Low-carbon retrofitting
Taking a whole-house approach ...

We all want to live in a home that’s warm and healthy for our family. Somewhere comfortable throughout the year, that uses less energy to heat, and has less impact on the environment for future generations.

Achieving this in older homes is more complex than in newer homes, as measures such as standard loft and cavity wall insulation might not be possible. To make the best choices for your home and get better results for your money, it’s important to understand your home first before you start making decisions.

Why assess the whole house?

A home is comprised of many elements, including: how it was built, how it has been adapted, what materials have been employed and how the building is currently being used. The ways in which these elements are connected and how any new measures may impact them needs to be considered in a comprehensive and logical way. Buildings function as a whole structure, sensitive to changes that happen within them, so planning measures in isolation rather than as part of a joined-up process risks incurring unforeseen and possibly undesirable outcomes.

This factsheet is intended to help you decide on which measures to choose when retrofitting your home and work out the best approach to take, including common issues you should consider. This is relevant for people who want to install only one measure, or for those who are considering refurbishing their whole house.

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Choosing an order

You may have heard lots about solid wall insulation and want to apply it to your house, or maybe you would like solar panels and the free electricity they provide. By considering the whole house, you can determine if these are the best options or if another measure may be more suitable or may provide the comfortable temperature you need at a lower cost.

The five sections below should help you work through which measures you should start with.

1 Maintenance first
2 Reduce risk
3 Order of measures
4 Energy hierarchy
5 Heritage impact

1 Maintenance first

Simply maintaining your home is the main way you can increase both your own comfort and the fuel efficiency of the building, as it allows the building to work as effectively as possible. For instance, rotten windows will be letting draughts in and heat out, whilst cracks in the guttering or render may contribute to damp, which in turn makes a home harder to heat to a comfortable temperature.

Maintenance makes your home ‘retrofit ready’ and should be done before undertaking larger measures.

It’s worth remembering that regular maintenance can offer opportunities to think about energy efficiency. For instance, if wooden window frames need repairing or replacing, you could consider installing shutters or sash double-glazing at the same time. Carrying out maintenance can also be a chance to think about the alterations that have been made to your home over the years, and to examine whether any might now be considered ‘detrimental’. There might be opportunities to ‘make good’ again through more sensitive refurbishment, which perhaps restores part of the building’s original appearance or uses more sensitive materials for the age and construction of the building. For instance, if the external render is cracked, you could consider replacing a concrete render with a lime-based render, which returns the home to a more ‘breathable’ system. You could also consider combining this with a breathable external wall insulation like wood fibre board, to increase the thermal performance of the walls.

2 Cost and risk

When you are considering different energy efficiency measures, you should think about any risk they could pose which might negatively affect the building. The risk is higher in older traditional construction homes because they were originally designed to be lived in very different to how we tend to use them now, so actions that we take will have a more significant impact on the building than with more modern homes.

Our factsheets on each measure explore the associated risks in more detail – but in general, the more complicated the measure the more you need to think about designing out any risk. Most measures will have an impact on the ‘common considerations’ listed later, and if you don’t think about them in advance they may cause issues further down the line. If you plan how to negate these potential issues then you will have reduced the risk, and are less likely to experience problems, whether that is trapping moisture in walls or causing condensation due to a lack of controlled ventilation.
A good approach is to start with installing lower risk measures, such as draught-proofing, before considering higher risk measures, such as solid wall insulation. A benefit of this is that lower-risk measures are usually cheaper to install, meaning less financial risk too, and are usually easier to reverse if needed. One option is to install a low-risk measure, see if it improves your comfort and the cost of your bills to the level you want, and if not you can then consider the next measure.

Of course it is not always as straight forward as this, especially if you are planning a larger scale retrofit programme or if in practice the measures should be done in a certain order, but it is a good principle to follow.

3 Impact of measures on each other

You should not think about measures in isolation, so if you have decided there are several measures you want to install then you need to decide the order to do them in. Sometimes it might not make much difference, but in some instances there might be a logical order.

You need to think about whether installing one measure will make another harder to do, or will undo some of the work involved. One example is external wall insulation and replacing the windows. If you want to do both, you should do the windows first. If you do the external wall insulation first, there’s a risk it will be damaged when the old windows are taken out and replaced. Similarly, if you’re considering a new heating system and significant new insulation measures, do the latter first. Otherwise you risk installing an over-powered heating system before the heat requirements of the house drops due to the new insulation.

The other situation where measures impact each other is when two or more measures are more cost effective when installed together, as costs will be shared across the measures. For example, scaffolding is expensive to erect and if you have some for solid wall insulation then you could think about solar panels at the same time.

4 Energy hierarchy

When trying to achieve sustainable energy objectives, we recommend using the ‘energy hierarchy’, which ranks the stages on the way to using less energy in the home – sometimes referred to by the motto ‘educate, insulate, generate’.

It starts with reducing the need for energy in the home (energy conservation) by looking at how you use your home and the appliances within it. Examples include simple things like closing curtains to retain heat, using the heating controls efficiently, or running the washing machine on a low temperature. Many small actions around the home can make a significant impact on your annual fuel bill. Regular maintenance fits in here too. (For more, see our ‘Tips for lower energy bills’ factsheet.)

The next stage is installing types of energy efficiency measures. As discussed so far, there are different ways to approach this, rather than going straight for the measures you think will cut energy use the most.

The final stage in this hierarchy is installing renewable energy measures. By reducing energy demand through the first two stages, you should have cut down on how much energy you use and therefore need to produce. This means the size of energy system you require to meet your needs may be smaller and cheaper than had you installed it without considering the other two factors.

It will not be as clear-cut as this in real life, but the energy hierarchy should still be regarded as an integral element of the ‘whole house’ approach, as it can help you decide which measures to prioritise.
5 Heritage value

Where a building is considered to have historic significance (whether through its design, location or previous occupants) the dwelling may then be protected through classification. This can restrict what you are able to do, and you will need to apply for Listed Building Consent if you want to make any changes.

The table below gives an indication of when you might need consent, but it could vary by local authority. If you are unsure, it is always best to check with your council’s planning department.

Planning Officers will base their decisions on various local policies and plans, and these decisions can vary significantly between different local authorities. This is another reason why it is a good idea to discuss your plans with a planning officer before applying for consent. Where there is ambiguity over whether a measure is suitable for a building, there may be options to reduce its impact by implementing the measures in a particular way or by carefully choosing an alternative mix of measures or materials.

Even if work to your home is not restricted you might want to think about the impact of measures on the heritage value of your home, and how to reduce this. One way to do so is consider whether the measure is reversible, should that become necessary in the future. Examples include installing window shutters or laying loft insulation.

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<thead>
<tr>
<th>Consent needed for internal work</th>
<th>Consent needed for external work</th>
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<tr>
<td>Listed buildings (Grades I and II)</td>
<td>✔️</td>
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<tr>
<td>Conservation area</td>
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<td>World Heritage Site</td>
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<tr>
<td>Area of outstanding natural beauty</td>
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<td>In a Schedule of Monuments</td>
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<td>Undesignated heritage buildings</td>
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Common considerations

When retrofitting traditional construction homes you will need to think about the **five considerations** listed below, which are very much interrelated. The following sections summarise the key reasons why the sustainable refurbishment of traditional homes can create unique challenges which require informed solutions. Professionals can help with the finer details, but it is worth being aware of them yourself.

1. **Moisture**

The management of moisture, or water vapour, is integral to maintaining a healthy home, and understanding where moisture comes from is the starting point of being able to manage it. Most moisture is produced by the buildings’ occupants through a range of activities, including breathing! Cooking and bathing, though, are the key contributors to the amount of moisture in the air, and generally these are confined to kitchens and bathrooms, which are called ‘high moisture’ areas. Appropriate ventilation is needed to remove the moist air because any moisture that stays within the home is attracted to cold spots in the building, condensing to become water and risking damp and condensation issues.

There are different approaches to managing moisture depending on the age and build type of your home. For example, most homes built before 1920 are likely to be of traditional construction, whereas any built after 1945 are likely to be modern construction. Traditional construction properties are built with materials that are better able to buffer moisture vapour, and they tend to be well ventilated through open fires and poorly fitting sash or metal framed windows. In contrast, modern buildings are generally built to keep moisture out – through, for example, the use of a damp-proof course – have less draughty windows and doors, and instead employ mechanical ventilation (e.g. fans) to extract moisture laden air.

Over time we’ve improved our homes, installing additional measures such as insulation or double-glazing, which affect the way these buildings work and manage the moisture we create. When planning future improvements it is important to understand the impact on moisture movement of any previous measures (including mitigating measures that have been taken) and any future measures. It means ventilation and building materials need to be thought about carefully, because if a building cannot work as designed, or has had no mitigating measures included, then damp or condensation problems could occur.

2. **Ventilation**

Ventilation can be thought about in terms of airtightness. Low airtightness means a lot of uncontrolled (passive) ventilation occurs, through things like draughts around windows, chimneys and floors. In a more airtight building this is minimised, and instead ventilation needs to be consciously thought about, such as using extractor fans.

Traditional construction homes were not designed to be airtight, partly because a home with open fires needs good ventilation. It wasn’t really until the 1990s that rising fuel costs and concern over fossil fuel emissions resulted in improved airtightness.
in concerted efforts to conserve fuel and heat, mainly through improved insulation. Most energy efficiency measures will improve airtightness, thereby impacting the movement of moisture, meaning that appropriate ventilation needs to be considered. The more airtightness is increased, the more important ventilation becomes. This might be through any ‘breathable’ materials you chose, but should usually include mechanical extractor fans as well, as a more reliable way of ensuring adequate ventilation.

If you are considering undertaking a very deep retrofit, by stripping the house back to the basic structure before improving its thermal performance, it may be worth considering a mechanical ventilation heat recovery system (MVHR). These are a system of ducts connected to a heat exchanger and air intake and outlet. Moist air from kitchens and bathrooms is extracted, but before being expelled outside the heat contained in that air is extracted through the heat exchanger, which then helps to warm fresh incoming air that is ducted to living rooms and bedrooms.

3 Materials

In broad terms, traditional materials are ‘breathable’ while modern materials are not. Modern materials are designed to prevent any movement of moisture, while traditional materials are ‘moisture-open’. Materials can be moisture-open in different ways; for example, by allowing water vapour to pass through them, or by absorbing the moisture and releasing it again when the humidity drops in the surrounding air.

In well maintained buildings, moisture-open materials can be an energy efficient system to use, as they provide both insulation and a comfortable internal environment (e.g. helping to balance humidity), whilst also causing less risk to the building fabric than moisture-closed materials. The very fact that our stock of traditional homes has lasted so long visibly demonstrates this.

However, while traditional homes were designed to be moisture-open, over time alterations may have included moisture-closed materials – such as replacing lime render with concrete render or waterproof paint. Moisture-open and closed materials can be used alongside each other, but the impact on moisture movement needs to be considered. For example, some external wall insulation products are designed to keep moisture out of the building but can have the unforeseen consequence of trapping moisture created inside the building within its solid walls (as moisture can no longer escape through the wall but there is not enough additional ventilation), meaning you can then develop issues with damp. Breathable external insulation products do exist, but you can look at the careful enhancement of mechanical ventilation within the building instead.

This means that when choosing the material for each measure it needs to be carefully tailored to the context of each individual building. When the balance of moisture movement is upset in some way, moisture can be retained in materials for longer periods than intended, and can cause permanent damage to the building fabric.

4 Damp

The main sign of unbalanced moisture movement is damp, and there are various forms of damp you might find.

- Condensation tends to be the most common: this is when moisture produced in the home condenses to become water on contact with cold surfaces and over time creates an environment for black mould to grow. You usually find this on the visible surface of materials, such as a wall or window.

Moisture will condense to water on contact with cold surfaces, and can cause condensation damp.
• Rising damp is caused by ground water rising up through the structure of a property, often resulting in crumbling bricks and the presence of salt crystals near the ground on internal walls. It can also lead to wet rot on wood joists and internal joinery items.

• Penetrating damp happens when moisture comes from the outside: it might be caused by a broken gutter or leaking overflow pipe causing the wall to remain saturated for long periods of time, or rain might penetrate through faults like cracks in the wall or damaged bricks. Properties with an exposed southwest facing wall are most at risk from penetrating damp due to the prevailing wind.

Issues with penetrating damp can usually be corrected with appropriate maintenance, whereas rising damp (if correctly identified as such) requires the plaster and rotten wood to be removed and the injection or insertion of a damp proof course, all before reapplying finishing materials. Often what is considered rising or penetrating damp may actually be condensation, which can be caused by cold spots on walls due to poorly installed insulation or inappropriate use of other materials. For instance, repairing a traditional lime render with cement can create unintended cold spots where moisture forms damp patches of condensation.

Once correctly identified, condensation can normally be rectified through appropriate interventions - some cheap and easy, but others more invasive and costly. For instance, when an old home is made more open plan it can result in warm moist air from the kitchen condensing on the high ceilings of floors above. Several simple measures can rectify this issue – installing an extractor fan, if possible have a curtain over the stairway to help contain the moisture, and ensure the loft is evenly insulated (even a very small space of uninsulated wall or ceiling can be the cause of water condensing on the surface). This is why you need to think about the whole house, and how moisture moves around the building, in conjunction with how you use the house.

Another form of condensation damage is from ‘interstitial’ condensation: this can happen when a change in the built structure (such as the addition of internal wall insulation) affects the temperature of different materials, causing moisture to build up within the wall, rather than on or near its outside surface. The danger with interstitial condensation is that it’s not noticable until the damage it causes is visible. Solutions involve making sure the new measure is appropriate and is correctly specified, and that there is sufficient ventilation to ensure that moisture does not become trapped in the wall. If there is a risk of interstitial condensation, make sure moisture can escape in at least one direction, meaning not having a moisture-closed material on one side.

5 Cold bridging

A cold, or thermal, bridge is caused when a material within the building structure transfers heat at a significantly higher rate than the material(s) surrounding it. Some, such as metal, transfer heat quickly, meaning they have a low ‘thermal capacity’ compared to others, such as wood.

Top: cold bridging around a window. Below: missing insulation and cold bridging around a roof light.
Images used with permission from the the CHEESE Project, www.cheeseproject.co.uk
which retains heat better. If these materials are next to each other the difference in thermal capacity has a negative effect on the one with a lower thermal capacity as the heat flow is increased through this cold bridge.

The problem with cold bridges is both that they let heat out, and that they create a cold spot which risks condensation forming. A cold bridge is usually a small surface area, but the amount of heat lost is entirely disproportionate to this, potentially up to 30% of a building’s heat loss. Imagine it like a breech in a dammed river, with a high volume of water passing through. Cold bridging cannot be eliminated entirely, but the time and expense spent on detailing these areas correctly is cost effective compared to dealing with the potential serious consequences.

When considering solutions to cold bridging, it’s worth remembering that the more you insulate the surrounding wall area, the higher proportion of heat is lost through the cold bridge rather than through the wall surface. It is therefore preferable to have less insulation and get the cold bridge areas correct, and in fact you lose less heat doing this than having thick insulation and poor cold bridges.

For example, the internal and external reveals of windows and doors tend to be tricky places to insulate, due to depth of the frame, but it is still best to add a thin layer of insulation around the reveal itself (for external wall insulation this may involve removing some render first). Whilst this will not stop the heat loss from this area, it will slow it down and reduce the risk of moisture condensing on the cooler surfaces and thus minimise the risks from condensation. In summary, coverage can be more important than depth of insulation.