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OUSE VALLEY ENERGY SERVICES COMPANY

Low-carbon retrofitting

Taking a whole-house approach ...

Retrofit refers to any improvement work on an existing home or building to improve its energy efficiency, making it easier to heat, able to retain that heat for longer, and replacing fossil fuels with renewable energy.

The benefits of retrofit

Retrofitting homes and buildings is one of the biggest challenges the UK faces in our efforts to reach net zero. Many homes aren't built for purpose, in fact the UK has some of the oldest and worst housing stock in Europe and 40% of UK emissions comes from homes.

Heat is constantly leaking out through windows, doors, and uninsulated walls, making our heating systems work harder for more money and less warmth. We're paying for wasted energy.

While any home can benefit from retrofitting, older homes usually have more problems. Common issues include damp, condensation, draughts and a lack of insulation that makes them harder to heat.

If we retrofitted the majority of homes across the UK, it would make a huge difference in reducing our collective carbon footprint.

Making homes more self-sufficient, through energy-efficiency measures like insulation and renewable energy, helps to protect against rising energy costs.

Where do I start?

Retrofit work is most successful when a 'whole-house approach' to identifying the most impactful and cost-effective measures is taken. This will help you make the best choices for your home and get better results for your money. It also means avoiding problems which can occur if we look at measures in isolation.

We can help you decide the best measures to choose when retrofitting your home and work out the best

approach to take, including common issues you should consider. It's relevant if you want to install only one measure, or if you're considering refurbishing your whole house.

The first step is to understand your home ...

A home is made up of many elements, including how it was built, how it has been adapted, what materials were used and how the building is currently being used now.

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 setting off a unintended chain reaction costing you more money – or not improving energy efficiency in the long run.

In which order should I retrofit?

Maybe you've heard loads about solid wall insulation and want to apply it to your house, or you want to save on energy bills by installing solar panels...

By considering the whole house, you can determine if these are the best options or if another energy efficiency measure may be more suitable.

These five themes will help you work through the best approach.

1 Maintenance first

Simply maintaining your home is the main way you can increase both your own comfort and the energy efficiency of the building, because this 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.

Regular maintenance gives you opportunities to think about energy efficiency. If wooden window frames need repairing or replacing, you could consider installing shutters or 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 of them might now be 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.

2 Cost and risk

Think about any risk new measures could pose which might negatively affect the building. The risk is higher in older, traditional construction, homes because how they were originally designed to be lived in is very different to how we tend to use them now.

Our information on individual energy efficiency measures (below) 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, and if you don't think about them in advance, they may cause issues further down the line. But if you plan how to minimise these potential issues you'll be less likely to experience problems. 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. Lower-risk measures are usually cheaper to install 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.

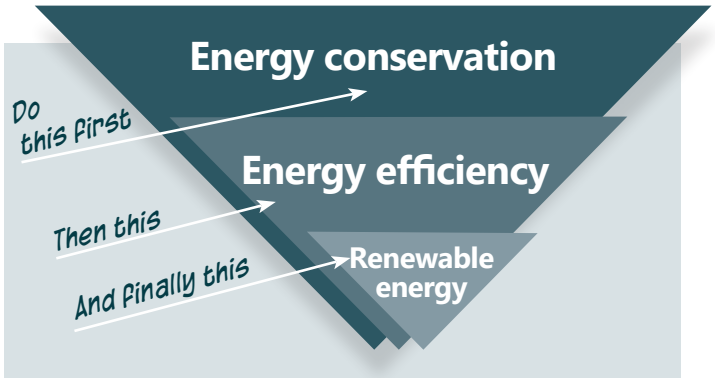
3 Mutual impact

You should not think about measures in isolation. If you've got several measures you want to install, you need to decide on a logical order to do them in. Sometimes it might not make much difference, but in some cases it may.

You need to think about whether installing one measure will make another harder 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, your heating system that was sized for an uninsulated property is likely to be over-sized once your insulation measures have been installed.

The other situation where measures impact each other is when two or more measures are more cost effective when installed together. 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.

Should the windows have been replaced before the external wall insulation was fitted?



4 Energy hierarchy

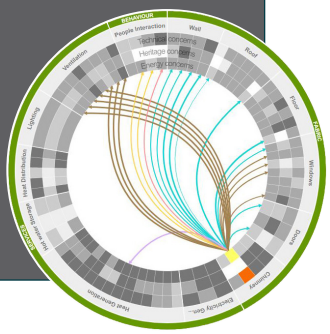
When undertaking a low-carbon retrofit of your home, we we recommend using the 'energy hierarchy' as a way of deciding which measures to prioritise.

The energy hierarchy starts with reducing the need for energy 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.

The next stage is installing types of energy efficiency measures, keeping in mind the stages and approaches we've covered so far.

The final stage 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 if you'd installed it without considering the other two factors.

A useful tool to refer to at the planning stage is the Responsible Retrofit Guidance Wheel designed by the Sustainable Traditional Buildings Alliance (**www.responsible-retrofit.org/wheel**). This allows you to input your building's key characteristics and then select the different works you are planning to do. The guidance will list any technical, heritage or energy concerns you need to think about, as well as other related measures you might want to consider installing at the same time.



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.

	Consent needed for internal work	Consent needed for external work
Listed buildings (Grades I and II)	✓	✓
Conservation area	×	✓
World Heritage Site	×	✓
Area of outstanding natural beauty	×	✓
Schedule of Monuments	✓	✓
Undesignated heritage buildings	×	×

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What do I need to consider when retrofitting my home?

There's obviously loads to think about when planning home retrofit. If you've got a traditional construction home, there are five particularly important considerations which are interrelated. 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 avoiding damp and mould problems. Understanding where moisture comes from is the starting point. Most moisture is produced by living in the building and a range of activities. Cooking and bathing are the key contributors, 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 where it condenses to become water and risks causing damp.

Most moisture is produced in the kitchen and bathroom.

There are different approaches to managing moisture depending on the age and build 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 'conventional' or 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. Most energy efficiency measures will improve airtightness, impacting the movement of moisture, which means appropriate ventilation needs to be considered. The more airtightness is increased, the more important ventilation becomes.

Properties with increased levels of airtightness need planned ventilation that should be provided by mechanical ventilation systems. The most common mechanical

Mechanical extractor fans help ensure adequate ventilation.

ventilation systems pull fresh air into the property through background vents and expel moist and polluted internal air out of the property through extract fans.

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 an air intake and outlet. Moist air from kitchens and bathrooms is removed, 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.

3 Materials

In broad terms, traditional buildings and 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 cement or the use of impermeable paint. Moisture-open and closed materials can be used alongside each other, but the impact on moisture movement needs to be carefully considered.

For example, some internal wall insulation products are moisture-closed but this can lead to a build-up of moisture trapped behind the insulation as the wall is colder than it was before it was insulated and takes longer to dry out.

Breathable/Vapour permeable insulation products are recommended to be used with traditional building materials such as solid brick or stone. However, if non-breathable insulation products have already been installed, issues with condensation may be resolved by mechanical ventilation, though this won't help any damp from outside. If problems persist, it may be best to remove the non-breathable building elements before it causes further damage to the original, traditional structure.

Choosing the material for each measure 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.ww

Sheep's wool insulation is an increasingly popular insulation material and can be an excellent choice in the right situations.

4 Damp

The main sign of unbalanced moisture movement is damp, which comes in various forms:

- **Condensation** tends to be the most common; this is when moisture produced in the home condenses to become water on contact with cold surfaces. Over time, this creates an environment for black mould to grow. You usually find this on walls or windows.

- **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, but rising damp may require the plaster and any rotten wood to be removed and the injection or insertion of a damp proof course.

Some treatments for rising damp may make the problem worse, such as tanking a wall with cement render rather than using lime plaster which moisture can pass through and evaporate. A wet wall should be left to thoroughly dry before plastering, even with lime. 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. It is typically caused by a combination of three factors: underheating, a lack of insulation creating cold surfaces, and a lack of extract ventilation to remove moisture. Some interventions are cheap and easy, but others more invasive and costly.

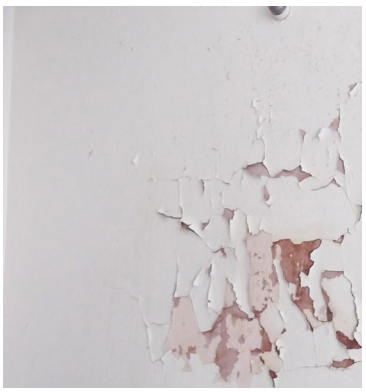
An example is when an old home is made more open plan, warm moist air from the kitchen can condense on the ceilings of floors above. The most important measures are ensuring you have an extractor fan in your kitchen (as well as your bathrooms and utility room) and having adequate continuous insulation in your loft (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.

Interstitial condensation is another danger and occurs when water vapour condenses within the building structure, risking a build-up of moisture which could lead to mould growth and damage elements within the structure itself, particularly timbers such as joists and lintels. It is a particular risk with internal wall insulation as the original wall becomes much colder, making condensation more likely which can then become trapped.

This is why detailing and material choice are critical for internal wall insulation. Ensuring airtightness on the warm side of the insulation is critical regardless of the material, and if using moisture-closed materials it is advised to have a vented cavity to the outside. If the original wall is moisture-open, however, it is advised to use moisture-open insulation to allow moisture movement through the entire wall and reduce the risk of interstitial condensation.

(Left): Moisture will condense to water on contact with cold surfaces, and can cause condensation damp. (Right) Peeling paint is generally a sign of penetrating damp.



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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 high level of 'thermal conductivity' compared to others. Wood fibre board, on the other hand, has a low thermal conductivity and therefore transfers heat more slowly. If wood fibre board insulation is attached to a wall with metal screws, heat will flow more quickly through the metal, making the screws an example of a cold or thermal bridge.

Imagine it like a breech in a dammed river, with a high volume of water passing through the breech. 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 potentially serious consequences.

The problem with cold bridges is two-fold. The first is that they let out more heat than the surrounding building fabric, reducing your property's thermal energy efficiency. The second is that they create cold spots, which increases the risk of condensation forming.

A cold bridge is usually a small surface area compared to the whole building, but as you increase the insulation levels in a property, cold bridges make up a higher percentage of total heat loss. Some buildings that have had wall, roof, and floor insulation installed have been seen to lose 30% of their total heat through cold bridges. However, this is only in extreme cases where care has not been taken to minimise thermal bridging.

When considering solutions to cold bridging, remember that the more you insulate the surrounding wall area, the higher the proportion of total heat loss is lost through the cold bridges. So it's usually better to have less insulation everywhere and get the cold bridge areas correct rather than a lot of insulation in some places and none in others, because you are likely to lose less heat by doing this and will also reduce the risk of condensation and mould forming on the cold spots.

An example might be the internal and external reveals of windows and doors. These 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, continuity of insulation can be more important than its depth.

Top: cold bridging around a window. Below: missing insulation and cold bridging around a roof light.

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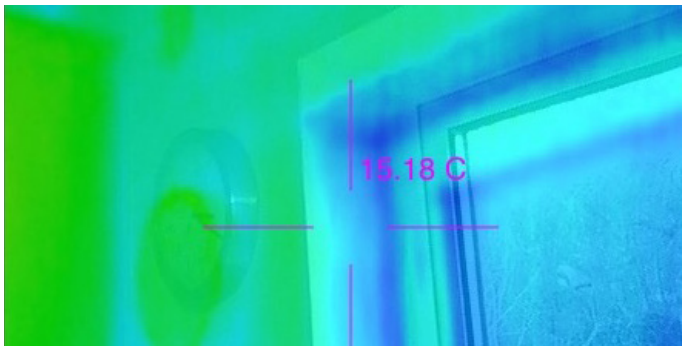

Ovesco is a Community Interest Company working towards net zero by developing community owned renewables.

For more information, visit www.ovesco.co.uk

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