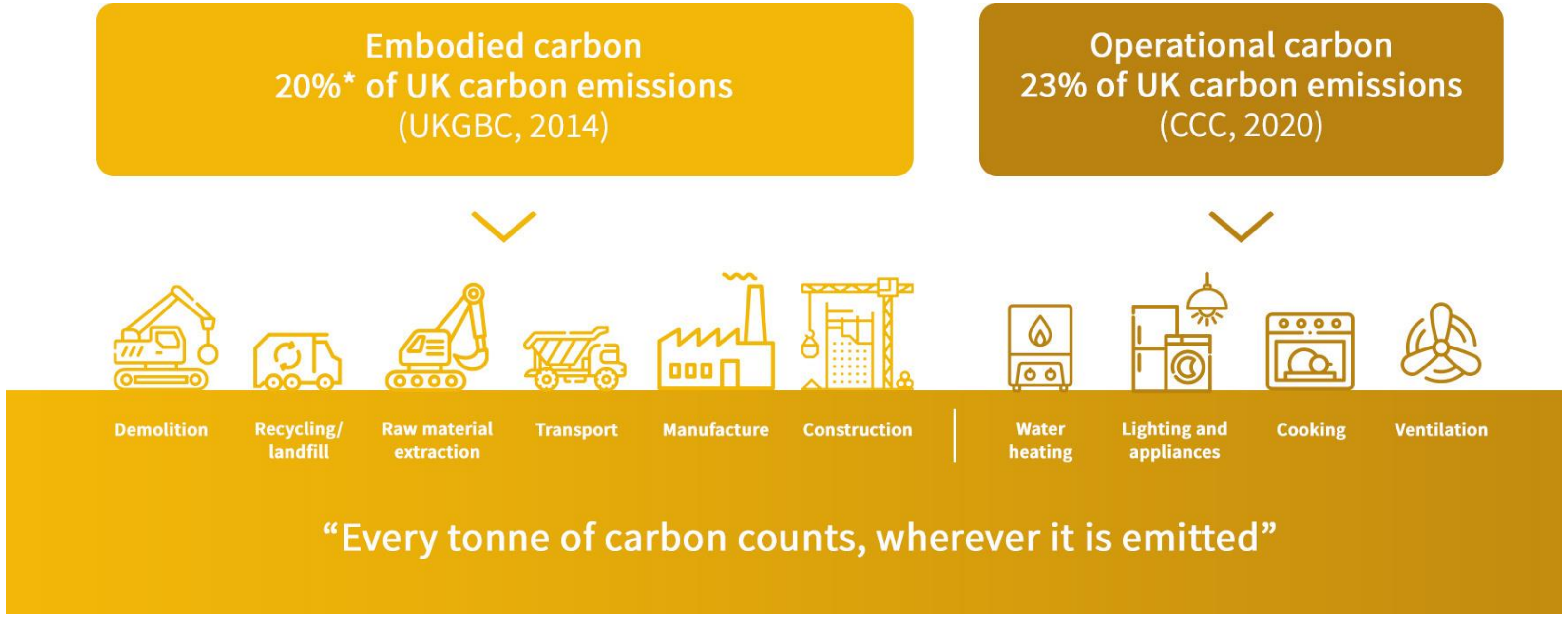
"Every tonne of carbon counts, wherever it is emitted".

Climate Change Committee (2019) [9]

Every time we use a new building product, or we demolish and construct part of or entire buildings, we produce carbon emissions. This is called **embodied carbon** and contributes to climate change. However, these emissions are currently largely overlooked[10]. Embodied carbon from buildings is estimated to account for as much as 20% of our total carbon emissions.

Operational carbon is the carbon emitted by buildings when we use them. Most of our current policies are targeted at reducing the operational footprint of homes.

Whole life carbon emissions from buildings



Sources: UKGBC (2014) [8], CCC (2020) [2]

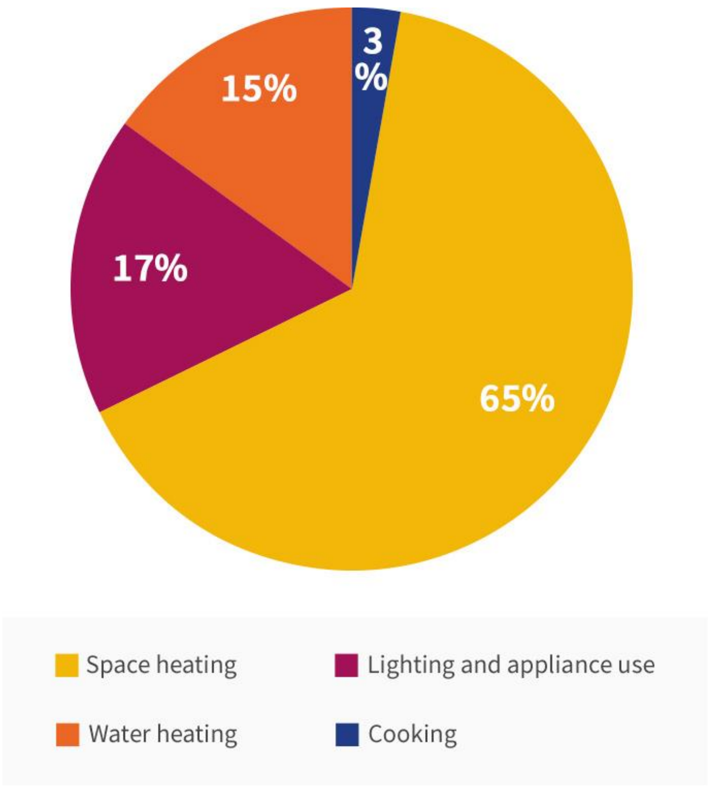
Sources of operational carbon emissions in our homes

Homes are the second largest consumers of energy after transport (which consumes 40%). 28% of all UK energy is consumed by homes.[11]

Some 65% of the energy we use in our homes goes to space heating (heating the air), with a further 15% for water heating.[11] Reducing energy for heating is therefore a key aim of our net zero targets.

The energy use of homes is influenced by multiple factors: the building's **location, orientation, design, construction and engineering services, but also the way it is used, managed and maintained.**[2]

Energy used in domestic buildings



Sources: BEIS (2020) [11]

Did you know?

The power sector has been a major success story in our nations net zero journey to date.[12] During the last decade, renewable and low carbon energy sources such as wind, solar and biomass have successfully helped reduce the power sector's emissions. Replacing traditional fossil fuels like coal, gas and oil with low carbon alternatives has resulted in emissions falling by 67% between 2008 and 2019.[12] But fossil fuels are still the main source of energy for heating buildings and hot water – 74% comes from natural gas and 10% from petroleum [11]. More needs to be done to reduce our homes' reliance on high carbon fuels in order to meet future net zero target.

“Buildings contribute to global warming over their whole lives: when we build, maintain, use and demolish them.

“Failure to model the whole life of the building ignores these impacts and so we simply shift the problem from one part of the building lifecycle to another.”

Prof Aidan Duffy, Lecturer & Centre Manager: Dublin Energy Lab, Technical University, Dublin [3]

CHAPTER 2

Understanding Traditional Homes

The UK's building stock is varied, with differences such as building types, materials and condition impacting on their carbon emissions.

Understanding homes, their significance and the factors that impact energy use are extremely important when devising an approach to reducing emissions.

Beresford Terrace, 40-49 Hillreach, Woolwich, Greenwich.
DP135204 © Historic England Archive

“Older buildings are stigmatised as ‘hard-to-treat’, or energy-hungry, despite the evidence of several thousand years of proven effectiveness in a low-carbon, low-energy environment ...”

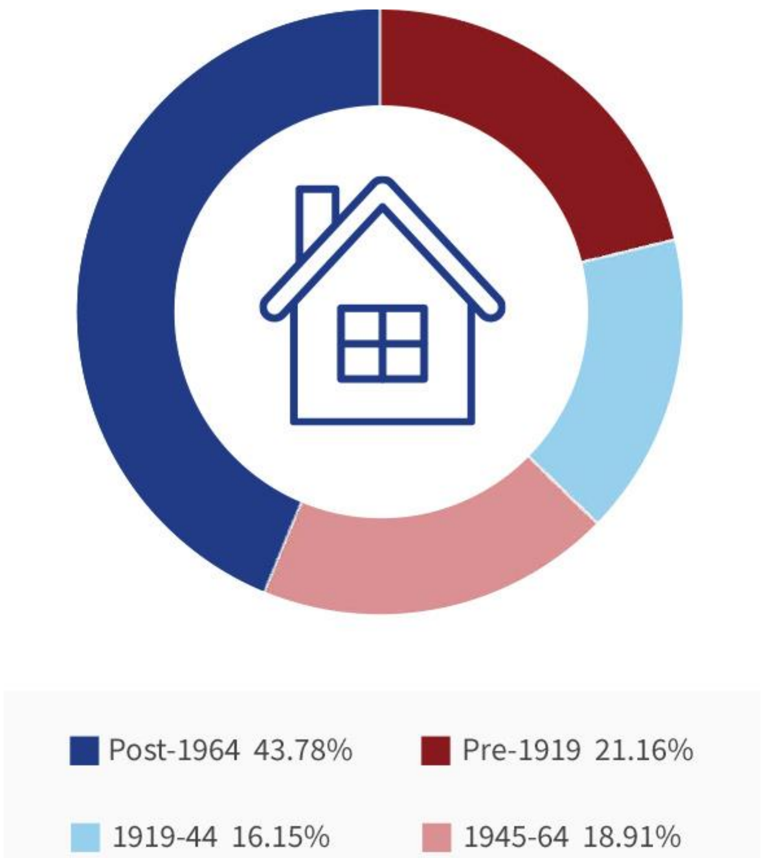
Robyn Pender and Daniel J Lemieux, 2020 [13]

Our traditional buildings are diverse

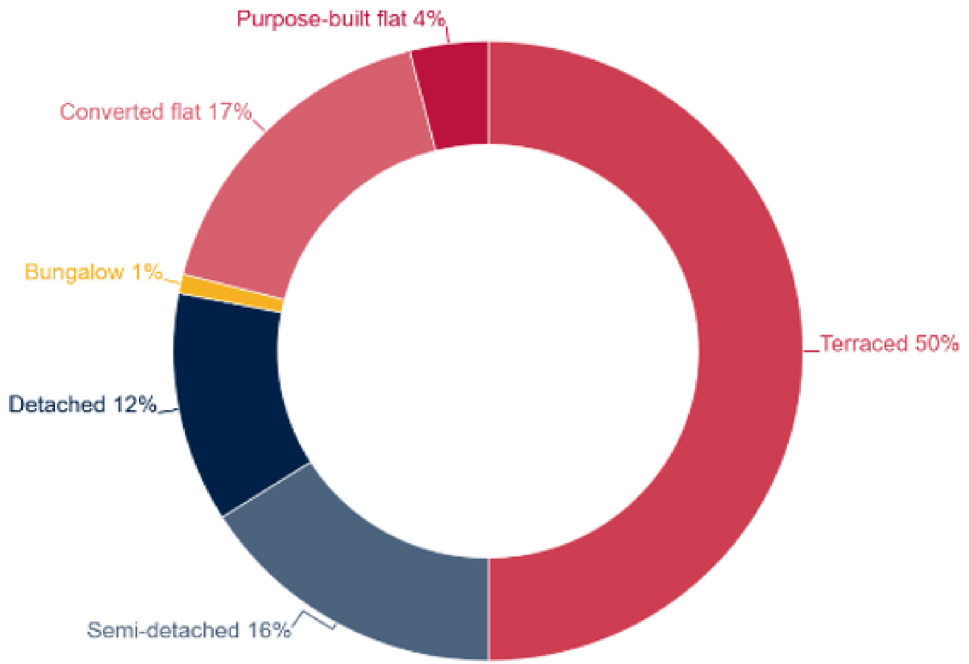
Traditionally constructed buildings are capable of lasting with regular repair and maintenance. This is clearly demonstrated by the age of our homes today, with more than 21% of all homes in England built over a century ago (pre-1919).[14]

About half of all our traditional (pre-1919) houses are terraces. In the recent past, we have seen the number of pre-1919 homes increasing as are result of conversion of non-domestic properties into homes and exiting homes into multiple homes e.g. converted flats.[15]

When was our housing stock built?



What types of home were built pre-1919?



Sources: MHCLG (2016) [14], VOA (2016) [15]

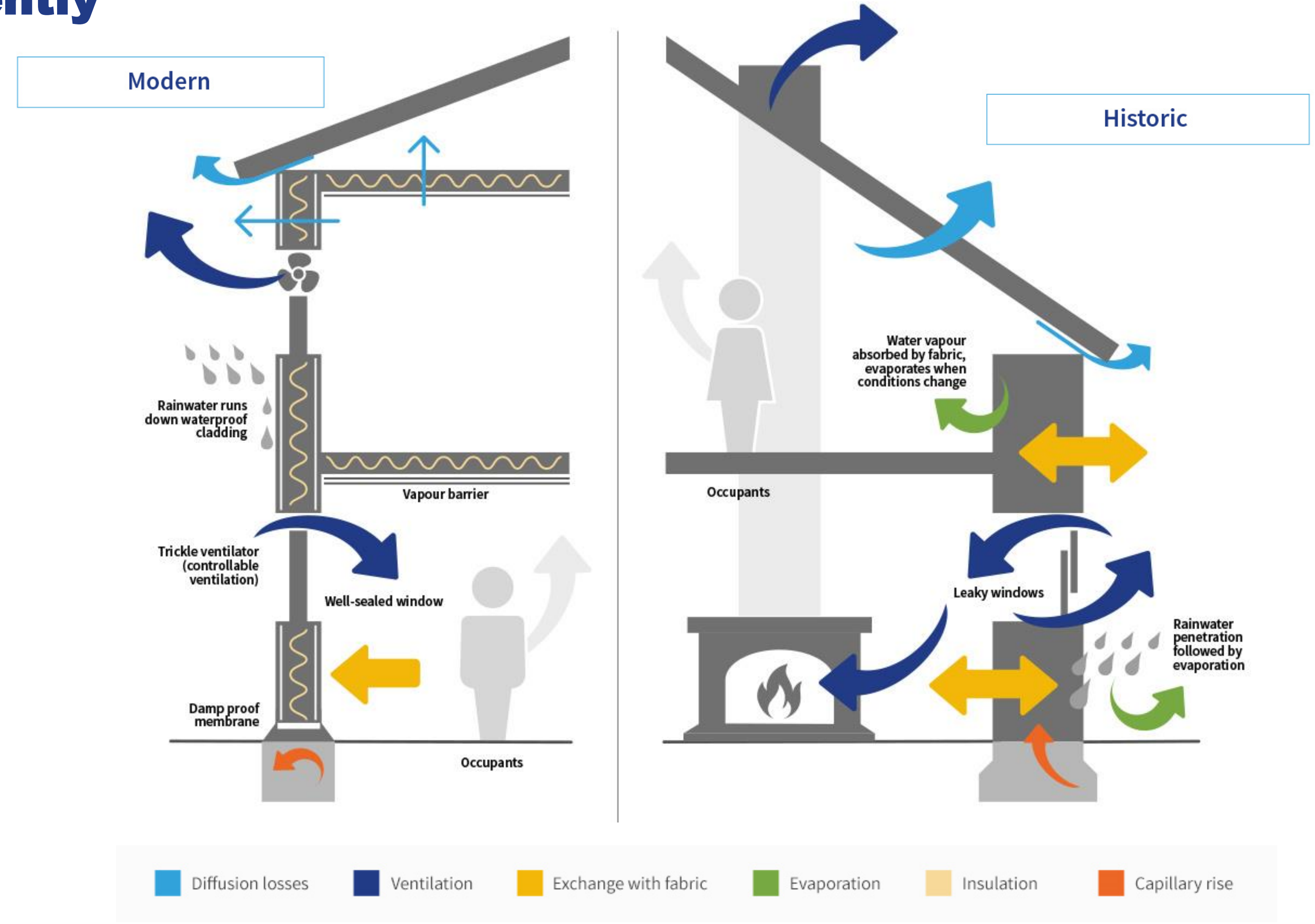
For more information see: pages 17-20 in the UWE technical report

Traditional buildings are constructed differently to modern buildings

Traditional buildings do not work in the same way as the buildings we construct today. They generally

- are built with porous materials that easily exchange moisture with the air (this is sometimes described as ‘breathability’); modern buildings are mostly based on layering of waterproof materials
- are constructed with solid walls of masonry or earth, or timber frames with solid infills, without additional insulation
- heat up and cool down more slowly than most modern homes
- have more natural ventilation than their modern counterparts.[16]

Because traditional buildings are different to modern buildings, they can react differently to energy efficiency actions. If these differences are not taken into account, actions intended to improve energy efficiency can damage their long term future, and the health and comfort of their occupants.



Source: Historic England (2018) [4]

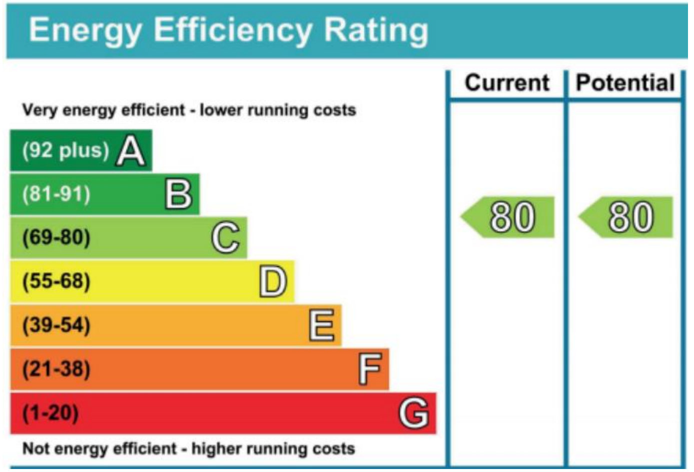
For more information see: Energy Efficiency and Traditional Homes and Sustainable Futures Tomorrow

Understanding your home's energy performance

An energy performance certificate (EPC) allots a property an energy-efficiency grade between A and G, with A being the most energy-efficient and G being the least.

Most EPCs are based on the assumed (modelled) energy performance of the building (not the actual energy performance of the building). The modelling is based on many assumptions, so a modelled EPC isn't a real estimate of the in-use (operational) carbon emissions from a home.

A study in 2016 found that nearly every building in the study had higher carbon emissions than predicted.[17] This is known as the "performance gap" requiring caution when interpreting modelled estimates – they are indicative rather than actual.



Did you know?

An energy performance certificate (EPC) is a certificate intended to indicate how energy-efficient your property is. It includes estimated energy costs, as well as a summary of your home's energy performance-related features.

EPCs for listed buildings and conservation areas: Exemption can be applied for where harm may occur as a result of installing measures to meet compliance. This is because some energy improvements to buildings of traditional construction can lead not only to problematic alterations to their character and appearance, but also because they can result in unintended consequences such as damp and deterioration of the structure. This can be avoided by adopting a 'whole building' approach to performance, which can help in meeting the combined objectives of increasing energy efficiency and sustaining significance. Where listed buildings are more complex, more detailed analysis is needed. Buildings in conservation areas may also be protected but this depends on whether or not the conservation area is covered by an Article 4 Direction.

Looking up an EPC: Using the government's EPC register's retrieval page, you can search for any property's energy performance certificate by postcode. This is useful for looking up your own certificate, or for finding the certificate of a property you are considering moving into. If your property doesn't already have an EPC, you'll need to get one before you can sell (this may not apply to listed and some other heritage buildings).

Sources: Which? Guide to EPC Historic England's advice on energy performance

CHAPTER 3

Reducing Operational Carbon Emissions in Traditional Homes

There are increasing pressures to make large scale changes to the fabric of traditional homes using technical measures to reduce in-use (operational) carbon emissions.

Success is unlikely to be achieved by technical means alone: people play a crucial role in reducing the carbon emissions from homes.

Squirrel's Heath Avenue, Gidea Park, Havering.
DP186469 © Historic England Archive

Towards low carbon traditional homes

This section of the report considers how different factors impact the carbon footprint of case study homes, particularly:

- People and household characteristics and behaviours.
- Building location and orientation (for example, where it is located; or whether it is north or south facing).
- Building characteristics (property size, design, and construction, materials, and the building's condition)
- Building services (heating, cooling, lighting and plumbing systems)

For simplicity, in the following text we look at these four main factors separately, but in reality they are all connected and interrelated: when we change one element of our homes we directly or indirectly affect other areas.

To find out more about the way these factors interact - known as the 'building performance triangle' - see Historic England's guidance here.[4]

People

“40% of the planned carbon emission reductions require a change in people's behaviour”

Climate Change Committee, 2020 [9]

People play a crucial role in our low carbon future

Since 1990, carbon emissions from buildings have declined by 20%. These reductions are largely a result of measures that haven't required changes in people's behaviour – most notably, the supply of electricity from lower carbon sources.[2]

Buildings are currently not on course to meet the government's carbon emission targets, so changing behaviours will play a much greater role in future alongside retrofit measures.[2]

Although 93% of the public said that climate change was a serious or very serious issue, their awareness of the sources of carbon emissions is low.[18]

"Only 5% of the public identified heating buildings as one of the more significant contributors to UK carbon emissions." (National Grid, 2020[18])

(Homes are the second largest consumers of energy in the UK after transport, largely due to the energy used to heat buildings[2]).

Wellington Terrace, Berwick-Upon-Tweed, Northumberland. DP065209 © Historic England Archive

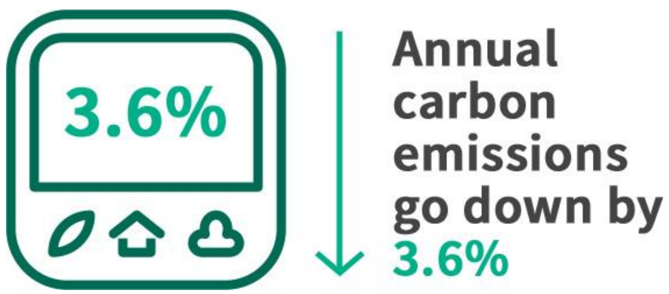
Assumptions for these calculations*
Type of home: Medium-sized Victorian Terrace
Location: Midlands
Total Floor Area: 103.9m²
Heating Fuel: Gas
Boiler Efficiency: 87%

What a difference people make:
What happens to carbon emissions in case studies when....

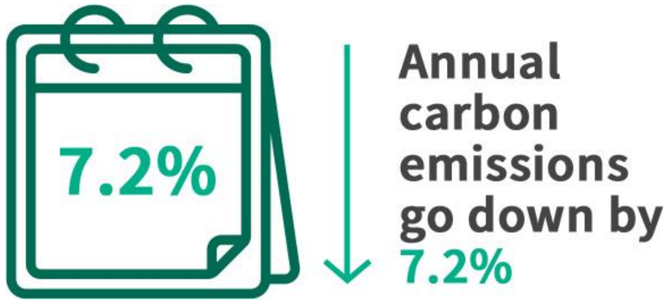
Heating use changes?
The amount of time spent at home and the way homes are heated will directly impact energy use and carbon emissions.

What if …

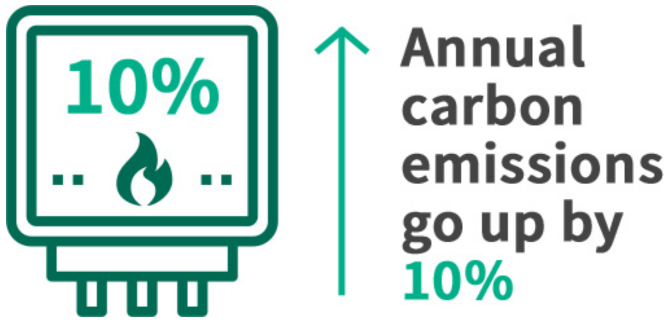
I reduce my space heating by just one hour?



I have the same heating times during the weekend as I do during the week when I am active and out of the house?



I increase my space heating by four hours each day during the winter?



Assumptions for these calculations *
Type of home: Medium-sized Victorian Terrace
Location: Midlands
Total Floor Area: 103.9m²
Heating Fuel: Gas
Boiler Efficiency: 87%
Unit Cost (Gas): 2.84p/kWh

What a difference people make: what happens to carbon emissions in case studies when…

Temperatures are reduced

Reducing the thermostat from 21°C to 18°C cuts space heating requirements, leading to a **20% reduction** in annual carbon (CO2) emissions.

Over time we get used to higher or lower temperatures, this is known as 'Comfort Creep'. Evidence shows that if you make a change gradually you will feel it much less.[19]

Slowly moving from 21°C to 18°C means:

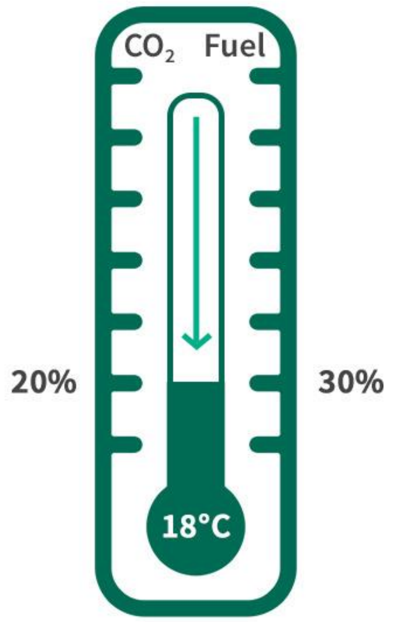
20% **reduction**
in annual CO2 emissions

or

30% **reduction**
in required space heating fuel

or

Saving **£130***
in annual energy bills

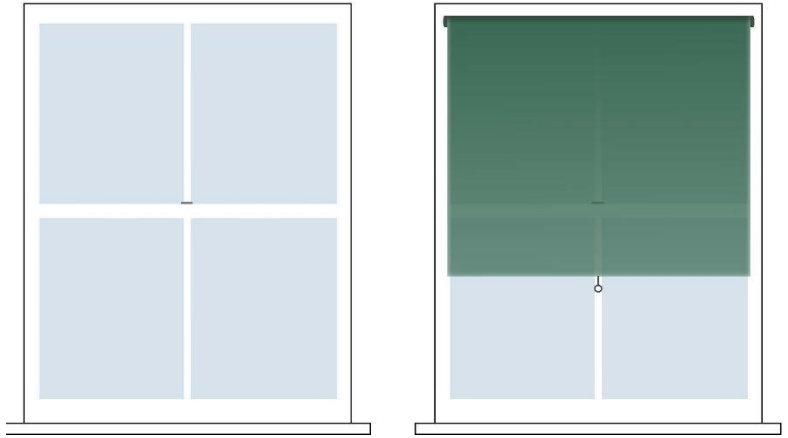


Assumptions for these calculations*
Type of home: Medium-sized Victorian Terrace
Location: Midlands
Windows: 5 single-glazed (U-value=4.8W/m^2K)
Fitted Blinds: U-value = 3.3W/m^2K

What a difference people make: What happens to carbon emissions in case studies when...

Small measures are taken

There are many smaller measures that can reduce the emissions in our homes that are within the control of people and require less professional support.



Simple window treatments can reduce heat loss

For example, well-fitted blinds in single glazed windows can reduce heat losses from windows. This has the potential to **reduce annual carbon emissions by up to 2.5%.***

Source: Georgetown University: Things you can do

Assumptions for these calculations:
Type of home: Medium-sized Victorian Terrace
Location: Midlands
Total Floor Area: 103.9m²
Heating Fuel: Gas
Boiler Efficiency: 87%
Unit Cost (Gas): 2.84p/kWh
Unit Cost (Electricity): 13.86p/kWh

There are other factors that impact energy use in a home

It's important to understand that it's not just the physical building itself that determines a home's emissions. For example, a larger household will generally consume more energy than a smaller household.

The difference in carbon emissions between **1 and 4 occupants in the same house is an estimated 15%.** This is calculated to cost an additional £310* per year in energy costs.

*note: these costs are specific to the assumptions in this modelled case. Each building and household will be different.

Changing consumer behaviour is vital for reducing CO_2 emissions, but to achieve this it's important to begin by understanding the different factors that affect energy use within homes.

What does 1 tonne of carbon (CO_2) mean? 1tCO_2 is equivalent to:

443 young conifer trees which is the equivalent of the forested area of 7 tennis courts

3,591 km in a small petrol car, equivalent to completing 11 journeys along the entire M1 motorway

114 days (2,700 hrs) of a TV using a streaming service

Low impact energy efficiency measures

Low impact energy efficiency measures are an important part of a low carbon strategy for homes.

Draughtproofing Measures
Having a good level of air tightness is important if you are space heating or cooling your home. Draughtproofing is quick, cost effective, and will greatly improve comfort at the same time as cutting carbon emissions.

It is important to be cautious about sealing a traditional home completely, as this could damage the building and the health of the occupants. Sealed buildings that don't have special mechanical ventilation, can have problems of air quality, and issues with condensation and damp.

For more information see Historic England guidance on improving energy efficiency.[4]

Calculated average capital costs* and annual CO_{2e} savings of eight traditional case study homes (Parity Projects, 2021)

	Average mod elled costs from 8 case studies	Modelled emission savings ($kgCO_{2e}$/ annum)
Windows & Doors (Draughtproofing)	£100 to £500	30-160
Chimneys (Draughtproofing)	£100 to £500	60-180
Compensating Controller (Gas)	£100 to £500	110-390
Multi Zone Heating Controls	£500 to £1,000	400-900
Low Carbon Lighting (e.g. LEDs)	Less than £100	120-190

*These costs and emissions savings are modelled based on examples of typical traditional homes. Given the diverse nature of England's building stock they should **only be considered as indicative rather than precise figures.**

Heating System Controls
Good controls help the user control the temperature in different parts of the home. It's important that these are easy to understand and use – unresponsive and poorly managed systems can lead to increased energy use.

Assumptions:
Heating hours are reduced from 9 to 8 (weekdays) and from 16 to 15 (weekends)
DP measures reduces air permeability from 12 to 10 m³/(h.m²)
Infiltration due to chimneys, flues & fans reduced from 0.8 air changes/hour to 0.1, Fitted blinds reduces Single Glazed U-values from 4.8 to 3.3 W/m²

Small changes in people's behaviour and low impact measures can accumulate to make big differences

Turning down the thermostat from 21°C to 20°C and having the **heating on for an hour less each day** can reduce annual carbon emissions by almost 10%.

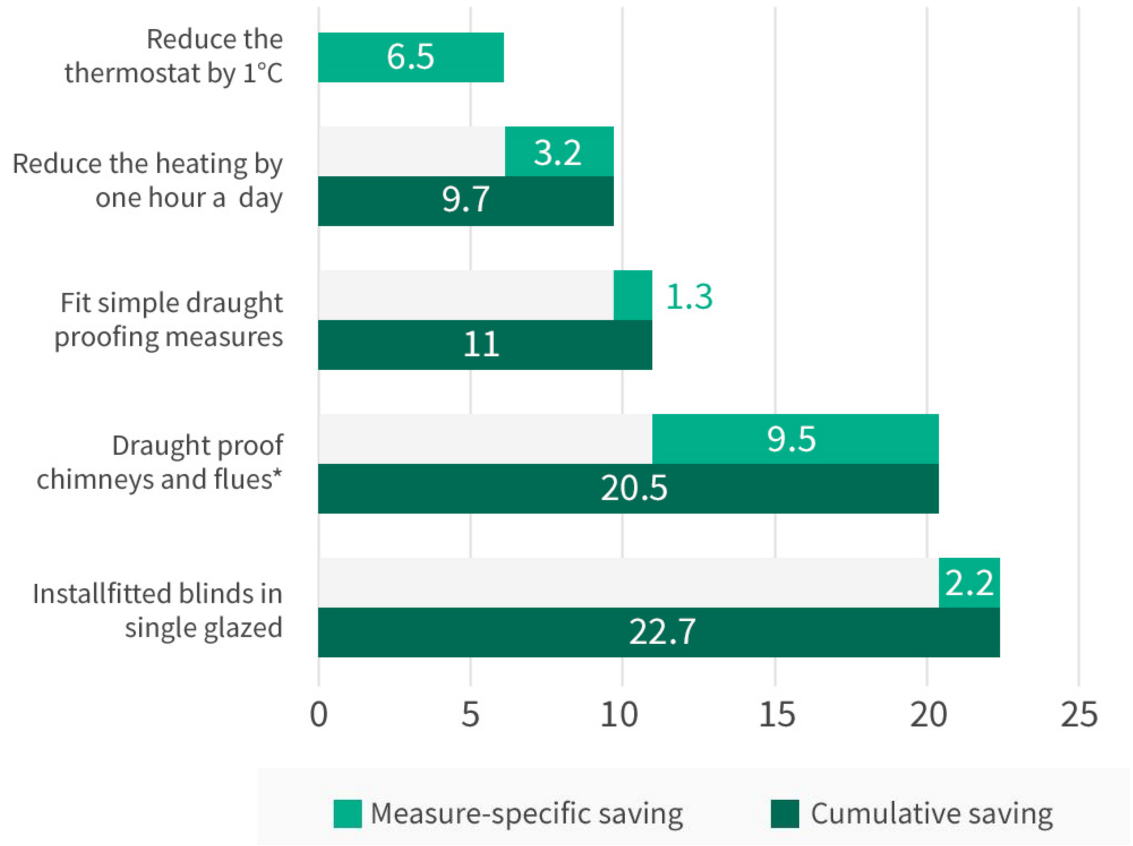
Adding draught proofing and **fitted roller blinds** to single glazed windows can make those emission savings more than double.

These measures are less likely to impact the heritage significance of homes and can be made quickly by homeowners without major upheaval or cost.

Small changes in people's behaviour and low impact measures are an important part of the low carbon future for traditional homes. **They can be made quickly as part of a phased approach, helping to reduce the sum of all emissions.**

(The impact of small changes are modelled and will differ from case to case.)

Cumulative annual CO_2 savings (%) through combined measures



*based on four open chimneys and one open flue

Building service

Building characteristics

“Breaking with previous messaging to households to make small and easy changes, high-impact shifts in consumer behaviours and choices are needed that are consistent with the scale of the climate challenge”

Dr Richard Carmichael, Centre for Energy Policy and Technology (ICEPT) and Centre for Environmental Policy (CEP) Imperial College London for Climate Change Committee, 2019 [20]

Reducing operational carbon emissions through retrofit

Given the enormity of climate change, we need to do more than small actions to reduce carbon emissions over the long term. There are increasing calls to make large scale changes to buildings through retrofit to reduce carbon emissions from buildings.

> **"To achieve net zero carbon by 2050, we will need to improve almost all of the UK's 29 million homes, meaning we need to retrofit more than 1.8 homes every minute between now and 2050."**
>
> UK Green Building Council [21]

Retrofit usually centres on reducing the loss of air that has been heated or cooled through walls, doors, windows, floors and the roof, thereby reducing energy use, heating costs and carbon emissions.[4]

Given the right, thoughtful approach to retrofitting, the twin objectives of protecting heritage significance and improving energy and carbon performance are compatible and achievable.[4] But there is no 'one size fits all' solution and what is suitable for one traditional home may not be in another.

Did you know?

Retrofit is the process of improving the energy and environmental performance of buildings by adapting the interior and exterior of buildings.

Good retrofit considers the unique properties of a building including the building characteristics, building services but also very importantly – the people.

Planning is critical part of any successful retrofit

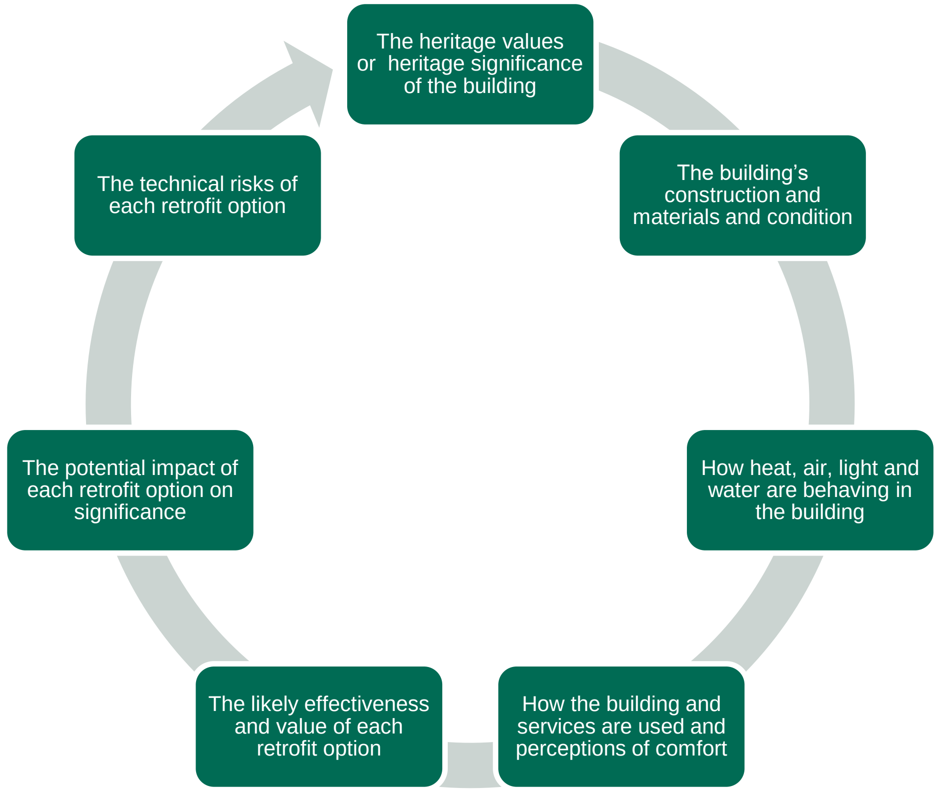
Retrofit can make a traditional building much more energy efficient, but it needs a well-considered plan that holistically considers the whole building performance triangle: *the building and building services, the building users and the heritage significance.*[4]

Before designing any retrofit, it is important to assess the building and the way it is being used. That will help to identify the measures that are best suited to individual buildings and households.[4]

Planning regulations and building regulations do apply to retrofit improvements.

It is often very helpful to get professional help from suitably qualified specialists with an understanding of traditional homes.[4]

Before retrofitting it is important to properly understand what you have and in particular consider:



Source: Historic England (2018)

Understanding the risks of retrofit

Large scale 'deep' retrofit work to homes carries significant risks. Poor quality retrofits that do not consider the unique differences of buildings and users can damage a building and the health of its occupants. Good planning and expert help can mitigate these risks.[22]

Work to traditional homes can impact upon their heritage significance in a variety of ways. Where planning permission and/or listed building consent are required, both the nature and scope of what is being proposed will be weighed against the risk of harm to the heritage significance.[22]

All works must also comply with building regulations and the requirements of the building's insurance providers.[22]

Retrofit that takes a **"fabric first**" approach and overlooks key elements such as occupants and the embodied carbon has been proven to lead to inefficient energy reduction outcomes over the long term.

For more information see Historic England's guidance on planning responsible retrofits.

Did you know?

There are three broad areas of risk to consider for retrofit: 1) Energy and Environment 2) Building Health (health of both fabric and people) 3) Heritage and Community.

Inappropriate retrofit measures can lead to unintended consequences, such as condensation and mould growth or more serious fabric decay such as wet and dry rot. These issues arise when moisture is prevented from drying out or channelled into cold areas through poor design or poor installation of retrofit measures. [22]

The costs of retrofit

Reducing the emissions of UK homes through retrofit is a costly and potentially disruptive challenge. The Climate Change Committee (CCC) estimates that **by 2050, £250 billion of investment into upgrading homes will be required.**[2]

The costs of retrofit depend on multiple factors that relate specifically to a home and its occupants as well as to the cost of products and local labour**. Costs of retrofit are therefore highly variable and bespoke.**

The costs of retrofit also depend on how and when the works are undertaken. Our research[23] shows that:

- **If retrofit improvements are treated as standalone projects**, the average cost of retrofit for traditional buildings is £457 per tonne of carbon. This includes additional costs for preliminary works, enabling works, professional fees, VAT and contingency.
- **If retrofit improvements are incorporated into a wider home improvement project or undertaken at 'trigger points'** (when an appliance needs replacing or when undertaking home renovations)**,** the average costs are reduced to £420 per tonne of carbon (including VAT), or £362 per tonne of carbon (excluding VAT).

It has been estimated that the annual cost of retrofitting three-quarters of England's pre-1919 housing would be in the region of £6.4 billion up to 2050. This reduces to £4.9 billion per year when considering only the cost of the retrofit measures and enabling works (inclusive of 20% VAT) and to £4.2 billion per year when removing VAT. [23]

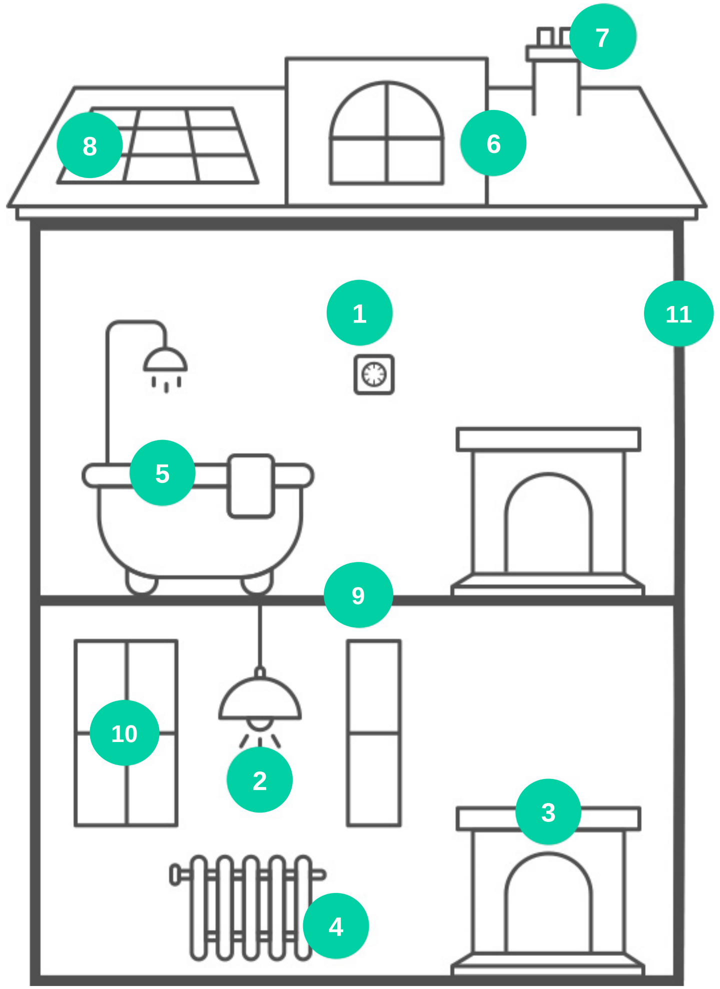
In this report we present costs based on very specific assumptions about specific or modelled case studies. All figures should be treated as indicative.

Did you know?

Costs for VAT, professional fees (e.g. architects fees, surveyor fees), preliminary works (e.g. scaffolding, site services), enabling works (e.g. ground investigation, treating damp) and contingency must be built into retrofit budgets.

The University of the West of England (UWE) research estimates that **the total cost of retrofit is 95% higher than the cost of the materials and labour.**

Retrofitting homes – the basics



1. **Heating Controls:** Controlling where and when heating turns on and off is a cost -effective method for reducing energy use.
2. **Low Carbon Lighting:** Replacing inefficient lighting with energy efficient versions (such as LEDs) is a simple and low cost, low risk way of reducing electricity consumption.
3. **Draught Proofing**: Simple and cost- effective measures, include filling in gaps around windows and doors. These measures are generally unobtrusive and carry low risk. Draft proofing needs to be considered alongside the overall ventilation of the home.
4. **Heating Upgrades: L**ow carbon space heating systems include efficient A-rated gas boilers and air source- or ground source heat pumps, powered by electricity. Depending on the additional actions required, heating upgrades carry medium levels of risk.
5. **Hot Water Upgrade**: Will depend on the existing system and is most often linked to the heating upgrade.
6. **Roof/loft Insulation:** Roof insulation can include loft insulation, ceiling level insulation, insulation between and above rafters, insulation between and above weatherproofing. There are significant risks with roof insulation works depending on the type of roof and insulation approaches. Loft insulation is relatively simple, quick and low risk. Professionally developed, bespoke solutions are needed.
7. **Ventilation:** is an essential part of any retrofit. Good ventilation helps to maintain a healthy indoor environment, control condensation, remove pollutants and ensure the safe operation of home appliances. If a home is made more airtight without ventilation, moisture levels could increase and cause problems such as damp, mould and poor air quality*.
8. **Solar Panels:** Solar photovoltaic (PV) panels can be fitted to a rooftop (preferably south facing), to generate electricity from sunlight.
9. **Floor Insulation:** Floor insulation options include insulating the space under a suspended floor or the solid floors. The risks of floor insulation can be high and vary by type of measure implemented.
10. **Glazing Upgrades**: Upgrades range from installing secondary glazing, to replacing whole windows. Replacing glass and whole windows carries high levels of risk, and needs to be considered alongside the overall ventilation of the home.
11. **Wall Insulation:** External walls represent a large proportion of a building's exterior, so they are considered to be a critical place where heat is lost. Insulation options generally include external wall insulation (EWI) and internal wall insulation (IWI). Wall insulation carries high levels of risk to the building, users and the heritage significance, and for thick solid walls may not be required. If solid wall insulation is required, professionally developed, bespoke solutions are needed.

Detailed guidance is available here - Making Changes to Save Energy

The impact of retrofit: evidence from case studies of typical traditional homes

Research for this year's Heritage Counts has examined the costs and impact of retrofit measures. The costs and carbon impact of retrofit have been estimated using real and modelled case study data applied to 8 traditional homes*. The results are typical of those used by policymakers, and it is important to note they provide **an indication rather than precise figures.**

These costs do not include VAT, professional fees, preliminary works, enabling works or contingency. These costs can add up to 95% additional costs.[23]

*Mid-terrace house with solid walls and gas heating ; End-terrace house with solid walls and gas heating; Semi-detached house with solid walls and gas heating ; Detached house with solid walls and gas heating; Converted flat with solid walls and gas heating ; Semi-detached house with solid walls and off-gas heating ; Semi-detached house with cavity walls and gas heating ; Grade II listed detached house with timber frame walls and gas heating

Calculated average capital costs and annual CO_{2e} savings, from eight case study examples (Parity Projects, 2021)

	Risks associated with the retrofit measure*	Average costs from the 8 case study examples	Average emission savings from 8 case study examples ($kgCO_{2e}$)
Heating Controls	Low	Less than £500	400
Energy Efficient Lighting	Low	Less than £500	160
Draughtproofing Measures	Low	Less than £500	100
Mechanical Ventilation	Low/ Medium	£3,000 to £5,000	-800*
Roof/ loft Insulation	High/ Low	£500 to £1500	450
Floor Insulation (Solid)	Medium/ High	£1,500 to £3,000	220
Floor Insulation (Suspended)	Medium/ High	£1,500 to £3,000	310
Single Glazing Replacement	High	£5,000 to £15,000	350
Solar PV Generation	High	£1,500 to £3,000	920
External Wall Insulation	High	£5,000 to £15,000	1,400
Internal Wall Insulation	High	£5,000 to £15,000	1,400

*no savings (actually produces emissions)

“The way we heat our homes needs to transform. Only 5% of the energy used to heat our homes today is from low carbon sources”

Ofgem, 2020 [24]

Looking at heating and water systems

The heating requirement for a building is driven primarily by the nature of the building's construction (building fabric) and the type of heat required (e.g. space heating, water heating) and of course the occupiers' use.

Improving a home's heating and hot water system can significantly reduce its carbon emissions, but the magnitude of these savings depends on the existing system.

For example, replacing an inefficient boiler that is at the end of its life with a low carbon alternative will be much better at reducing overall emissions than swapping out a newer, more efficient model that still has many years of operational life left.

Calculated capital costs and annual CO_{2e} savings based on of eight case study examples (Parity Projects, 2021)

	Costs: range from 8 examples	Emission Savings: range from 8 examples ($kgCO_{2e}$)
Gas Boiler (from E to A rated)	£1800-£3000	1200-1400
Gas Boiler (from C to A rated)	£1700-£2900	600-950
Air Source Heat Pump (from E rated boiler)	£5000-£11000	1850-2050
Air Source Heat Pump (from C rated boiler)	£5000-£11000	1500-1850
Hot Water Tank Insulation (Change from 12mm to 80mm)	£750	500
Hot Water Tank Insulation (Change from 25mm to 80mm)	£750	100

100$kgCO_{2e}$ is equivalent to the emissions produced from driving a small petrol car approximately 360 miles, more than the length of the M1 motorway.

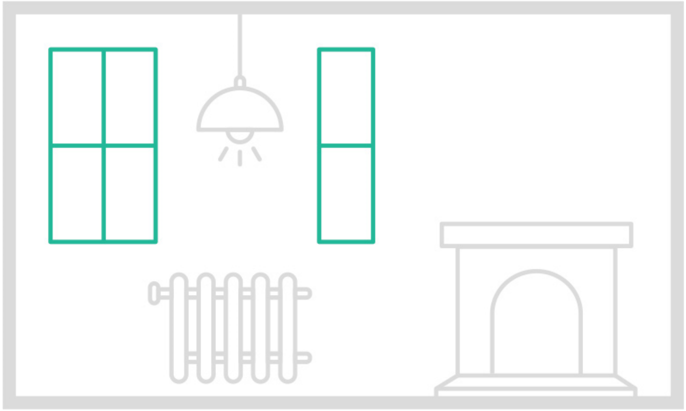
Looking at windows

Research into traditional windows has demonstrated that current thermal performance standards can be reached by using both traditional treatments such as shutters or modern solutions like secondary glazing. These measures are extremely effective in reducing heat loss and keep the historic features of the building whilst also reducing your operational carbon emissions. Caring for what is already in building and ensuring that it performs to the best of its ability is a great way to ensure cost effective and successful improvements, with regular maintenance historic windows can last hundreds of years and still perform well.

The average cost and carbon savings from the modelled case studies shows that secondary glazing is a very cost-effective measure for reducing carbon emissions. Further analysis found that secondary double glazing delivered better energy and carbon savings than completely replacing existing single glazing with double glazing[23].

Guidance on windows can be found here [25]

"Historic windows and doors make a major contribution to the significance and character of historic buildings and areas so every effort should be made to retain them rather than replace them. Windows and doors can tell us a lot about the history of a building, changing architectural taste and style, social hierarchy, building economics, craft skills and technical advances."



Calculated average capital costs and annual CO_{2e} savings from eight case study examples (Parity Projects, 2021)

	Costs – range from 8 examples	Emission Savings – range from 8 examples ($kgCO_{2e}$)
Secondary Glazing	£2,000-£3,000	300-500
Double Glazed Sash (A+)	£8,000-£12,000	500-900
Double Glazed Casement (A++)	£5,000-£7,000	550-950
Triple Glazing	£7,000-£11,000	400-750

100kgCO_2 is equivalent to the carbon stored in 44 young conifer trees, broadly representing a forest area the size of a tennis court.

Looking at loft and roof insulation

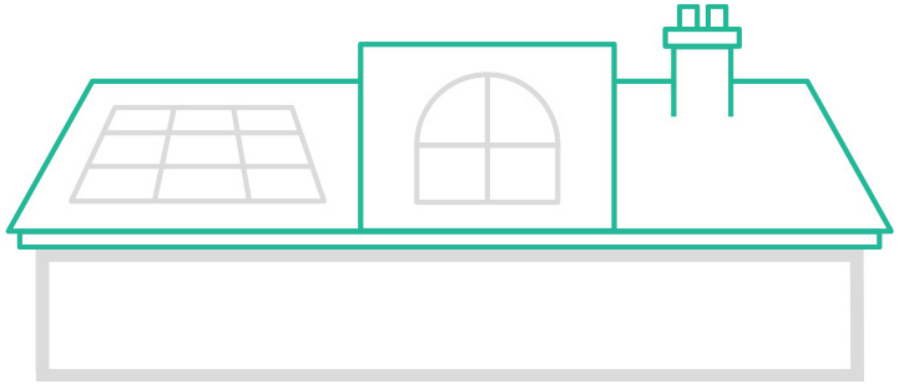
Heat rises, so if a roof has no insulation, properly installed loft insulation is one of the most effective and simple things you can do to improve the energy efficiency of you home. Consider suitable materials and ventilation to ensure risk of condensation is limited.

A more intrusive and expensive way to insulate a roof is to introduce insulation above the rafters to create a warm roof structure. It can, however, be challenging to carry out well, and needs professional installation as well as design. If a roof is currently at the end of its life and needs to be replaced, this form of insulation could be considered.

Different insulation materials will produce different amounts of embodied emissions.

Guidance on warm roof insulation can be found here [26]

"It is important that the significance of a historic building is not compromised by alterations to install insulation, such as changing roof levels and materials, removing historic plaster ceilings, altering the positioning of gutters and rainwater pipes. These type of alterations are likely to require consent if the building is listed. Any change to the roof material or roof configuration of a building in a conservation area may require planning consent. In each case all proposed changes should be discussed in advance with the local planning authority"



Calculated average capital costs and annual CO_{2e} savings from eight case study examples (Parity Projects, 2021)

Loft insulation thickness – before and after retrofit	Costs – range from 8 examples	Emission Savings – range from 8 examples($kgCO_{2e}$)
from 0mm to 300mm	£450-£750	900-1500
from 150mm to 300mm	£400	100
from 200mm to 300mm	£400	<50

$100kgCO_2$ is equivalent to the emissions from producing 29m² of slate roof tiles which is enough to cover the roof of a small terraced house.

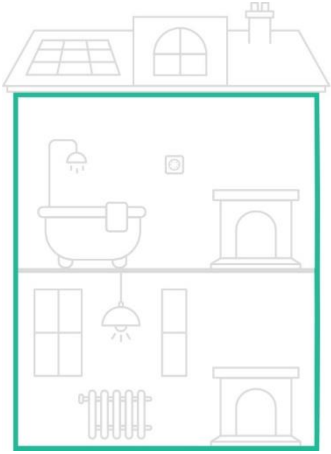
Looking at wall insulation

The suitability of wall insulation for pre-1919 buildings of traditional, solid wall construction, depends on many factors including how thick the original wall is, its level of exposure and its existing condition. An estimated 70% of solid wall homes are built with 9-inch thick brick and, in these cases the thermal performance can often be improved with the application of suitable insulation. Wall insulation has been shown to carry significant risk for traditional buildings[38], so needs very careful planning, high-quality materials and installation. Different insulation materials will produce different amounts of embodied emissions.

Success depends on understanding the building, how it is built, the way it performs and its use. It is important to consider not only how the building works now, but how it will cope during storms, prolonged periods of rain and in high temperatures. Every building is different and needs to be carefully assessed to ensure the insulation measures are effective and well installed.

Guidance on wall insulation can be found here [27]

"Whether applied externally or internally, installing wall insulation can have a significant impact on the appearance of the building. Wall insulation will also alter the technical performance of the solid wall and can either exacerbate existing moisture-related problems or create new ones. In some cases, the technical risks of adding insulation to solid walls will be too great and alternative ways of providing a more cost-effective long-term solution to improving energy efficiency may be more appropriate".



Calculated average capital costs and annual CO_{2e} savings from six* case study examples (Parity Projects, 2021) *Solid wall insulation not applicable to 2 of the case studies

	Costs – range from 6 examples	Emission Savings – range from 6 examples($kgCO_{2e}$)
External wall insulation	£5,000-£14,000	600-2100
Internal wall insulation	£3,500-£11,000	600-2100
Scaffolding for external wall insulation	Average cost for scaffolding = £1,800 Represents a 21% uplift on the estimated average cost of External Wall Insulation	

100kgCO_{2e} is equivalent to the emissions produced from driving a small petrol car approximately 360 miles, more than the length of the M1 motorway.

Retrofit case studies: done well, retrofit can reduce the operational carbon of traditional homes

Using case studies of five different types of homes, researchers from the University of West of England estimated the costs of retrofit and the carbon savings when several retrofit measures were taken. Depending on the type of traditional building, operational emission savings of 54-84% (based on 2020 carbon factors) could be achieved through implementing the lower impact energy efficiency measures and installing low carbon heating.

Case study: Small 1900s' mid-Terrace, small in Sheffield

Annual Emission Savings: 1.5 tCO_2, that's a **58% reduction.**

Retrofit can reduce carbon emissions by 58% at a cost £21,000 (excluding costs such as VAT, fees, preliminary works etc) or £41,000 when these are included.

The continued decarbonisation of the main electricity network and future progress in decarbonising the main gas network and heating networks will have a big impact on the extent to which traditional buildings can meet net zero targets. The decarbonisation of the grid can lead to 100% carbon emission reductions for *some* traditional homes.

Retrofit measures taken:	Costs*
Low Energy Lighting	£100
Loft Insulation	£700
Mechanical Ventilation	£500
Floor Insulation	£1,600
Windows (Double-glazed)	£3,000
Heating (Air Source Heat Pump)	£7,200
Renewable Energy Generation (PV)	£4,000
External Wall Insulation (Back only)	£2,500
Internal Wall Insulation (Front only)	£1,400
Costs (materials and labour)	£21,000
Total Costs including preliminary works, enabling works, professional fees, VAT and contingency	**£41,000**

Similar measures applied to different buildings

Pre-Victorian Detached
Savings: 10.5 tCO_2 (84% reduction)
Cost: £20,400
Total Cost: £38,800

Georgian Terrace (L)
Savings: 5.4 tCO_2 (62% reduction)
Cost: £27,000
Total Cost: £51,300

Victorian Terrace (M)
Savings: 2.3 tCO_2 (54% reduction)
Cost: £31,700
Total Cost: £60,000

Victorian Semi-detached
Savings: 3.5 tCO_2 (56% reduction)
Cost: £35,400
Total Cost: £67,300

*Costs = materials and labour; Total costs = costs including preliminary works, fees, VAT etc. The costs and emission savings are specific to the individual buildings and should not be considered definitive. However, they are indicative of what could be achieved from the general traditional building types.

Building location and orientation

“Changes in the UK’s climate will impact on the energy demand of buildings between now and 2050”

Climate Change Committee, 2020 [28]

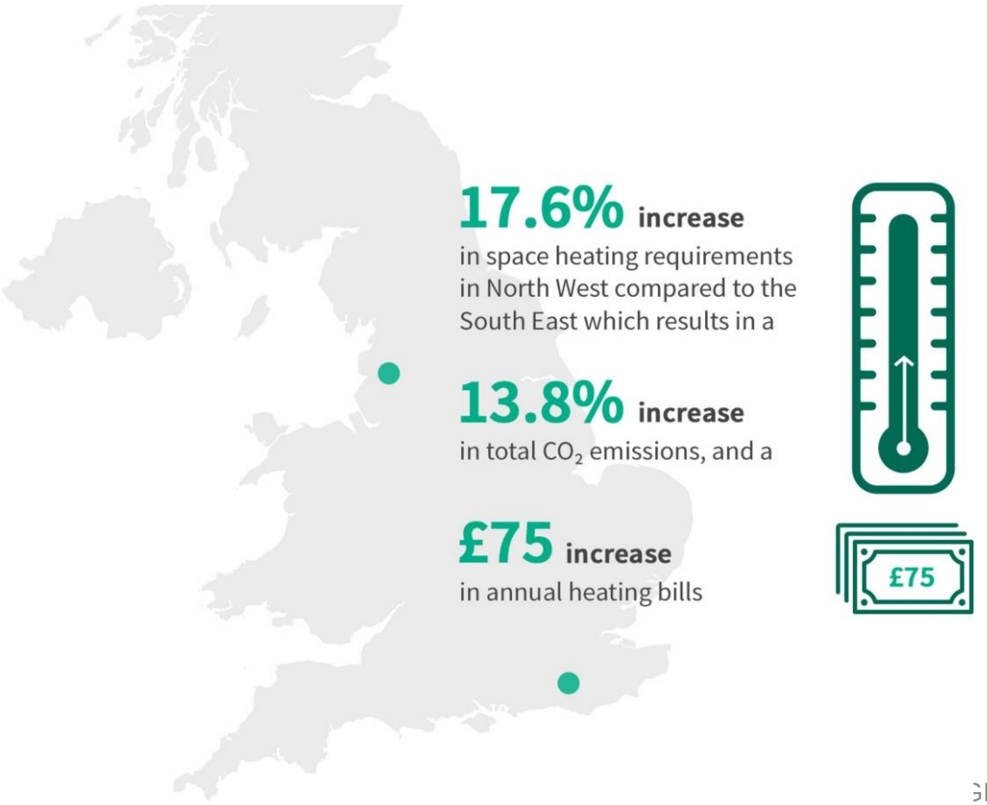
Assumptions
Type of home: Medium-sized Victorian Terrace
Total Floor Area: 103.9m²
Heating Fuel: Gas
Boiler Efficiency: 87%
Unit Cost (Gas): 2.84p/kWh

Regional weather and building orientation make a difference to operational carbon emissions

Climate change is impacting weather – our planet is getting warmer, but we are also seeing more weather extremes in weather patterns with high rainfall events, heatwaves and cold snaps.[2] **Buildings can be significantly impacted by local weather conditions.**

To demonstrate the impact of weather we modelled the energy use of two identical homes located in different parts of the country, taking into account the regional differences in temperature, sunshine and wind.

When comparing the energy requirements and carbon emissions for a traditional terraced home in the North West of England and an identical property in the South East, there is a…



Overheating: We are heading toward a much hotter climate

Around 20% of homes in England suffer from overheating today, with an estimated 2,000 heat-related deaths each year. Our climate is changing – it is predicted that maximum summer temperatures could rise by 6 to 9°C by the end of the century compared to the 1981-2000 average. In such a scenario overheating will become a much more significant problem with heat related deaths estimated to be as high as 5,000 per year.[29]

Traditionally constructed homes are less likely to overheat as they tend to heat up and cool down more slowly than modern homes. Homes that are shown to be more prone to overheating include 1960s – 1970s and post-1990s mid- and top-floor purpose-built flats that lack sufficient ventilation and protection from heating by the sun.[29] In seeking to make traditional buildings more energy efficient, for example introducing insulation and sealing buildings, their ability to cool down is impacted.

As well as thinking about our buildings' emissions and what we can do to reduce them, we also need to consider future climate, what it will be like? We are already seeing hotter, drier summers and warmer wetter winters, with more intense rainfall. By planning retrofit for future climates we can avoid retrofit options that lead to overheating in the future.

“In our rush to modernise and retrofit it is important we don’t inadvertently throw out these good things just because they seem old or because we have forgotten how useful they can be."

Dr Hannah Fluck, Head of Environmental Strategy, Historic England

The Esplanade, Weymouth, Weymouth And Portland, Dorset.
DP055560 © Historic England Archive

Embodied carbon and Low Carbon Retrofit

Retrofitting and refurbishing traditional homes results in embodied carbon emissions through the use and processing of new materials, construction and demolition.

Reusing and recycling building materials and retaining buildings avoids embodied carbon emissions.

Cobcar Terrace, Elsecar, Barnsley
DP234738 © Historic England Archive

“The attention we have placed on saving energy use has sometimes been at the expense of the whole life carbon footprint for a building. We should view energy efficiency as only one component of sustainability. ”

Soki Rhee Duverne, Historic England

We cannot new-build our way out of climate change

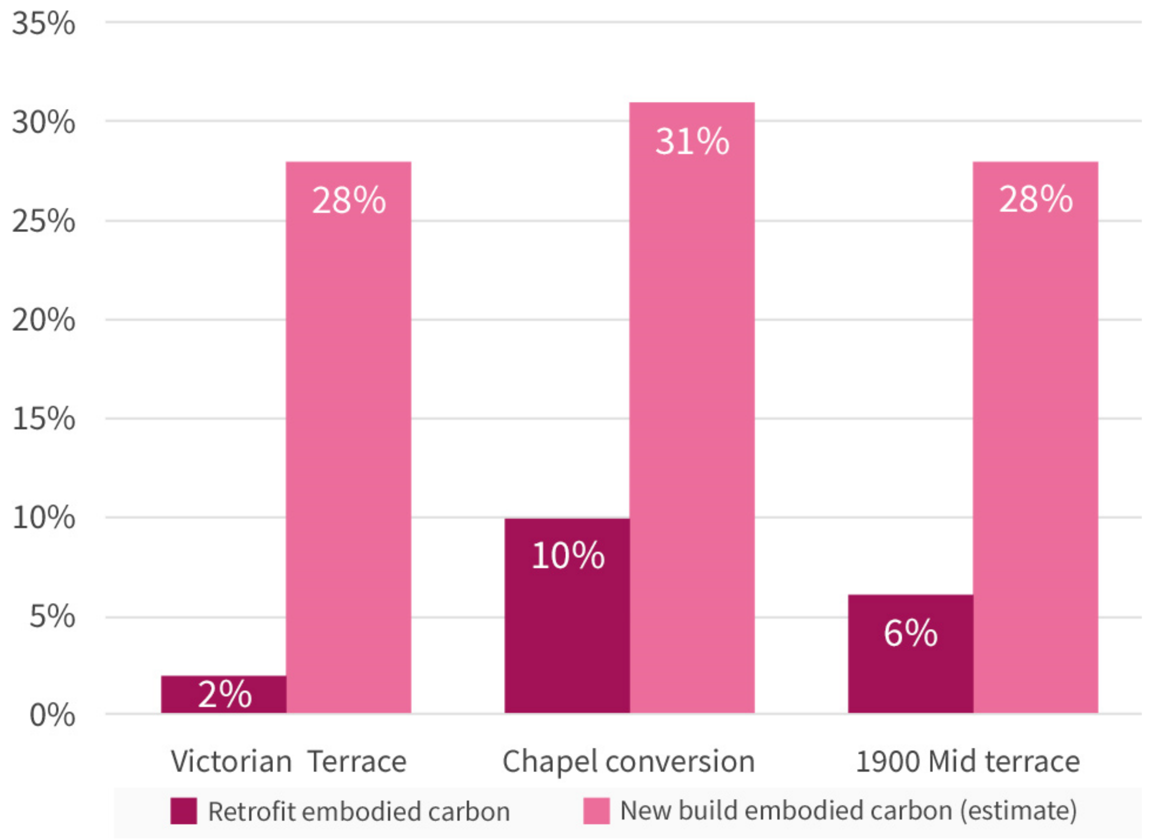
Buildings contribute to climate change over their whole lives: when we build, maintain, use and demolish or re-purpose them. Raw materials extraction, transportation, construction and demolition create carbon – known as embodied carbon.

> "...achieving net zero emissions from the construction sector is not possible without addressing them [embodied carbon emissions]." [17]

Last year's Heritage Counts research found:[3]

- **Up to a third of all the carbon emitted by a new home over a 60-year period is embodied carbon.** This includes emissions from demolishing the existing building as well as those produced during the extraction and manufacture of materials and the building's construction.
- When a typical traditional building – the Victorian Terrace- is sympathetically refurbished and retrofitted, i**t will emit less carbon by 2050 than a new building. But only if the embodied carbon emissions are counted.**
- **Retrofitting and refurbishing traditional homes also results in embodied carbon emissions**, however these are much smaller than those produced during a new build.

Nearly one third of the carbon emitted by a new building is embodied carbon



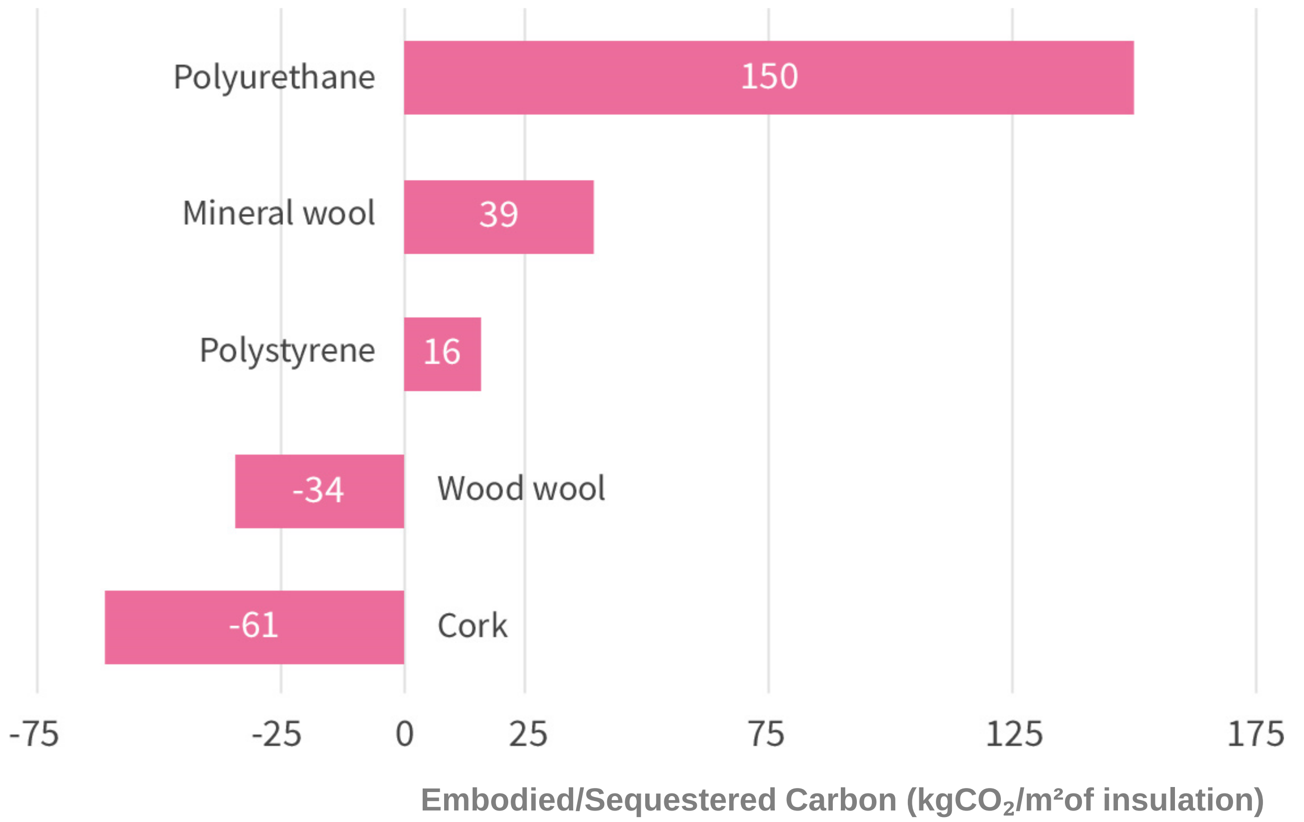
Sources: Historic England (2019) [39], Carrig (2021) [40]

Using materials with low embodied carbon to avoid emissions from retrofit

Properly fitted insulation can reduce in-use (operational) emissions, however different insulation materials have different amounts of embodied carbon.

Options such as mineral wool and polyurethane require large amounts of energy during their production, resulting in them having large embodied emissions.

Although the production process for wood, wool and cork insulation produces embodied emissions, the carbon that is effectively stored within the materials outweigh these and result in them being a net carbon store.[31]



Source: Greenspec (2021) [31]

Using natural and recycled materials to avoid emissions from retrofit

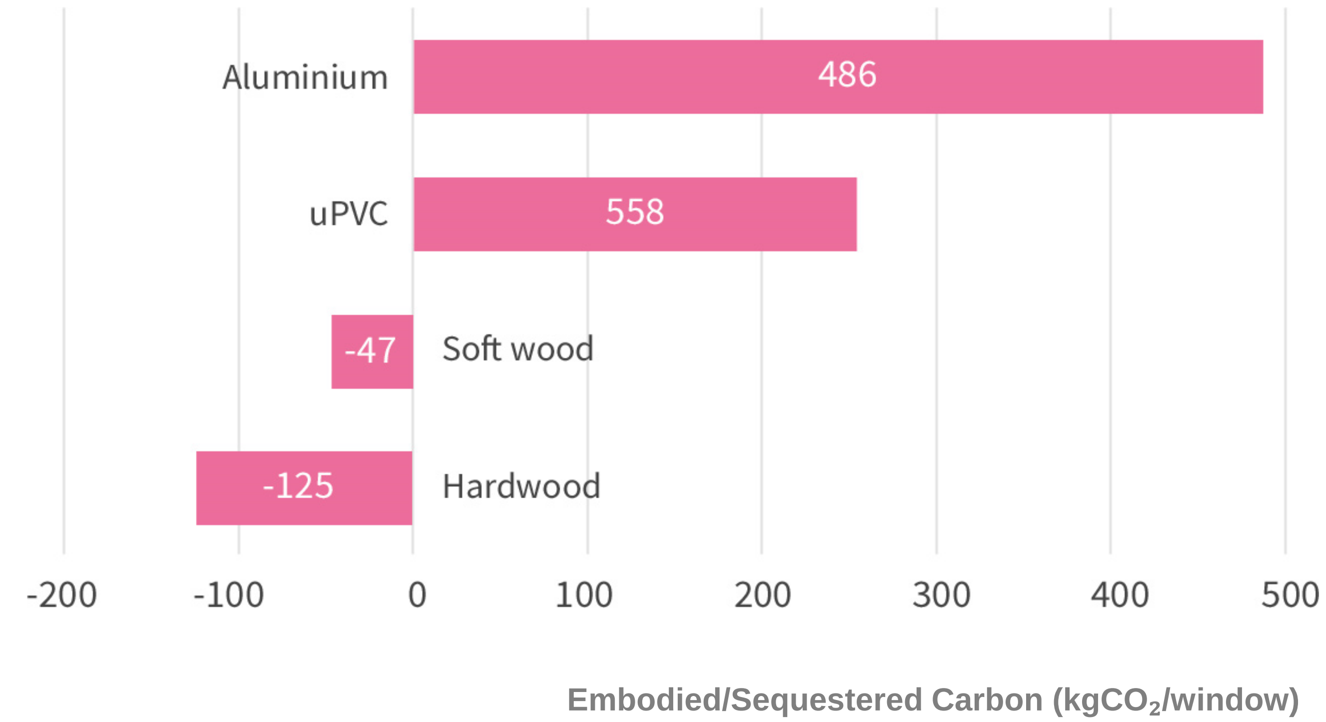
There are differences in the **embodied carbon of window materials**. Different types of timber store different amounts of carbon, with hardwoods tending to have the edge over softwoods. They are also more resistant to moisture so last longer.

Secondary glazing has embodied benefits because you are retaining the existing window and its materials as well as using less new material; this is particularly important when the window is framed in old high-quality timber that can have a long lifespan.[32]

There are embodied emissions associated with h**eating systems.** An air source heat pump has nearly five times the embodied carbon of a high efficiency boiler.[33]

Embodied carbon of heating systems [33]

- A-rated gas fired boiler = 330 $kgCO_{2e}$
- Air source heat pump (ASHP) = 1560 $kgCO_{2e}$
- Ground source heat pump (GSHP) = 3200-3900 $kgCO_{2e}$



Source: Sinha and Kutnar (2012) [32]

Reducing embodied carbon emissions to save natural resources

Embodied emissions and consumption: off-shoring our carbon footprint?

Many of the materials used to construct new building or used to retrofit existing building are imported to the UK. The UK has extensive mineral and stone resources, but we are increasingly importing building materials from aboard.

For example, in 2018, the UK imported approximately 130,000 tonnes of 'worked stone'; most of this (68%) was sourced from China and India.[30]

"Trade expansion over recent decades has allowed higher-income countries to 'off-shore' the adverse impacts of their consumption on ecosystems and biodiversity, through trade in commodities, goods and services with lower-income countries" (in Dasgupta, P. 2021).[6]

More than 50% of the biodiversity loss associated with consumption in developed economies is estimated to occur outside their territorial boundaries.

Wilting et al. 2017 in Dasgupta, P. 2021[6]

Not counting embodied carbon means we continue to place enormous pressures on our limited natural resources while underutilising and wasting the resources that have already been extracted from nature.

Did you know

The UK's net zero target is based on measured carbon emissions that occur within the UK's borders, known as **territorial emissions.** [34]

There are other measures that consider emissions resulting from our consumption – known as **consumption emissions.**[7] This measure of carbon emissions better covers the whole life carbon emissions from buildings (embodied emissions and operational emissions) as they include emissions produced during the making and transporting of imported construction and retrofit materials and components. **The UK's consumption emissions are substantially higher than our current territorial emissions.**[7]

We need more information about embodied carbon emissions

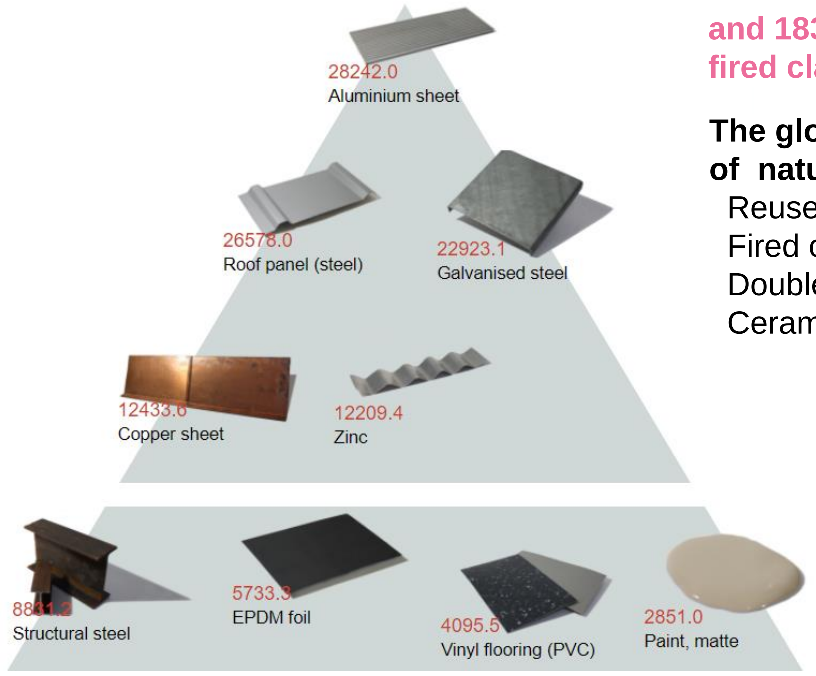
There is very little information freely available on the embodied carbon emissions of buildings and building materials. Yet, the evidence that does exist shows these emissions are a crucial part of the whole carbon footprint of buildings.

Industry professionals are leading the way.

Environmental Product Declarations (EPDs) is an international standard that a manufacturer can use to measure and reduce the environmental impact of its products and services. With an EPD, manufacturers can show the good, the bad and the evil about the environmental performance of their products and services. But very few manufacturers offer EPDs.

In late 2020, The Chartered Institution of Building Services Engineer (CIBSE) published step-by-step guidance for engineers and manufacturers on how to estimate embodied carbon of products. This is seen as an interim but much needed solution to the dearth of easily accessible embodied carbon emissions data, in the wait for good quality EPD data in the UK.[10]

In Denmark, academics at the Centre for Industrialised Architecture (CINARK) at the Royal Danish Academy have developed the construction material pyramid - an interactive tool that estimates part of the embodied footprint of different construction materials. The tool is based on data from Environmental Product Declarations (EPDs).[35]



A diagram to show the range of construction materials available and their embodied carbon value. Source: CINARK [35]

Recycled brick produces 108 times less embodied carbon then a fired clay brick and 183 times less than double fired clay brick:

The global warming potential of natural stone (kg CO2e/m3)

Reused brick =	4.9
Fired clay brick =	528.5
Double fired red brick =	898.2
Ceramic tiles =	1725.3

The embodied emissions created by retrofitting can be greater than the operational carbon emission savings in the short term

Using case studies of three different types of homes, Carrig Conservation International estimated the potential embodied emissions of different retrofit measures in comparison to new builds.[39–40] The research highlights the importance of considering embodied emissions when retrofitting existing buildings.

Case study: Retrofit of a small '1900s' mid-Terrace in Manchester

Cost: £36,000
Average annual Carbon Emission Savings: 1.2 tCO_2e
Embodied carbon emissions of the retrofit: 4.2tCO_{2e}

The retrofit achieved a **53% reduction in emissions.**

The embodied carbon of the work was more than three times greater than the operational carbon saving of the retrofit. It would take 3.5 years for the annual emission savings to cover the embodied carbon of the retrofit.

Energy efficiency measures taken:	Embodied Carbon created ($kgCO_{2e}$)
Internal Wall Insulation	802
Floor Insulation	2,372
Chimney Insulation	298
Low Energy Lighting	13
Mechanical Ventilation	413
Thermal Bridges	264
Heating (Boiler replacement)	42
Total	4,204
Additional Measures	
Windows (Triple glazed)	536
Radiators & piping	299
Roof/loft Insulation	293

Similar measures applied to different buildings

'1970s' Semi-detached
Savings: 1.1 tCO_2 (51% reduction)
Embodied Carbon: 2.55 tCO_2
Cost: £20,400

Victorian Terrace
Savings: 1.6 tCO_2 (62% reduction)
Embodied Carbon: 4.15 tCO_2
Cost: £26,250

The estimations are specific to each individual building and should not be considered definitive. However, they are indicative of the general types of traditional homes.

Repair and Maintain to Avoid New Carbon Emissions

Up and down the country we see traditional homes ranging from the Victorian terrace to grand stately homes, still in use and providing much needed homes for local populations. These homes have survived the test of time with some racking up 100, 500 or even 900 years since they were first constructed.

If we continue to repair, maintain and use these buildings, future generations will be able to benefit from them as we have done.

Florence Terrace, Ramsgate, Thanet, Kent
DP251262 © Historic England Archive

“A few sheets of lead put in time upon the roof, a few dead leaves swept in time out of a water-course, will save both roof and walls from ruin."

"Lamp of Memory" from the Seven Lamps of Architecture, by John Ruskin

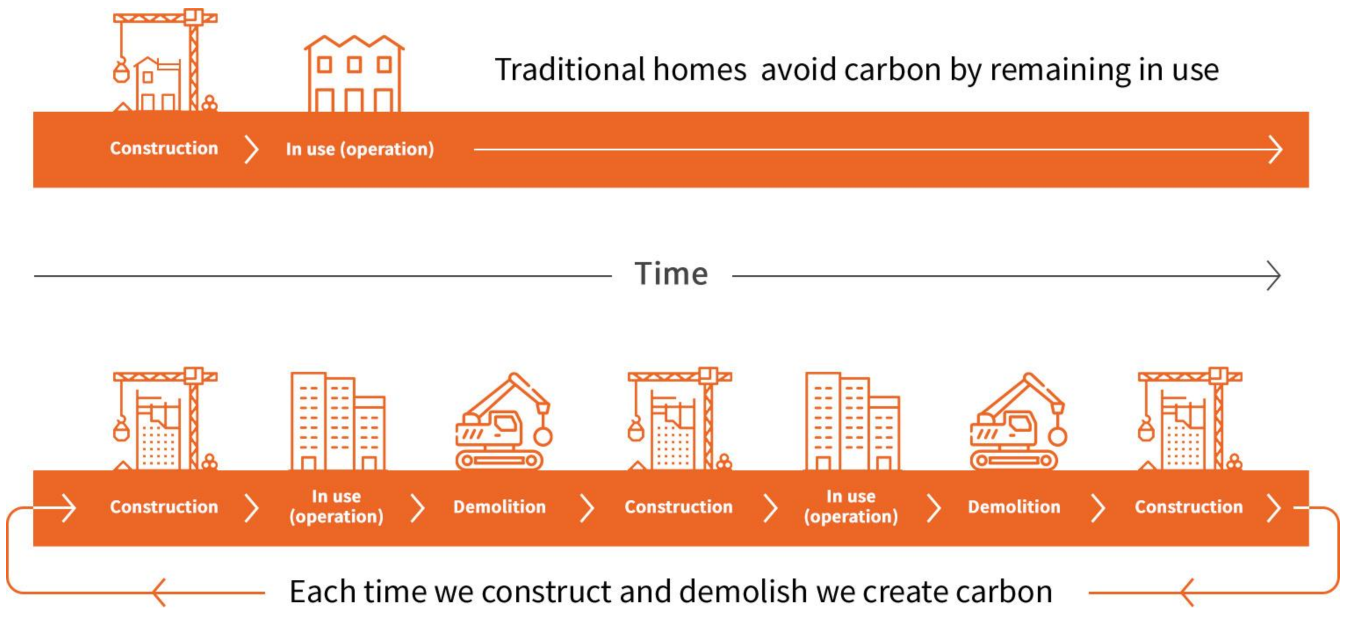
Repair and maintenance is an important part of an overall low carbon strategy

Traditionally constructed buildings are generally capable of lasting indefinitely with moderate amounts of regular maintenance.[36] Repair and maintenance increases the durability of buildings and components, and in turn avoids embodied carbon emissions over the life of homes. It also avoids carbon emissions by reducing the frequency of material or component replacement.

The correct and sympathetic repair of a traditional building will bring its technical performance back to the optimum level and also provide a sound basis for the development of proposals for further upgrading. Carrying out repairs can also provide many cost effective opportunities for improving thermal performance.[36]

Repair of decay using materials which match the originals as closely as possible, particularly in their technical characteristics, will greatly enhance both the performance and the durability of the building.[36] For example, cracked joints and voids in masonry allow liquid water to penetrate where sound mortar would once have effectively kept it out.

It is important that buildings are repaired before they undergo retrofit measures to increase the effectiveness of the retrofit and to reduce risks of failure.



Repair and maintain to avoid carbon, avoid costs and avoid disruption

Repair and maintenance can:

- **Prevent decay** damaging the building and it can lengthen the lifespans of buildings. This means buildings can function well while avoiding carbon emissions from the production and use of new products and materials.
- **Limit the need for major building works** and helps the building to perform in the way that was originally intended.
- **Minimise costs** as building defects are discovered while still small and easily fixed. Damp and significant draughts are more often the result of inadequate maintenance or ill considered changes, rather than original defects in the design and construction of the building.
- **Minimise disruption** to the building's owners and users.

Increasing the life of buildings and building components through repair and maintenance avoids carbon.

Case study: The Value of Maintenance - Delaying repair results in a significantly increased cost

Every five years, some church buildings are inspected by a qualified professional, considering the state of repair of the church building. Research commissioned by Historic England tracked and followed the progress of defects and repairs from the inspection reports of a sample of 30 churches with differing repair and maintenance regimes. The study concluded "it is *clear that the churches that carry out regular works have far less cost associated with delayed repair or increased number of defects.*" (**Historic England, 2019)**[37]

Estimated cost of repairing defects when first identified (total for a sample of churches)**: £6,950,000**

Estimated cost of repairing defects at a later date: £8,150,000

Cost of delayed repairs: ⇧ 17%

Knock on costs of delayed repairs* : ⇧ 26%

***** total including where one issue causes another defect elsewhere to the building

For more information see: Maintenance and Repair of Older Buildings

CHAPTER 6

Towards a Low Carbon Future

We must address carbon emissions over the whole life of buildings, otherwise we risk meeting our carbon targets without actually reducing carbon emissions and in the process lose the war against climate change.

3-5 Porchester Terrace, Bayswater, City of Westminster.
DP186443 © Historic England Archive

“The greatest threat to our planet is the belief that someone else will save it.”

Robert Swan, Polar Explorer and Environmentalist

Conclusion

Our homes, including traditional homes, are large carbon polluters and we urgently need to reduce carbon emissions from them.

This year's Heritage Counts demonstrates the incredible value of good custodianship as a means of reducing energy use and carbon emissions. By conserving heritage, we avoid new embodied carbon emissions; by maintaining our buildings in good repair we avoid waste and avoid new pressures on global natural resources; by adapting our heritage assets through well considered energy efficiency improvements we reduce carbon emissions.

Heritage Counts also highlights just how important each individual heritage custodian is. In the face our greatest societal challenge, climate change, the role of the heritage custodian is becoming ever more important in seeking out the most suitable opportunities available to reduce the carbon footprint of traditional homes.

From small changes in behaviours, to larger energy efficiency improvements, we can reduce the carbon footprint of our precious traditional homes while maintaining their historic significance. And we can all contribute to climate goals by making our homes more climate friendly.

Kelvin Grove, Gateshead
DP034498 © Historic England Archive

People are a vital part of our low carbon future.

Small changes to people's actions and low impact energy efficiency improvements can accumulate to make large differences to the carbon emissions from buildings with little impact on the fabric of the building and the heritage significance of the building. These actions and improvements can be made quickly, helping reduce carbon emissions from buildings in the short term, which is particularly important given the urgency of climate change and the need to **act now** to reduce carbon from buildings.

Small actions also give an owner or occupier the opportunity to better understand their homes and how they can interact in a low carbon way which is also a vital part of the transition back to a low carbon environment.

Repair and maintenance avoids waste and avoids carbon emissions.

Elongating the lives of existing buildings through repair and maintenance and conserving heritage assets avoids vast amounts of embodied carbon carbon. Repair and maintenance also means we use our existing assets more efficiently and productively while maximising the use of the products and materials we have already extracted from the natural world and providing people with (in this case) spaces to live. **Repair and maintenance should be a key feature of our low carbon reduction strategies for buildings.**

Retrofit done well can reduce carbon in traditional homes.

Carbon emission savings ranging between 54% to 84% can be achieved by implementing carefully considered retrofit measures and installing low carbon heating in traditional homes. Many traditional properties have the potential to reach 100% carbon savings by 2050, as progress to decarbonise the power sector further reduces homes' reliance on fossil fuels and reduces carbon emissions from all homes.

Retrofit done well and thoughtfully, taking a long-term perspective, can achieve the twin objectives of effectively reducing carbon while maintaining the heritage significance of traditional buildings. If not planned well however, retrofit does carry significant risks, not just to the heritage significance of the buildings, but to effective energy and carbon reduction and to the health of occupants. "*Fabric first may not always be the best solution, particularly in the context of a rapidly decarbonising electricity grid*".[17] **Rather than a 'fabric first' approach, effective retrofit requires a 'think first' approach that includes taking the time to properly look at the building, the people and the way the home is used.**

Retrofit can reduce carbon in the long term but creates significant amounts of carbon emissions in the short term.

Demolition, building new and replacing building components creates **embodied emissions** and adds pressure on our natural resources. The research shows that the embodied carbon emissions created by retrofit are greater than the operational (in-use) carbon savings of retrofit in the very short term. By reducing the quantity of materials used; by reusing and recycling existing materials where possible and by using low carbon emitting materials we can reduce the overall carbon emissions from buildings and reduce the carbon emissions from retrofit. **These are currently undervalued solutions to the carbon emission reduction strategies for buildings.**

Move to low carbon retrofit.

Greater volumes of improved information is still needed to understand the embodied carbon emissions of retrofit, including the carbon emissions from products and materials, such as through Environmental Product Declarations (EPDs). In the same way that food labelling has helped inform consumers choices for food products, an ambitious programme of high quality, well labelled EPDs or equivalent **could result in informed owners and occupiers empowered to make low carbon and climate friendly choices for their buildings and for their retrofits.**

Retrofit is costly and costs are often understated.

The government has made various commitments to date to reduce carbon emissions from buildings, but acknowledges costs of retrofit are a real challenge to our low carbon future. Solutions to this challenge are still needed.

"...*the scale of change required to mobilise the economy to achieve net-zero is unprecedented but possible, provided immediate, sustained and decisive action is taken."* [17]

The research reported here indicates that there is up to a 95% uplift on the stated cost of retrofit and estimates that the annual cost of retrofitting three-quarters of pre-1919 housing would be in the region of £6.4 billion up to 2050. This reduces to £4.9 billion per year when considering only the cost of the retrofit measures and enabling works (inclusive of 20% VAT) and to £4.2 billion per year when removing VAT.

We can take action now by changing behaviours, repairing and maintaining, taking small and simple retrofit measures and staged low carbon retrofits to address the challenges of climate change, while high impact, longer term solutions to the challenge of financing large scale retrofits are developed.

"Humanity's future will be shaped by the portfolio of assets we inherit and choose to pass on, and by the balance we strike between the portfolio and the size of our population.

"Assets are durable objects, producing streams of services. Their durability enables us to save them for our own future, offer them as gifts to others, exchange them for other goods and services, and bequeath them to our children."

Dasgupta, P. 2021 [6]

Useful Information and Resources

Bournville, Birmingham.
DP110941 © Historic England Archive

Glossary

Climate change

The Earth’s natural climate has historically been in a continued state of change, with naturally occurring greenhouse gases (GHGs) essential to our existence. However, human activities have directly increased these levels and, as a result, human produced GHGs are the leading cause of the earth’s now rapidly changing climate.

Carbon emissions

The most common greenhouse gas is carbon dioxide (CO_2), sometimes referred to as ‘carbon’. The other GHGs also have a warming effect on the earth’s atmosphere, but their potency differs from CO_2. In order to calculate the total effect of the gases, each is converted into values that are equivalent to carbon dioxide (CO_{2e}) which are then added together .

Retrofit

Retrofit is the process of improving the energy and environmental performance of buildings through technical interventions. Good retrofit considers the unique properties of a building including the building characteristics, building services but also very importantly – the people.

Decarbonising the power sector

Decarbonising the power sector or ‘the grid’ means reducing the emissions per unit of generated electricity. The power sector has been a major success story, with carbon emissions falling by 67% between 2008 and 2019 – the biggest reduction of all sectors in the UK. This has been achieved by reducing our reliance on coal-fired power, increasing the use of renewables – such as wind turbines – and biomass utilisation.

Renewable and low carbon energy sources

Different energy sources produce different amounts of GHG emissions. During the last decade, renewable and low carbon energy sources such as wind, solar and biomass have successfully replaced traditional fossil fuels like coal, gas and oil.

Sequestered carbon

Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide and will likely play a key role in helping meet net zero targets. Natural forms of carbon storage include forests, which store carbon in their timber and within the soil.

Net carbon

Balancing carbon dioxide emissions against capturing or eliminating existing atmospheric carbon dioxide is key to achieving carbon neutrality. It requires a rapid reduction in carbon emissions and, where zero carbon emissions cannot be achieved, the remaining carbon should be offset.

Thermal performance

In terms of a building, this refers to the efficiency in which it retains, or prevents the passage of heat. Materials with a good thermal performance do not readily transmit heat.

Comfort Creep

In terms of buildings, comfort creep refers to how, over time, we become used to gradual changes in the temperature (and other areas).

Embodied carbon

This refers to the lifecycle emission of CO_{2e} produced during the manufacture and transportation of materials, the construction process and the end-of-life aspects of a building.

Operational carbon

These are carbon emissions produced during the operational or in-use phase of a building, such as through heating and lighting.

Environmental Product Declarations (EPD)

An EPD is a document which transparently communicates the environmental performance or impact of any product or material over its lifetime. Within the construction industry, EPDs support carbon emission reduction by making it possible to compare the impacts of different materials and products in order to select the most sustainable option. An EPD is usually valid for five years, and is generated according to the relevant standards. Construction EPDs are based on the ISO 14040/14044, ISO 14025, EN 15804 or ISO 21930 standards.

Oriel Terrace, Weston-Super-Mare, North Somerset
DP218739 © Historic England Archive

The basis of the evidence

Energy-saving retrofit opportunities for pre-1919 homes

Parity Projects' research explored the potential for reducing energy use in traditional dwellings. The evidence uses existing energy performance certificate (EPC) data and a top-down method for estimating the performance of existing buildings. This included baseline calculations on the energy performance of eight "typical" traditional building examples, ranging from small solid wall middle and end terrace properties, through to a large detached, listed building with timber-framed walls.

The data includes estimates on the costs and emission savings of each individual measure, using Parity's own calculations.

Carbon reduction scenarios in the build historic environment

The University of West England (UWE) were commissioned to evaluate the opportunities for England's pre-1919 buildings to contribute to reducing emissions in the built environment. The research developed five archetypes that best represented the diverse nature of the pre-1919 domestic housing stock in England. Retrofit strategies were designed for each archetype, considering appropriate energy efficiency and low carbon heating measures that reduce CO_2 emissions.

Using realistic costs and rates of deployment up to 2050, the total emission savings from rolling out the measures to approximately 3.2 million traditional homes were then estimated.

Useful resources

Further information on energy efficiency measures guidance and advice on maintenance and repair can be found on the Historic England website.

- Making Changes to Your Property
- Energy Efficiency and Historic Buildings (Directory)
- Energy Efficiency and Traditional Homes
- Energy Efficiency and Historic Buildings: How to Improve Energy Efficiency
- Maintenance and Repair of Older Buildings
- Buildings Must Be Recycled and Reused to Help Tackle Climate Change
- Planning Responsible Retrofit of Traditional Buildings
- Historic England's Practical Guidance on Energy Efficiency

:

- Energy Performance Regulations
- Windows and Doors in Historic Buildings
- Insulating Roofs in Historic Buildings
- Insulating Walls in Historic Buildings
- The Value of Maintenance?
- The Planning System
- National Heritage List for England
- Statements of Heritage Significance: Analysing Significance in Heritage Assets

Further information on planning can be found here.

Building Regulations: Insulation and thermal elements
Planning Permission: Doors and Windows

Other useful resources include:

Maintenance Calendar
Energy performance certificates explained

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