Retrofit 101

Make your home energy efficient

Energy prices are rising and burning fossil fuels to warm our homes contributes to global warming, so reducing the energy needed to warm homes is a win-win. ‘Retrofit’ has a general meaning but also a specific meaning - modifying buildings to reduce energy needs.

Global warming may mean that long spells of hot weather may mean summer overheating becomes a bigger issue in Britain but for now, most energy is spent keeping homes warm in winter.

The following is designed to help decide which retrofit measures might reduce your heating bills. The following pages look at these aspects aspects of your home:

Type of property
Ground floor
External walls
Roof
Doors and Windows
Fires, stoves and chimneys
Heating and hot water
Ventilation
Renewables

Type of property

Is it a house or a flat?
How many floors?
Detached, terrace or semi?
How old?
Is it listed or in a Conservation Area?
Is there a built-in garage, porch, conservatory?
Glazing and orientation?

- As a rule, more recently built homes will be better insulated than older ones. For example, 1970 Building Regulations required a U-value (thermal transmittance) below 1.6 for external walls. By 2020 this had been improved to 0.18.
- Flats/apartments typically have other flats on one or two sides, above and/or below. If you share a party wall or floor with another property both will normally be heated and so heat losses are negligible. Similarly for houses - terrace houses with neighbours each side will lose heat through the front and back walls but not the party walls; detached houses lose heat through all external walls and semis are somewhere in between. A three-storey house will have proportionately more wall than roof or ground floor area than a bungalow, so wall insulation plays a bigger part in overall heat loss, while heat loss through the roof and floor are more significant in a bungalow and a well-insulated roof can be more effective than adding wall insulation.
- If a property is in a Conservation Area and especially if it is listed, the options for retro-fitting will be narrower in scope. External wall insulation, rooftop solar panels, replacement doors and windows and, if listed, even double glazing may not be permitted.
- Unheated add-ons like garages, conservatories and porches provide a buffer between the warm interior and the outside cold, reducing heat losses. Porches can also act as ‘draught lobbies’ lessening air leakage around doors. Conservatories can actually ‘collect’ heat on sunny winter days but trying to heat them in cold weather is just throwing energy (and money) away.
- Heat loss is invariably greater through doors and windows so bigger windows = higher heating bills, though actual heat loss varies enormously by window type, quality and draught-stripping. South-facing windows, though, allow winter sun to warm the property - passive solar heating.

Ground floor

Is there an (unheated) cellar or basement?
Is the floor solid or suspended with a void below?
Timber or concrete?
Insulated?

- A suspended floor or a floor over an unheated cellar can allow a lot of heat to escape but is generally easy to insulate by adding insulation from below.
- The space below suspended floors will be ventilated and heat loss by conduction through the floor and (particularly for timber floors) by air leaking through gaps and joints. There are options to add insulation and this may be easy if there is access below or difficult if the floor needs taking up.
- Solid floors can be replaced, incorporating insulation below if they have other problems (eg damp) or if you want under-floor heating.
- If insulating below a ground floor is not an option it may be possible to add insulation and a new floor finish above, possibly including under-floor heating. This will affect headroom and window heights as well as skirting boards and the bottom of stairs.

External walls

Masonry or timber?
Solid brick or cavity wall?
If masonry, stone, brick or rendered blockwork?

- Older properties will benefit from additional wall insulation. Post-war houses usually have cavity walls. Newer ones have insulation in wider cavities giving better insulation. Earlier builds may have had cavity-fill insulation added.
- Old houses will usually have solid brick or stone walls which allow high heat losses. They can be improved by adding insulation in the inside face of the wall (IWI or internal wall insulation) or on the outside, confusingly known as external wall insulation (EWI) meaning the external face - it is the external wall in either case!
- External insulation (EWI) is often preferable if circumstances allow. It will radically change the appearance and things like roof overhangs and rainwater pipes need to be considered. Often internally-applied insulation will be the better choice but this will reduce internal space and affect skirting boards, window cills, power sockets, etc.

Roof

Pitched or flat?
If pitched, is there a roof space?
Insulated?

- Most homes have pitched roofs with a roof space above the upper floor. If recently built they will already be well insulated, while older houses may already have had loft insulation installed. If not, or if it is poorly done or not very thick, adding loft insulation is probably the easiest retro-fit technique.
- Some homes have sloping ceiling following the roof slope, especially in loft conversions. Try to find out how well insulated they are. If need be, insulation can be added to the interior face (like IWI) or if the roof has problems, re-roofing can allow more insulation within the roof thickness.
- Flat roofs will normally have some insulation built in - more so in recent builds - but more can be added to the underside (again, like IWI). Older flat roofs are prone to leaks and if they need refinishing with more reliable modern single-ply coverings additional insulation can be incorporated within or on top of the roof structure.

Doors and windows

Wood, PVCu or metal frames?
SIngle/double/triple glazed?
Draught-stripping?
Orientation?
Curtains, blinds and shutters?

- Most buildings lose most of their heat through windows and doors, so this is often the first place to look for improvement.
- As with walls and roofs, more modern homes will have less heat loss through openings - windows, doors, rooflights, etc. Older buildings may still have single glazing and steel window frames without draught-stripping. Metals conduct heat more than wood or plastic (PVCu) but modern aluminium or steel windows will have thermal breaks to improve their insulating properties. Some windows have a composite construction with wood frames internally for better thermal performance and appearance, and aluminium outer frames for reduced maintenance.
- Double glazing has become the norm in recent years but triple glazing is becoming more common - heat loss is reduced and sound insulation improved. There is more to it than just the number of layers: wider and argon-filled cavities and low-emission glass all improve performance.
- As insulation is added to the house and fabric heat losses are reduced, ventilation heat loss - basically warm air from inside being replaced by cold air from outside - becomes more significant. Ventilation is necessary, but in most homes much of it is unintentional and results from air leakage where elements join. Doors and windows are particularly vulnerable, so draught stripping is essential. It is also a relatively easy fix for older doors and windows.
- As well as being a major channel of heat loss, windows can allow heat in when it is sunny. This can be a problem in summer, causing overheating, but can also be a benefit in winter. South-facing windows allow the winter sun, low in the sky, to penetrate and warm the home. If carrying out alterations or extensions, reducing north-facing openings and trying to place windows on the south side will be beneficial.

- Curtains and blinds will help a little to reduce heat loss and blinds or shutters, especially external ones, will help reduce unwanted solar gain in summer, as will shading from roof overhangs or brise soleil.
- If replacing windows in a listed building or even a Conservation Area, planners may place limits on your options. They may preclude metal or PVCu frames and even rule out double/triple glazing. Sometimes the only option is internal secondary glazing.

Fires, stoves and chimneys

Fireplaces, flues and chimneys?
Used/disused?
Sealed/ventilated?

- An open fire, requiring a supply of fresh air and shifting vast quantities of hot air and carbon dioxide up the chimney, is a remarkably effective way of consuming energy and warming the planet. Closed stoves, if their combustion air is ducted from outside, are better and wood is a renewable rather than a fossil fuel, but burning stuff for heat is always going to waste energy.
- Disused chimneys and flues should be removed, sealed or incorporated as part of a whole-house mechanical ventilation or a passive system.

Heating and hot water

Whole-house central heating?
Radiators, under-floor heating or warm-air?
Individual/supplementary room heaters?
Gas, oil, LPG, solid fuel or electric?
Air/ground/water-source heat pump?
Hot water storage?
Heating controls - thermostats, programmer?

- Modern homes invariably have central heating while it will often have been retrofitted in older properties. While this will be more energy-efficient than wood or coal fires - the norm until around 1960 - much will depend on the fuel used, the controls and the way it is used.
- By far the most widely-used fuel is natural gas but this is a fossil fuel and will soon not be an option. LPG and heating oil are no better, and while biomass (wood or wood chip) is renewable it still produces more CO2 and particulates than electricity - increasingly from clean, renewable sources.
- The best option is a heat pump. Ground-source (or water-source is a body of water is available) heat pumps are more efficient but air-source heat pumps (ASHP) are the usual and cheapest type. Heat pumps do not create heat, but transfer it from the environment into the home, typically producing around three times as much heat energy as the electricity used.
- While gas boilers may have outputs above 25kW and circulate water at 60C, heat pumps may have 5-10kW output and heat water to 45C. This means under-floor heating, which runs at lower water temperatures than radiators, is a better fit. It does not, though, rule out radiators. A heat pump will be sized to exceed the steady-state heat loss from a house and be perfectly capable of providing the heat required, but may struggle to heat a home from cold quickly. The common pattern of heating being programmed to warm the home quickly at breakfast time then again after the house is left unheated while the occupants are at work or school will not suit. Better to keep the home in a steady temperature range - just a couple of degrees cooler at night and when you are at work. A steady heat output of say 3kW will use no more energy than bursts of 15kW.

- Plumbers used to fitting gas boilers will often say bigger radiators will be needed for heat pumps, but water in a radiator at a steady 45C will heat a space just as well as shorter spells at 60C.
- Heat pumps do not provide instant hot water like combi boilers, so are fitted with well-insulated hot-water cylinders. They also have sophisticated controls for temperature and programming, usually controllable from an app on your smartphone or tablet. Good controls make any heating system more effective and efficient.
- While central heating in Britain usually uses hot water underfloor or in radiators, warm-air heating is much more widely used in America. Air-to-air heat pumps can be a good choice, particularly for smaller homes. Simpler to install than water-based systems, they are basically similar to air conditioning, with a heat pump outside the home feeding one or more internal fan units warming the inside air. A bonus is that they will work in reverse and can provide cooling in hot summer weather.

Ventilation

Extract fans?
Humidity controlled extract?
Whole-house mechanical ventilation with heat recovery (MVHR)?

- As mentioned above, as insulation is improved, ventilation and air leakage account for a greater fraction of heat loss.
- In recent years, Building Regulations have required new homes to be reasonably air-tight to reduce unwanted air leakage, but also require extract fans in kitchens and bathrooms to get rid of excess moisture in the air. This is basically throwing warm air away to be replaced by cold air from outside. Controlling extract using humidity sensors rather than switching fans manually or when lights are turned on/off will increase effectiveness and efficiency but energy is still being thrown away.
- Whole-house mechanical ventilation with heat recovery (MVHR) typically uses a fan/heat exchanger in the roof space to extract air from kitchens and bathrooms and supply fresh air from outside to living spaces, crucially transferring most of the heat from the extract air to the fresh supply air by means of a simple heat exchanger. Air is kept fresh and filtered while energy loss is largely avoided. This system is not yet standard for new homes but may be simple and economical to retrofit, depending on the layout and construction of the house.
- A passive ventilation solution designs in the flow of air using natural thermal convection to provide ventilation, avoiding the need for fans, but does not recover heat.

Renewables

PV solar?
Thermal solar?
Batteries?

- Photovoltaic solar panels, generating free power from sunshine, have become commonplace in recent years as prices have fallen, installers have proliferated and electricity tariffs have been tailored to suit. There are no real drawbacks but they do require significant space - an uncluttered south-facing roof slope is ideal - and may not be permitted in Conservation Areas.
- Thermal solar panels are very effective in heating water via a coil in the hot-water cylinder on sunny days and require less roof space but...
- Solar PV provides the most power on sunny summer days - often the time when the least power is required. This is still very good as the excess goes into the grid, providing clean energy and reducing the need for less sustainable generation. You will get paid by your energy company but often only a pittance. One alternative is to use excess PV output to heat your hot water - as simple as connecting it automatically to your immersion heater - as an alternative to thermal solar panels.
- Another option is to add a ‘solar’ or ‘home’ battery. Batteries do not create energy but they can save a lot of energy both for you as a consumer and for the grid. Using excess daytime energy to run your oven, TV and heating in the evening, or to help charge an electric car, means you need less electricity from the grid. Energy companies also offer lots of tariffs with electricity prices varying between day and night or even dynamically with varying grid loads, so you can charge batteries with cheap night-rate electricity then use it the next day, again saving you money. Energy companies may also pay you to ‘borrow’ your batteries to balance the grid, helping them operate more efficiently and saving overall energy use.

A word of caution

All the ideas and options above are just that - ideas. If changes are made to the fabric they need to be done with care: knowledge, expertise and experience being required for both design and execution. A particular issue when adding insulation is that of condensation. Not only does the temperature vary through the thickness of a wall or roof but so does water vapour. Materials can allow or resist the flow of heat but equally the movement of moisture. Unless attention is paid to both heat and vapour flow adding insulation can cause water vapour to condense within the structure risking damage from decay, corrosion, mould, and so on. Such problems can be accentuated at corners and junctions where there can be ‘cold bridges’. Another example of the need to take care is when re-roofing or adding solar panels when the weight might overload the roof structure. Whatever you decide to do, get expert help.