A DETAILED GUIDE TO

INSULATING YOUR HOME

SUSTAINABLE ENERGY IRELAND

The energy for life…

Energy is essential to our daily lives. It heats our homes, fuels our transport and supplies our electricity. At the moment, most of the energy we use comes from fossil fuels such as oil, gas, coal and peat. Unfortunately there is a limited supply of fossil fuels in the world and we are using them up at a very fast rate. The other downside to fossil fuels is that burning them for energy also produces CO_2, a greenhouse gas, which causes climate change. That's where sustainable energy comes in.

So what is sustainable energy?

Sustainable energy refers to a way we can use and generate energy that is more efficient and less harmful to the environment. Another way of explaining sustainable energy is that it will allow us to meet our present energy needs without compromising the ability of future generations to meet their own needs. We can do this by being more efficient in how we use energy in our daily lives and also by increasing the amount of energy that comes from renewable sources such as the wind, the sun, rivers and oceans.

What are the benefits of sustainable energy?

The good news is that being sustainable in how you use energy has immediate benefits:

- It will save you money on your electricity and heating bills
- Your home will be more comfortable and convenient
- And you will also be making a vital contribution to reducing climate change

Believe it or not, the small actions you take to be more energy efficient in your home can have a very significant impact on improving the environment. The collective efforts of individuals can often be the most powerful of all.

Who is Sustainable Energy Ireland?

Sustainable Energy Ireland (SEI) was set up by the government in 2002 as Ireland's national energy agency with a mission to promote and assist the development of sustainable energy. SEI's activities can be divided into two main areas:

- ***Energy Use -*** Energy is vital to how we live our daily lives but most of us don't use energy as efficiently as we could. By assisting those who use energy (mainly industry, businesses and householders), to be more energy efficient, SEI can help to reduce the amount of energy we use overall.

- ***Renewable Energy -*** Energy that is generated from renewable sources such as wind and solar power is clean and doesn't produce harmful greenhouse gases. By promoting the development and wider use of renewable energy in Ireland SEI can help to further benefit the environment, in particular reducing the threat of climate change.

SEI is also involved in other activities such as stimulating research and development, advising on energy policy and producing energy statistics.

Sustainable Energy Ireland is funded by the National Development Plan 2000-2006 with programmes part financed by the European Union.

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Did you know…

- **Energy use is responsible for two-thirds of Ireland's greenhouse gas emissions.**
- **Irish homes use around a quarter of all energy used in the country– that's even more than industry.**
- **The average home consumes almost 40% more electricity than it did in 1990.**
- **Renewable energy currently accounts for just 2% of Ireland's energy supply.**

contents

Many Irish houses, particularly those built before 1980, are very wasteful of energy. Various cost-effective energy saving opportunities exist which, through reducing fuel and electricity bills, can pay for themselves in a relatively short time. The implementation of energy conservation measures can also make the house warmer, more comfortable, and eliminate cold draughts and condensation.

By conserving energy in our homes, we can

- save money
- help to conserve fuel resources
- promote a cleaner environment.

On a wider scale, conservation can reduce polluting emissions, provide employment, and reduce Ireland's fuel imports bill. Most of our energy currently comes from oil, coal, natural gas and peat. These resources are finite, and if we continue to use them at current rates, they will run out within a small number of generations. In the meantime, the burning of these fuels releases pollutants into the atmosphere, contributing to smog, acid rain and, in the longer term, climate change.

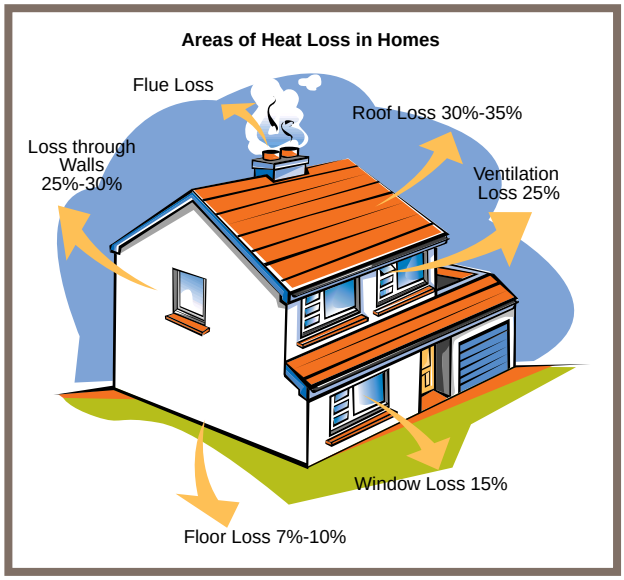
Energy Conservation measures in the home include:

- design and shape of the building
- insulation of the building fabric
- energy-efficient heating and lighting systems, and controls
- energy-efficient appliances

Heat loss through the fabric of the building can be substantial, and in this booklet we are going to look at methods of insulating the building fabric of your home to reduce this loss.

Insulation of the Building Fabric

Insulation evenly distributed over all your home generally produces better results than additional insulation applied to only one or two areas. It is better to have a good overall level of insulation than, for example, a highly insulated roof with no wall insulation.



Since increasing insulation thickness does not produce a pro-rata reduction in U-value, there comes a point where the economic return on additional insulation for any one element will be virtually nil.

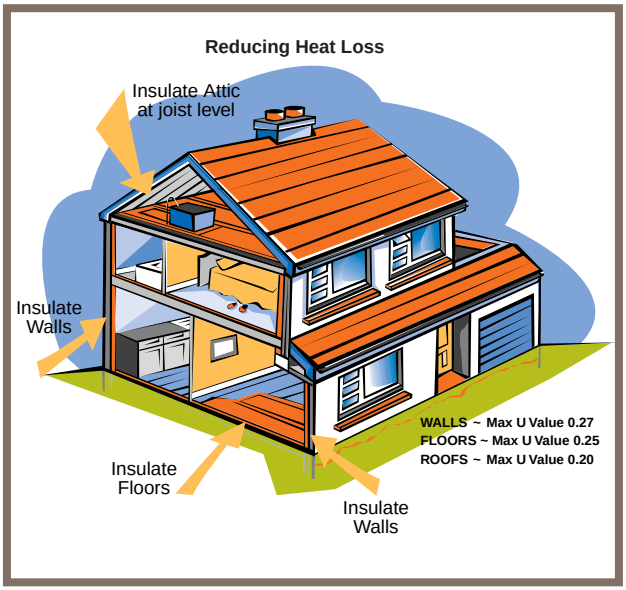
When selecting insulating materials, choose those that have an Irish or British Agrément Board Certificate. This Certificate will give you information on the Technical Specification, Design Data and Installation recommendations for the material. For the purpose of U-value calculations, it will give you the thermal conductivity of the thickness of the material.

Good workmanship and attention to detail are most important when insulating your home, to avoid thermal bridging and other related problems, and could have greater impact on overall heat loss than simply increasing the thickness of insulation. Use only approved installers.

Some measures are more cost-effective than others and you will recover the cost in reduced energy bills more quickly than others. These could be undertaken first and are outlined throughout this guide.

What is Thermal Bridging?

Thermal bridging occurs in small areas where the insulation level is reduced significantly compared with the remainder of the element.



Hot Water Cylinder

One of the quickest and simplest ways to save energy in your home is to insulate your hot water cylinder and pipes. Hot water will stay hot longer and you will save money on heating it by fitting a lagging jacket. An 80mm jacket can cut heat loss by 75% and could pay for itself in just a few months. Even if your cylinder is already insulated, if the jacket is less than 75mm thick, it is worth getting a new one. Care should be taken not to cover the cap of the electric immersion heater with the lagging jacket.

If you need to replace your cylinder, choose one with a pre-formed foam insulation jacket. This is more efficient and less bulky than a cylinder with a separate jacket.

Conservation of Energy and the Building Regulations 2002

The Building Regulations 2002, Part L Conservation of Fuel and Energy, require that all new buildings achieve minimum standards of energy efficiency. Existing houses should be refurbished to achieve these standards also. Levels of insulation higher than those required in the Building Regulations are in many cases worthwhile, since a house being built or refurbished today can be expected to be occupied for 60 years or more, and an energy-efficient design can yield considerable savings over its lifetime.

Once you have decided to adopt energy-saving measures in your home and start investigating issues more deeply you may find yourself coming across unfamiliar measures and concepts. One of those is the thermal transmittance, or U-value, of a construction.

What is a U-value?

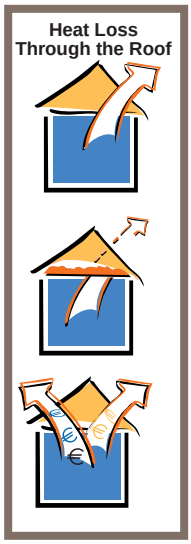
To put it simply, it is the measure of the rate at which heat is lost through a wall, for instance. As it is a measure of heat loss then the lower the U-value the better it is for your home comfort.

Part L gives maximum values which should be met to comply with the Building Regulations Standards of energy conservation.

Maximum Average Elemental U-values (W/m²K)

Fabric Elements	New buildings and extensions to existing buildings	Material alterations to, or material changes of use of, existing buildings
Pitched roofs, insulation horizontal at ceiling level	0.16	0.35
Pitched roofs, insulation on slope	0.20	0.35
Flat roof	0.22	0.35
Walls	0.27	0.60
Ground floors	0.25	—
Other exposed floors	0.25	0.60
External doors, windows and rooflights	2.20	2.20

Roof Insulation



You put a hat on your head and keep your body heat in. Thermal insulation in your roof will do the same for your house!

If you do not have insulation in your roof, up to 30% of your heat could escape, costing you money and contributing to atmospheric pollution and global warming.

If you have already insulated your roof, you may want to replace it or add another layer to improve its performance and bring it up to current Building Regulations Standards.

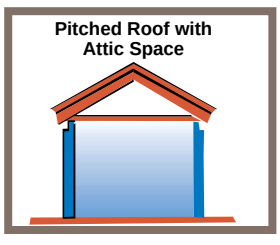
Savings

Insulating the 50 sq.m. (540 sq.ft.) attic space of a typical house costs around €400 and could save approximately €130 a year (up to 20% of your fuel bill) so it would pay for itself in about three years. Insulating a flat roof of the same size could cost about €1,000 and will pay for itself in around five years.

As well as saving your money, you will be helping to reduce the emission of carbon dioxide and other environmentally-polluting substances.

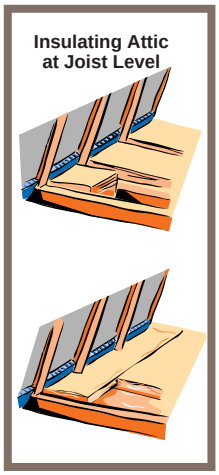
Types of insulation suitable for different types of roofs

Pitched roof with an attic space



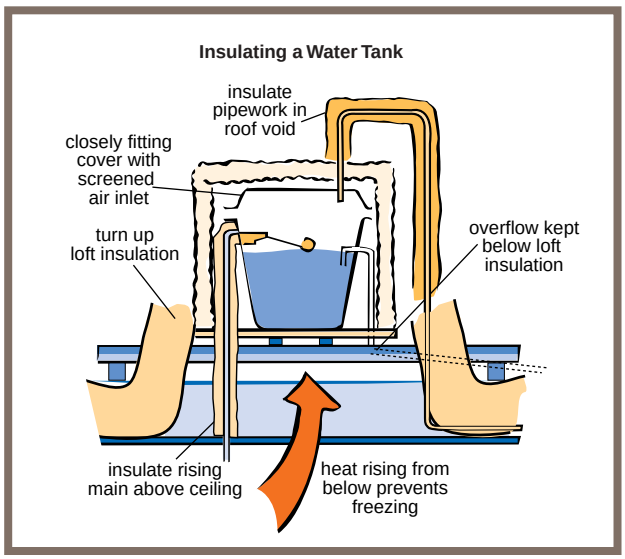
If you have a pitched roof with an attic space, it can be insulated in many ways. Probably the simplest is to lay quilt, such as glass fibre quilt or mineral fibre quilt in a roll between the ceiling joists and a second layer in the opposite direction over the joists.

Another method is to have shredded glass fibre, mineral fibre or cellulose fibre blown into the attic between and above ceiling joists. This method requires a professional contractor. Be careful not to compress fibreglass insulation, otherwise it will lose part of its insulating value. So if boarding is to be put down in some areas of the attic for storage, it should not compress the insulation.

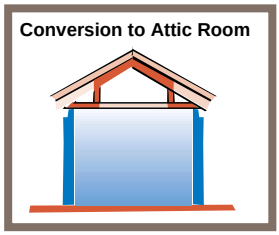


After the attic is insulated at joist level, its temperature is reduced, so you must insulate the water storage tank and pipes.

The water storage tank can be insulated with any semi-rigid insulating board and the pipes with closed cell neoprene, polyethylene, glass fibre and mineral fibre in pipe section form.

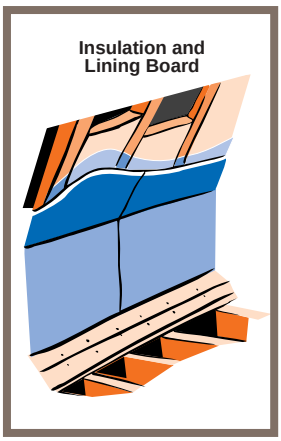


Conversion to an attic room



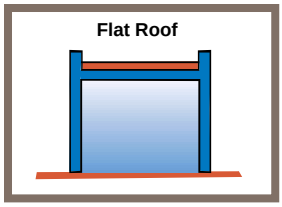
When converting your attic into a room, insulation is placed in between the rafters. The insulation can be semi-rigid insulation boards such as expanded polystyrene board, extruded polystyrene board, glass fibre batts, mineral fibre batts, urethane foam board or phenolic foam boards. Some contractors also offer a spray-on cellulose fibre or polyurethane foam insulation system between rafters. If a first layer of insulation is placed between rafters, a second, thin layer applied to the underside of the rafters avoids thermal bridging. Glass fibre quilt and mineral fibre quilt can also be used. A vapour check should be installed on the warm side of the insulation and ventilation above.

These materials can be held in place by a plaster lining board which also provides the necessary fire protection.

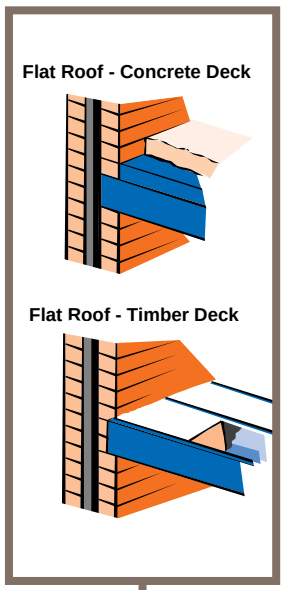


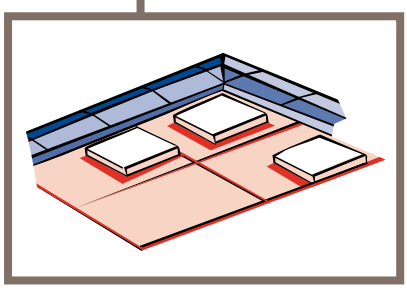
Lining boards can have integral insulation backings, such as glass-fibre-backed insulated plaster and urethane-foam-backed insulated plasterboard, often lined with aluminium foil.

Flat roof



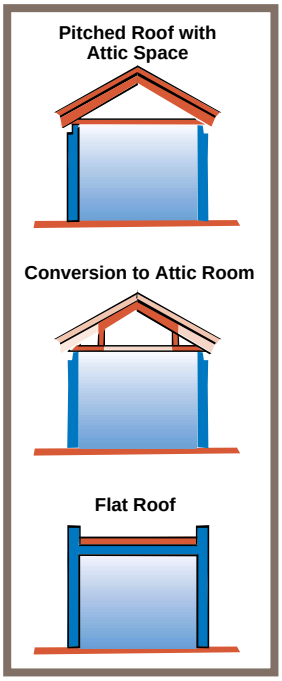
The type of insulation used in new flat roofs is dependent on the roof structure. On a new concrete slab, with a screed, semi-rigid insulation boards such as expanded polystyrene board, extruded polystyrene board, glass fibre batts, mineral fibre batts, urethane foam board or phenolic foam board are laid under the roof covering. In a new timber structure, glass fibre quilt and mineral fibre quilt can be laid between the joists.





If you have an existing flat roof, insulation can be increased externally with extruded polystyrene or foamed glass, or internally with an insulated lining board such as mineral fibre or polyurethane foam-backed plaster-board.

Can you do it yourself?



Pitched roof with an attic space

The majority of Irish houses have a pitched roof, which is the easiest type to insulate and with a little care and guidance can be insulated by yourself.

Attic room

Attic conversions are more complicated as the roof structure has to be insulated, so the appointment of a building contractor is advised.

Flat roof

The insulation of new and existing flat roofs should be carried out by a roofing contractor.

Guidelines for choosing insulation

- Insulation is available from builders' providers, DIY and hardware stores and specialist contractors.
- Buy insulation from a reputable supplier who can help you choose the most suitable insulation for your roof type. If using glass or mineral fibre wool insulation, specify a minimum thickness of 100mm between joists and 150mm across joists. To find out how much insulation you need, check the measurements between the joists, their length and the number of joist spaces in your attic.
- If installing the insulation yourself, check if special precautions should be taken when handling the material.

Guidelines for laying quilt insulation in a pitched roof attic space

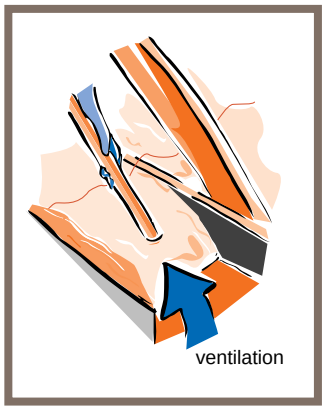
- Before you insulate your attic, read the manufacturer's instructions.
- Some insulation materials irritate your skin and throat, so wear a mask, rubber gloves and goggles and tuck in your clothes when handling these materials.

- Stretch a long board across two or three joists to walk and kneel on. Do not stand on the section between the joists or your foot is likely to go through the ceiling.
- Check the depth of the joists. If the insulation is going to be higher than the joists or if you are going to lay a second layer of insulation across the joists, you may need to fix timber battens to some joists to raise the boarding in the area of the attic where access will be needed, thereby avoiding compression of the insulation.

- Fill any cracks or holes in the ceiling to prevent warm, moist air rising into the attic as this causes condensation.
- Open and unroll the insulation in the attic.
- Lay insulation between joists in widths sized to fit tightly between the joists and a second layer over the joists in the opposite direction.
- If possible, fit insulation over the wallplate to abut with the wall insulation while leaving the necessary air gap around the eaves and soffits. This will help to avoid cold bridging.

ROOF, ATTIC AND ATTIC ROOM INSULATION

- To ensure that there is adequate ventilation at the eaves, cut the ends of the insulation in a wedge shape. Alternatively buy specially shaped plastic eaves pieces to ensure that the insulation does not block the eaves ventilation.



- At the gable wall, insulation should be turned up 225mm above ceiling level.

- After you insulate the attic, its temperature will be reduced. Therefore it is essential to insulate water storage tanks and pipes to prevent them from freezing. Do not put insulation directly under the water storage tank as the warm air from below will help prevent it freezing. The tank sides and top should be insulated, as should the pipes, to prevent them freezing in the cold attic.

- Insulate the hatch by cutting a piece of insulation and sticking it onto the hatch.

Precautions

- It is essential to cross-ventilate the attic space to prevent condensation by leaving a continuous air gap along the eaves at each side.

- In attic room conversions, it is essential to ventilate the roof structure between the insulation and the roofing felt with continuous air gaps along the eaves and at the ridge. Special ventilation tiles are available for ridge ventilation.

- Don't bury electric cables under the insulation. Leave cables clear and avoid compressing. Keep plastic-insulated cables away from polystyrene insulation.

- Leave clearance for recessed lights to avoid them overheating.

- The use of combustible insulation is not recommended for attics.

Up to half of the heat loss from a house occurs through the walls. This can be reduced by two-thirds by insulating the walls.

Most houses built before about 1980 have no wall insulation. Many (though not all) houses built during the 1980s have some wall insulation. Houses built since the 1991 Building Regulations came into effect are required to have wall insulation.

Insulation may be placed on the outside, in the cavity or on the inside of a wall, without altering the overall insulation properties.

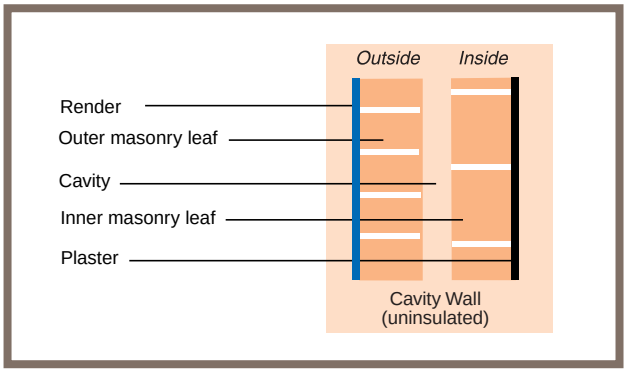
What is Thermal Response?

External or cavity insulation allows the internal wall to act as a thermal store, absorbing heat during the day and releasing it at night-time, reducing fluctuations in room temperature throughout the day. Internal insulation isolates the thermal mass from the room. This reduces both the response time of the heating system and the energy required to reach comfort levels in the room. Occupancy patterns, the response time of the central heating and its controls, and the optimal thermal mass of the building will determine the appropriate action.

When considering wall insulation, first you should find out whether your house has cavity walls or solid walls. A building contractor or architect will be able to tell you if you have cavity walls in your new or older house. If you have cavity walls, then cavity insulation is likely to be the most cost-effective insulation method. If cavity insulation is not an option, then the more expensive options of either internal or external insulation may be considered. It is not possible to fill the cavity in a wall constructed simply of 9-inch hollow blocks.

Cavity wall insulation

The walls of many houses consist of two 'leaves' of brick or concrete block with a cavity or space between them to resist rain penetration.

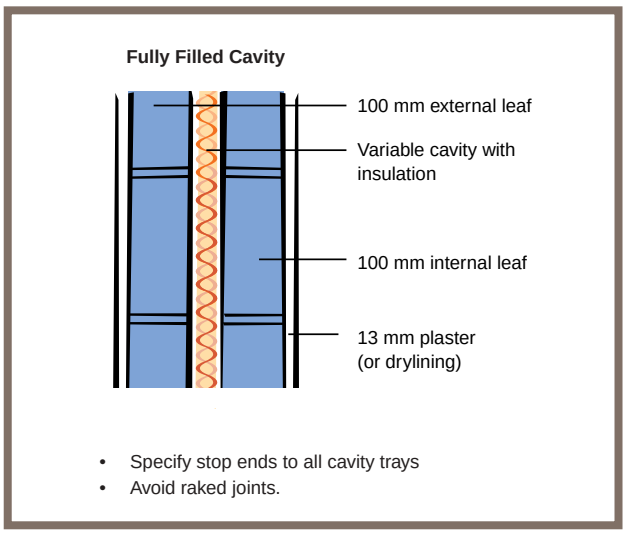


New Housing

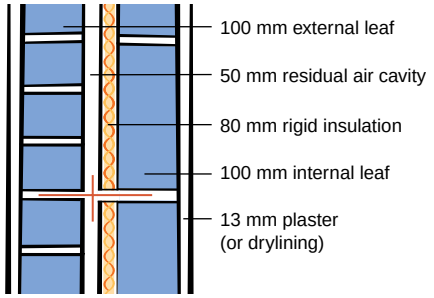
It is standard practice when building new houses to insulate this cavity as the wall is being constructed, either with full-fill batts or partial-fill boards.

For cavity walls a minimum of 78mm rigid insulation board, with a thermal conductivity of 0.25W/mK must be used, unless there is additional insulation outside the cavity.

Initially the architect or installer will carry out an assessment of the walls to check their suitability for cavity insulation, particularly for full-fill insulation. This assessment will determine the degree of exposure of the house to wind-driven rain and the construction details of the walls.



Partially Filled Cavity



- Specify a minimum of 50 mm clear residual cavity
- Specify drips on wall tiles to be in the centre of the residual air cavity
- Specify rigid insulation boards
- Hold insulation boards tight against inner leaf with retaining clips and avoid gaps between the boards.

When full-fill cavity insulation is being used it is essential that such walls are designed and constructed to incorporate the normal precautions to prevent moisture penetration. Insulation thickness should remain constant and should any change in vertical thickness occur, a horizontal damp-proof cavity tray should separate each thickness change.

It is important to ensure during installation that wall ties are fitted correctly and cleaned, excess mortar is cleaned from the inside faces of the wall, mortar droppings removed from the cavity and cleaned from the exposed edges of the insulation slabs. All insulating materials should be installed in accordance with manufacturers' instructions and procedures.

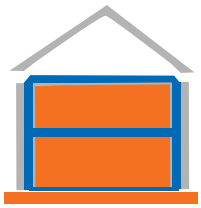
Older Housing

In older houses insulation can be injected into this cavity through holes drilled through the outer leaf, by means of a blowing or pumping machine.

Insulating From Outer Wall

Since the work is done from the outside, it causes minimum disturbance inside. The drilled holes, which are typically about 25 mm (1 inch) in diameter and spaced a metre or so apart, are then filled to match the wall appearance as closely as possible. The job typically takes less than a day.

House with Insulated Cavity Walls



Materials used for cavity insulation include mineral wool (glass or rock), polystyrene beads or granules and cellulose fibre. The thermal properties of these materials do not differ greatly (in technical terms, their thermal conductivities tend to fall within the range 0.025 to 0.04 W/m K). Insulating the cavity with such materials will typically reduce heat loss through the wall to one-third of its original value. Such cavity insulation materials are generally water-repellent and rot-proof and some are non-combustible.

It is most important before deciding to insulate existing cavity walls that you check their suitability for cavity insulation. This assessment will take account of the degree of exposure of the house to wind-driven rain and the construction details and condition of the walls. Any ventilation openings in the wall will also be checked to ensure that these will not be blocked by the insulation. If the walls suffer from rain penetration at times, this problem must be remedied first. In some cases, the walls may be found to be unsuitable for cavity insulation or may require some remedial work beforehand.

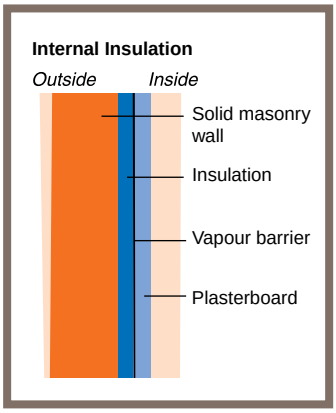
The Irish Agrément Board (IAB) provides independent certification of cavity wall insulation systems and maintains a register of approved installers for certified systems. These installers should be able to show you an IAB certificate for the insulation system they propose to use and proof of their reputation as approved installers.

Economics

The cost of cavity wall insulation depends on a number of factors, including the width of the cavity, but is typically in the region of €5 to €7 per square metre. For a typical semi-detached house, this gives a total cost of about €550 - £700. With annual fuel savings of €100 to €160, the pay-back period will be in the region of 4 to 7 years.

You may be able to negotiate a lower price if you can persuade some of your neighbours to have their walls insulated at the same time.

Internal insulation



Internal insulation involves fixing insulation to the inner surfaces of external walls (insulated dry lining). One method involves fixing insulation boards to the wall and covering with a vapour barrier and plasterboard. Alternatively, composite boards of plasterboard backed with insulation and incorporating a vapour barrier may be fixed to the wall. The work is quite labour-intensive, involving the repositioning of skirting boards, any electrical sockets or switches and other wall attachments.

Types of insulation material used include expanded polystyrene, fibreglass and polyurethane boards. Polyurethane tends to be more expensive, but its thermal performance is approximately 50% better than polystyrene or fibreglass, so a 25 mm (1 inch) thickness of polyurethane will have roughly the same insulating performance as a 38 mm (1.5 inch) thickness of polystyrene.

A disadvantage of internal insulation is that it reduces room space. This limits the permissible thickness of insulation in existing buildings. If room space is a factor, high-performance insulation may be preferred.

Some brands of insulation (e.g. polyurethane foams) use ozone-damaging substances (e.g. HCFCs) in their manufacture. From the point of view of environmental protection, it is preferable to select an insulation product which does not use such substances (e.g. expanded polystyrene, fibreglass). Sometimes a balance between conflicting aims (cost, thermal performance, environmental impact) is required.

Economics

Internal insulation costs more to install than cavity insulation, and because it is generally installed in smaller thicknesses, energy savings will be lower. It is most cost-effective to install internal insulation when the inside of the house is being refurbished. The additional costs will depend on the particular circumstances, but annual fuel savings of €75 to €150 can be expected for a typical semi-detached house.

Precautions

Interstitial Condensation

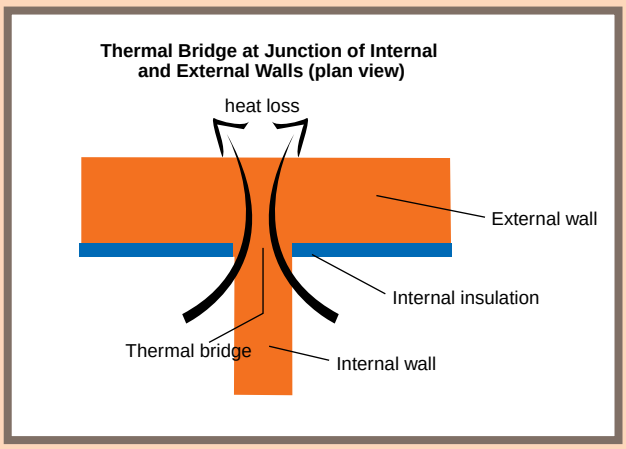
If warm moist air from inside the house were to pass around or through the insulation to the colder wall surface behind, it would condense on the wall. This invisible or 'interstitial' condensation is undesirable and is prevented by installing a vapour barrier (e.g. a polythene sheet) on the warm (room) side of the insulation. Composite boards for internal insulation generally incorporate a vapour barrier. It is important that the vapour barrier be well sealed at wall, floor, ceiling, door and window junctions, around light switches and at all other breaks in the insulation. The avoidance of interstitial condensation problems depends on good workmanship in sealing the vapour barrier, so a reputable installer should be chosen.

Electrical wiring

Polystyrene insulation should not be placed in contact with PVC-coated electrical wiring, otherwise the PVC may degrade. Also, steps should be taken to ensure that any electrical wiring covered by the insulation does not overheat.

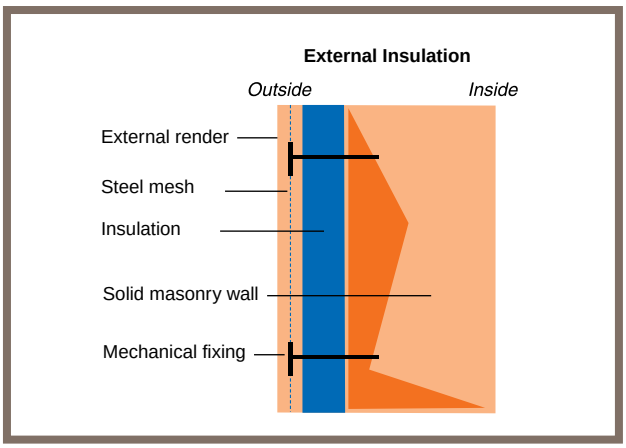
Cold bridging

When installing internal insulation, the junctions of internal walls and floors with external walls may 'short-circuit' the insulation, allowing heat to escape. The presence of such 'thermal bridges' will reduce the effectiveness of internal insulation. In so far as is practical, insulation should be installed so as to minimise thermal bridging.



External insulation

External insulation involves fixing insulation materials such as mineral wool or expanded polystyrene slabs to the outer surface of the wall. This insulation is covered with a special cement-based render to provide weather resistance. A steel or fibreglass mesh is embedded in this render to provide strength and impact resistance. It may be necessary to extend eaves and sills and relocate downpipes. A thin layer of insulation may be applied around the edges of window and door openings to minimise thermal bridging. The technology is well-established in northern Europe, where it has been in use for many years, but is not yet widely used in Ireland.



It is worth asking the installer if the proposed external insulation system has independent certification, for example from the Irish Agrément Board or equivalent. Such certification means that the system has been tested by an independent body and found fit for the purpose for which it is intended.

Economics

In relation to energy savings alone, external insulation of existing buildings is expensive. However, if the walls are vulnerable to rain penetration or frost damage, external insulation may be one means of solving these problems. An additional benefit may be an improvement in the appearance of the house.

At a cost of up to €150 per square metre, the cost of insulating a typical semi-detached house could amount up to €15,000. Annual fuel savings would be similar to cavity insulation, i.e. about €100 to €160, so the pay-back period based on energy savings alone would be more than 30 years. However, if work on the outside of external walls is already required, the economics of external insulation may be improved.

Precautions

- Since external insulation may change the appearance of the house, planning permission may be required. An approved installer or architect should help with this.
- Cavity insulation and external insulation are jobs for professional contractors. It is possible to fit internal insulation as a DIY job, but anyone undertaking such a job should be fully aware of the required precautions (see internal insulation section above).

Note on costs and savings

Costs given in this leaflet are indicative only - quotes may be obtained from installers. Savings are estimated assuming initial annual space-heating fuel costs (excluding standing charges) of €650. Particularly in colder houses, some of the savings may be absorbed in higher temperatures and increased comfort, offsetting the reduction in fuel bills.

Of all the components in a building, it is through the windows that most heat is lost. This is because glass allows heat to escape more readily than most other building materials.

For example, given the same area of wall and window, the window will allow up to eight times more heat to escape. For this reason, it is important that your windows are as efficient as possible.

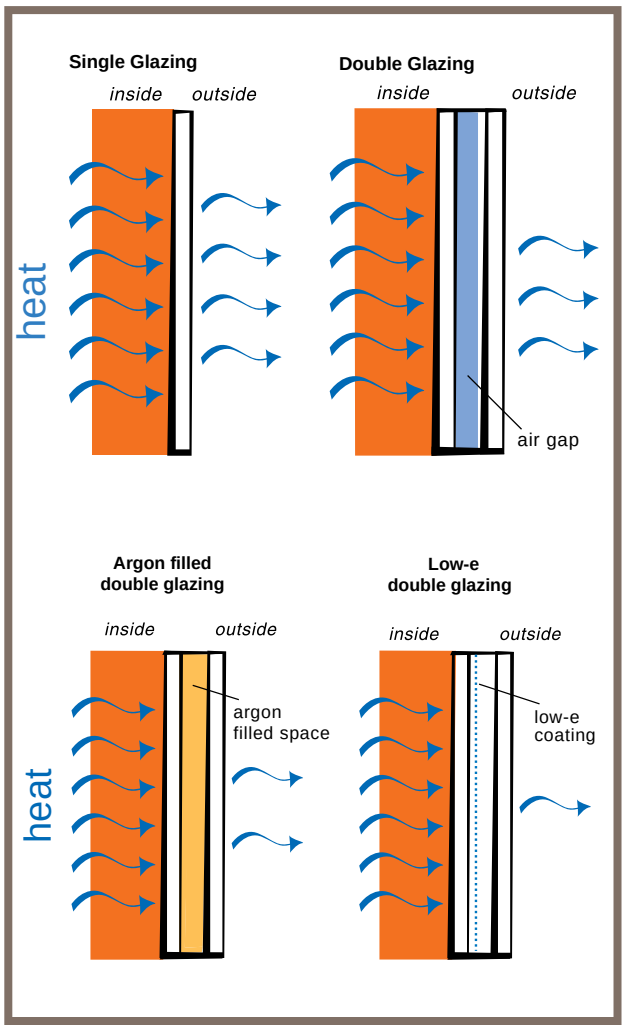
Different types of glazing

To meet the current regulations a minimum standard of double-glazing with a 12mm air gap and soft low-E glass is necessary. This change is due to the need to reduce energy consumption and the desire to improve comfort.

So why do double glazed windows prevent more energy from escaping? It's mainly because of the space between the two panes of glass. This gap is filled with air, which is a poor conductor of heat, thereby making it more difficult for the heat in the room to bridge the gap to the outside pane.

While standard double glazing is a great improvement over single, even more advanced glazing systems are now available on the market at affordable prices. Two examples include gas-filled double glazing and low emissivity glazing.
In gas-filled double glazing the cavity between the two panes of glass is filled with an inert gas (usually argon) which conducts less heat than air, therefore improving the window's energy efficiency. This type of system generally costs about 10 - 20% more than standard double glazing, but will vary from one manufacturer to another.

The low emissivity or low-e type system is more complex. The outside face of the internal glass pane is coated with a special material, which allows light to pass in through it while very little heat is allowed to pass out. When light hits an opaque surface much of its energy is turned to heat. Heat is similar to light in that they are both forms of energy which travel in waves. However, heat has a much longer wavelength than light. The specially applied coating on the glass prevents the long wave heat energy from escaping. It also prevents much of the heat generated in a home heating system from escaping. In short, it acts as an invisible layer of insulation.



This will generally cost between 10-15% more than standard double glazing but is very energy-efficient. In both Denmark and Germany this form of glazing is fast becoming the standard installed in all buildings and it is possible that in Ireland it will also become the norm in the not too distant future. Other combinations of glazing systems include low-e gas-filled double glazing or triple glazing.

Window frames

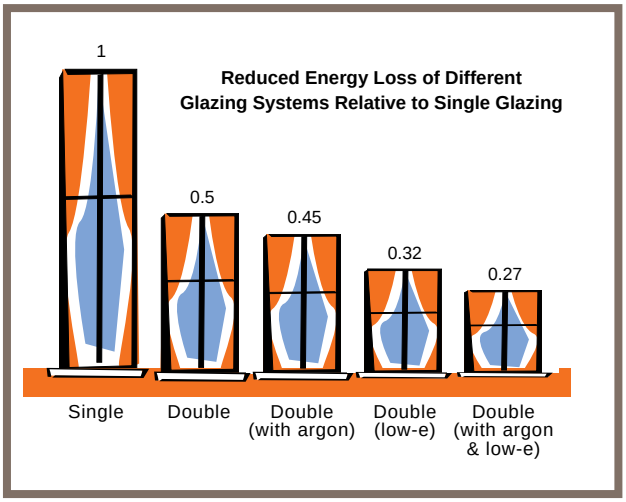
In addition to the glazing, the window frame must be considered when addressing the energy efficiency of a window. When viewed in terms of overall heat loss the difference in performance of these materials is not significant.

Air leakage through gaps in window frames can also lead to considerable heat loss. By selecting a well-designed system, further energy and cost savings can be made. All proprietary systems should have draught strips built into the frame.

Finally, other points to consider include ease of opening for ventilation and cleaning, the security features and provision for controllable 'trickle' ventilation. The durability of the window frame is also important as poor quality will result in higher maintenance.

What to do if you are thinking of replacing your windows

With such a selection of new glazing systems it can be difficult to know which one to choose. If you are thinking of replacing your existing windows you probably have single glazing - up to just a few years ago this or poor quality double glazing was still being installed in most houses. In recent years, however, the cost of double glazing has dropped considerably, making it much more affordable. Good quality double-glazed windows should have an air gap of 12 mm or greater.



If you are replacing your windows you should consider installing double glazing as a minimum. Not only will you save energy but you will also increase your comfort levels immediately. When selecting double glazing you should shop around. There are numerous reputable window manufacturers in Ireland who can supply, and in many cases fit, good quality double-glazed windows.

The extra cost of double glazing with a low-e coating is not a whole lot and could save you even more money. If your budget allows, you should give this option serious consideration. Not all window manufacturers or installers will be familiar with low-e glazing. However, it won't be long before most manufacturers and installers will be offering it.

Who will install them? The manufacturer from whom you will buy them will probably recommend an approved installer. Otherwise you will need to find one. Remember, this is a job for a professional.

If replacement windows are beyond your budget then there are also secondary glazing systems available on the market. These are normally installed inside your existing windows, creating an air space between this and the new 'window'. There are a number of different designs - for example those with sliding frames. While these systems can help to reduce heat loss and save you money if installed correctly, provision for the ventilation of the air gap is important. Otherwise, condensation could become a problem.

What to do if you are buying a new home

In a new home, nothing but double glazing, as a minimum, will do. However, since you have to install windows anyway, why not consider low-e double glazing, and start saving from day one? In years ahead, it may even add value to your home. Talk to your building contractor as early as possible to assess the options.

Important

If you are changing from old single-glazed windows to more modern double-glazed systems it is likely that draughts will be greatly reduced. While this will help to save energy it can cause moisture levels in your house to increase. You should always ensure that there is some controllable means of ventilating all inhabitable rooms.

Heat loss through the ground floor of a two-storey house typically accounts for about 10% of total heat loss. For a one-storey house the figure is about 15%. However, if a house is well insulated everywhere except for the ground floor, the percentage will be higher.

The amount of ground floor heat loss depends on the type of soil – houses built on wet soils tend to lose more heat through the ground than those on dry soils. Also, detached houses tend to lose more heat through the ground floor than terraced houses because their ground floors are exposed on all sides. So if you plan to live in a bungalow built on damp soil, floor insulation merits special attention.

The 2002 Building Regulations, Part L, Conservation of Fuel and Energy, recommends that the U-value (a measure of the rate of heat loss) of the ground floor in new houses should be no greater than 0.25 W/m^{2}K. Compliance with this requirement can in most cases be achieved with the insulation thicknesses given below (indicative only). Thicknesses greater than these can reduce heat loss further and are recommended.

The insulation thickness depends on the material used. Typical thicknesses for different house types would be:

Detached two-storey house	103 mm
Detached bungalow	90 mm
Semi-detached two-storey house	90 mm
Mid-terrace two-storey house	60 mm

This insulation should cover the full floor area, not just the perimeter as was sometimes done in the past. Note that for houses with irregular perimeters (e.g. extensions), greater thicknesses may be required. Also, if underfloor heating is to be used, an additional 30 mm or so can help to avoid increased heat loss from the warmer ground floor.

Existing houses

A relatively simple way to reduce heat loss through the ground floor is to lay a carpet with foam backing or a foam underlay. Both carpet and underlay should be 'wall-to-wall'.

Sealing of gaps in the ground floor will help to reduce draughts, and also radon levels in houses with radon problems. Gaps commonly exist at skirtings, at cracks in the concrete slab, and at service (pipework) entries. Sealing may be done as a DIY job using:

- Acrylic or silicone sealants for small gaps. The more flexible silicone sealants are better for gaps where shrinkage, settlement, or expansion/contraction may occur.
- Expanding (polyurethane) foam for large gaps.
- Polymer-modified cement mortars for large gaps in areas which are to be walked on.

Suspended timber ground floors require sub-floor ventilation to avoid dampness and wood rot. Ventilation openings to the sub-floor space should not be blocked.

The insulation methods illustrated below for new houses may also be implemented in existing houses. In some cases this would be disruptive and costly, but if work needs to be done on the floor anyway, this is a good time to consider an insulation upgrade.

New houses

Examples of insulated ground floor constructions are given below. Other configurations are also used. In all cases the insulation manufacturer's instructions should be followed.

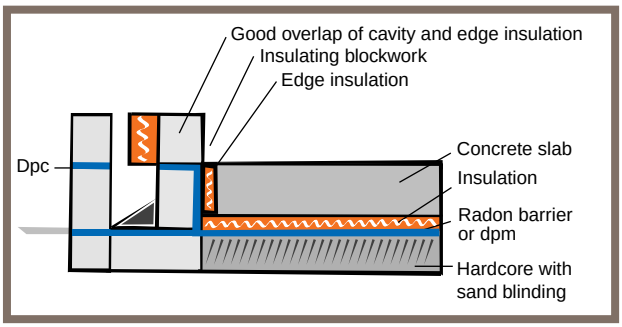
Concrete floor with insulation under slab, cavity walls

The insulation material chosen should have a high moisture resistance and compressive strength. Rigid insulation board is positioned on the damp proof membrane, which is laid over sand blinding on hardcore. There should be no gaps between the insulation boards. A strip of insulation is placed vertically at the slab perimeter to minimise thermal bridging via the inner blockwork leaf. Extending the cavity wall insulation down to the level of the horizontal floor insulation, and/or using insulating blocks between the wall insulation and floor perimeter insulation, will further reduce thermal bridging.

Radon is a naturally occurring radioactive gas, which enters buildings from the underlying soil, and in some areas can accumulate in a building to such a concentration that it is deemed to be a health hazard. The 1997 Building Regulations, Part C, requires that a radon barrier be provided under new dwellings in parts of the country worst affected by radon. This barrier must bridge the cavity in cavity walls. Care is required in design to ensure a good radon seal while avoiding thermal bridging at floor-wall junctions.

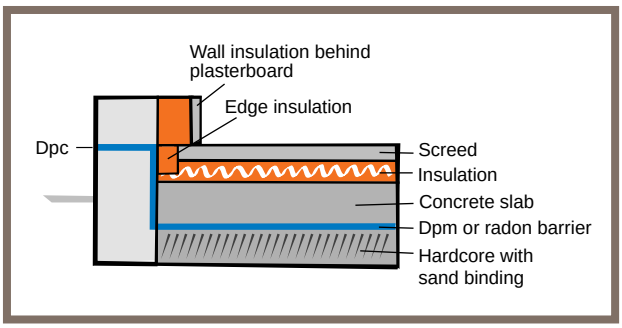
GROUND FLOOR INSULATION

In cases where interstitial condensation on the damp-proof membrane may be a problem, suitable types of insulation may be placed below rather than above the damp proof membrane (or radon barrier).



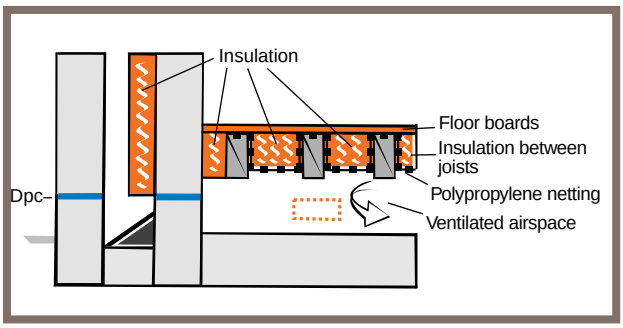
Concrete floor with floating screed, hollow-block or solid walls

Rigid insulation board is laid over the concrete slab. A strip of insulation is placed vertically at the screed perimeter to meet the wall insulation. The screed should be at least 65 mm thick with reinforcing mesh. Wood-based flooring boards may be used instead of screed, in which case a vapour control layer may be required.



Suspended timber floor

The insulation is laid between the joists, supported on polypropylene netting. The netting is first draped over and between the joists and stapled to the side of each joist, low enough to accommodate the full thickness of insulation. Air should not be allowed to circulate around the insulation.



In all cases, the designer/builder should try to minimise penetration of the insulation by pipework and wiring, and to keep heating pipework above the insulation in order that heat loss from the pipework contributes to heating the room above.

Insulation materials

Insulation materials commonly used for floors are given below, along with typical thermal conductivities. The thermal conductivity of an insulation material is a measure of its resistance to heat flow – the lower the number, the smaller the thickness required for a given insulating performance.

Insulation	Typical thermal conductivity (W/mK)
Expanded Polystyrene board (HD)	0.035
Expanded Polystyrene board (SD)	0.037
Extruded polystyrene board	0.025
Glass fibre / wool quilt	0.040
Glass fibre / wool batt	0.035
Phenolic foam	0.025
Polyurethane board	0.025

Precautions

- Ensure there is no danger of pipes below the insulation freezing.
- Design to avoid dampness problems associated with interstitial condensation, construction moisture and spillages.
- Minimise thermal bridging and associated condensation risks.
- Provide sub-floor ventilation if required.
- Check that materials in contact are compatible, e.g. polystyrene should not be in contact with PVC electrical wiring.
- Electrical wiring buried in insulation may need to be derated (ask an electrician).

All houses need a supply of fresh air, but over-ventilation in the form of draughts can be undesirable, particularly in cold, windy weather. For many homes, draught-sealing doors, windows and other gaps can be an inexpensive way of improving comfort and reducing heating bills while helping to protect the environment.

The key to applying draught seals to doors and windows is to seal the gap without making the door or window difficult to close. In many cases, a perfect seal is neither practical nor desirable, and it is sufficient to form a seal which excludes most of the draught.

This section provides an overview of the various types of draught-sealants available, their suitability to various applications and a quick guide to determining whether draught-sealing is likely to prove a financially worthwhile exercise. The 'Precautions' section, which should be consulted before commencing work, highlights the importance of ensuring that the house does not become 'over-sealed', as inadequate ventilation may result in a stuffy atmosphere and condensation problems and may even pose a safety hazard if the air supply to combustion appliances is insufficient.

Sources of draughts

In older houses, more than half of the cold outside air entering the house is admitted through the windows and doors. Other sources of draughts include attic hatches, suspended wooden floors, and spaces between window- and door-frames and wall openings. There may also be gaps around pipes penetrating external walls, floors and ceilings.

New windows and doors are generally supplied with draught-seals, but many older units are unsealed. If the opening part of the door or window does not fit tightly against the frame, draughts can enter or leave through the gap. Large gaps can generally be detected by inspection, and in cold, windy weather, it may be possible to feel a cold draught entering the house. (Bear in mind, though, that cold draughts will enter only on the upwind side of the house. On the downwind side and at the top of the building, warm air will tend to exit through gaps.)

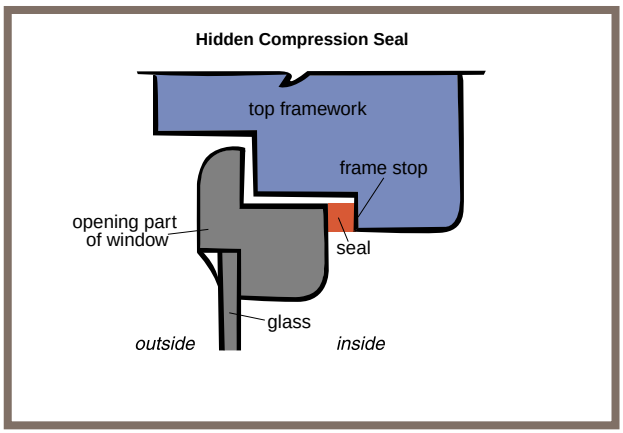
The width of the gap around windows and doors may not be uniform. Gap sizes of up to 8 mm around wood-frame windows and 10 mm for wooden doors are not uncommon. The larger the gap, the more worthwhile draught-sealing is likely to prove.

Draught-sealing products

The main categories of draught-sealing products available are compression and sliding seals, both of which are available in hidden or visible options, and fillers or sealants. Compression or sliding seals are often used for gaps between moving components, for example, the opening part of windows and doors. Fillers or sealants are generally more convenient for fixed openings, for example, at skirting boards. Examples of each type are illustrated in this leaflet. Some guidance on installing draught-stripping is also provided, though manufacturers' instructions should be followed for particular products.

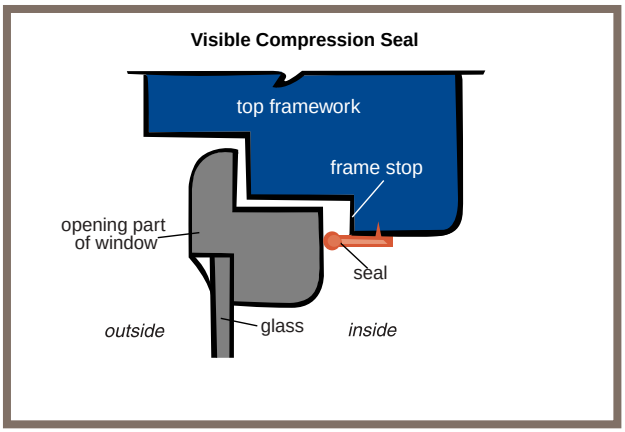
Hidden compression seals

The most common hidden-type compression seal product available is a self-adhesive foam tape. This sometimes comes with a backing that is peeled off as the tape is stuck on to the frame. Surfaces to which the strip is to be applied should be clean and dry. Generally, the strip is applied to the frame stop opposite the closing face of the door/ window. The closing face should compress the foam rather than slide across it and pull it off. If the gap at any part of the opening is too wide to be sealed by one layer of the tape, another may be applied over the first layer. On the other hand, in places where the gap is less than a millimetre or so, no tape should be applied, since it could make the door or window difficult to close.



Visible Compression seals

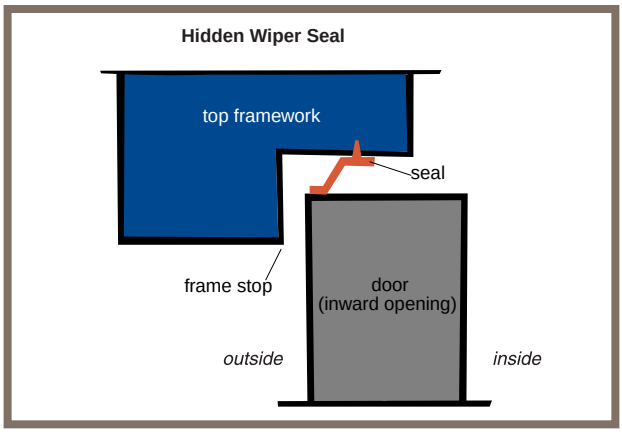
Visible compression seals are usually soft rubber or plastic mouldings mounted on a rigid support, which can be attached to the frame. They form a seal as they are deflected by the closing window/door and remain visible after closure. They may be attached by screws, tacks or adhesive, and, in the case of a metal frame, clips. It is important that the attachment used is of a weather-resistant material, for example brass or stainless steel. When fixing the strips in position, pressure should be applied gently to the soft moulding. If the moulding is applied too tightly, it may become difficult for the unit to close. For wooden windows/doors, the moulding should be compressed enough to allow for small seasonal changes in gap width.



Wiper seals

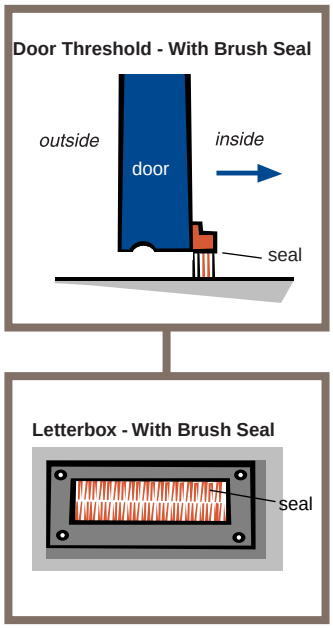
Wiper seals form a seal by sliding, normally against the closing edge of the window or door. They offer relatively little resistance to closure, and, thus, are particularly suited to large windows and doors involving a long length of seal, where the use of compression seals could make closure difficult.

Hidden wiper seals are generally metal or plastic strips and can be used if a sufficient gap (e.g. 3 mm) exists between a closing edge and the frame. If the gap is insufficient and if the visual appearance of seals is acceptable, visible wiper seals may be used. These are attached to a closing face and slide over the frame to form the seal.



Other seals

For sliding sash windows, compression or wiper seals may be used at the frame stop ends. Purpose-made seals are generally required to seal along the sliding window edges and at the junction between sashes; various types exist.



Special seals are also required for door thresholds, and brush seals are a common choice. Seals used to keep out wind-driven rain will also help to exclude draughts.

Letterboxes with just one inward-opening flap will tend to admit draughts, particularly when the wind is blowing directly on the front door. Brush seals are commonly used to reduce draughts through this type of letterbox.

Suspended wooden floors must be vented from underneath to prevent rot. This is often achieved through the use of air-bricks at the base of the outer walls. These vents should not be blocked; instead the room should be sealed from the space under the floor. Linoleum or carpet with underlay will help to prevent draughts between the floorboards, and a filler or sealant may be used to fill gaps around the skirting.

Attic hatches may be sealed with compression or wiper seals in the same way as windows and doors. If the hatch does not sit tightly against the seal, it may be weighted or bolted down. Other gaps in the top-floor ceiling, for example where pipes penetrate into the attic and around ceiling-mounted light fittings, may be sealed with filler or sealant. This will also help to avoid condensation problems in the attic.

Unused chimneys may be blocked with baffles or closed up, but a small opening should be left to air the chimney.

Economics

Draught-sealing is generally a DIY job, and sealing products may be purchased at DIY stores. Costs vary depending on the type and quality of product. Self-adhesive foam is generally inexpensive, though rubber mouldings on rigid supports, while more expensive, will be more durable. If the job is to be carried out by a contractor, it is worth investing in a high-quality, long-lasting product.

In many cases, draught-sealing will pay for itself through reduced heating bills in a matter of months rather than years. In other cases, more comfortable conditions rather than reduced bills may be the priority.

As a rough guide to determine whether it is worth draught-stripping your house, ask yourself the following four questions:

- Are windows and doors poorly fitting with gaps around the edges?
- Are there obvious draughts?
- Is the house sited in a location exposed to wind?
- Is a high level of heating required (i.e. must the house be warm for most of the day)?
- Are your fuel bills high?

For DIY installation, draught-sealing is likely to be worthwhile if the answer to at least one of the above questions is yes. For contractor installation, two yes answers should make it worthwhile.

Precautions

Adequate ventilation

Adequate ventilation is required in all houses for the following reasons:

- to provide fresh air for occupants
- to remove odours
- to remove pollutants eg. cigarette smoke
- to remove water vapour – persistent condensation can result in mould growth and damage to furnishings and the building materials.

The amount of ventilation required varies with the number of people present and related issues such as whether or not they are smokers. Ideally, ventilation should be provided through controllable ventilation openings such as slot ventilators, and the house should be well sealed to keep uncontrollable infiltration and draughts to a minimum.

In cold, windy weather for a house with only one or two occupants, infiltration may fulfil all the ventilation requirements even in a well-sealed house, so slot ventilators can be closed fully. In calm weather with several people smoking in the house, slot ventilators (and windows if necessary) can be opened.

Before draught-sealing, check for signs of inadequate ventilation such as persistent condensation and mould growth. If such problems exist, they should be addressed first, since draught-sealing may make the problem worse.

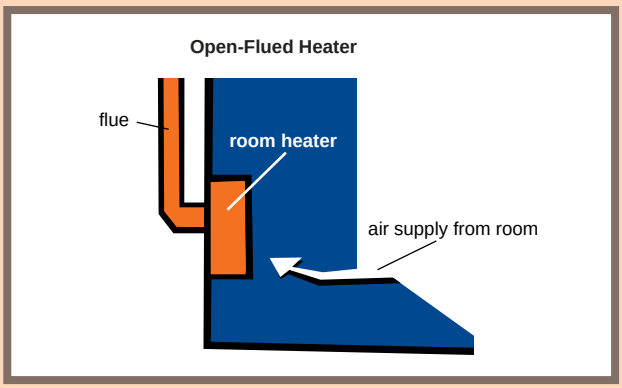
Leave a minimum of ventilation in every room. If a room does not have a vent, air brick, chimney or other ventilation source, part of the window can be left unstripped.

Evaporation of water in kitchens, bathrooms and toilets produces moist air. Windows in these rooms may be left partially or fully unstripped (depending on gap width and window perimeter length) in order to help vent moist air to the outside.

Combustion air supply

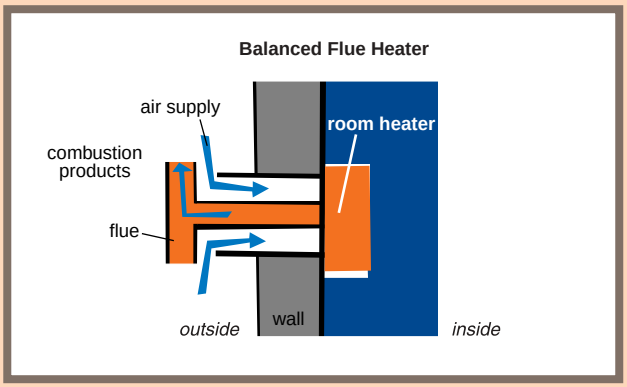
Adequate ventilation must be provided for combustion appliances that draw their air supply from the room. Examples of this type of 'open-flued' appliances include open fires, fuel-effect gas fires, and most stand-alone gas, oil, and solid fuel-fired room heaters. Ventilation is required not only to supply combustion air, but also to remove combustion products.

In rooms where these appliances are used, a lack of combustion air could lead to a build-up of carbon monoxide in the room, with potentially fatal consequences.



Building Regulations require that permanent ventilation openings are provided in such rooms. Provided adequate vents exist and are not blocked off, the room's windows may be draught-sealed. If in doubt, seek professional advice.

Air supply concerns do not apply to radiators, since no combustion occurs in these heaters. Nor do they apply to balanced flue heaters or balanced flue boilers, since these units draw their combustion air directly from the outside and are sealed from the room.



Air always contains some invisible water vapour. The amount of water vapour that the air can hold depends on its temperature - warm air can hold more water vapour than cold air. When warm moist (humid) air comes into contact with a cold surface, it will cool and may become saturated. If it cools further, some of the water vapour will condense out on the cold surface.

The people living in a house add to the water vapour in the air simply by breathing (picture your breath on a cold morning) and through activities such as cooking and bathing. Normally, this moist air leaves the house through ventilation. Ventilation not only removes moisture, but also provides fresh air for occupants to breathe, and removes pollutants and odours.

However, if moisture is allowed to accumulate in the house, some of it may condense on cold surfaces within the building, particularly in winter. Examples of such cold surfaces include

- Single glazed windows
- Cold water pipes
- Uninsulated external walls and ceilings, particularly at corners and at the north side of the house
- External walls behind large items of furniture and within built-in wardrobes
- Around the edges of window and door openings, where surface temperatures may be lower due to an uninsulated part of an otherwise insulated wall (a 'thermal bridge').

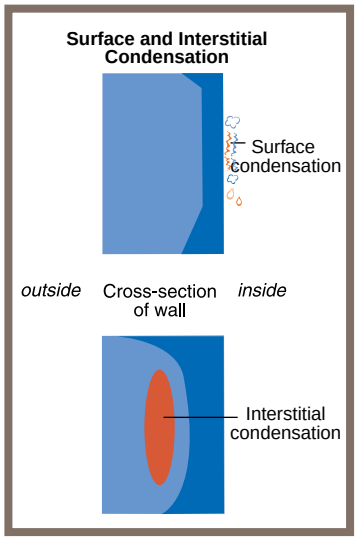
In many houses, the inside surfaces of single-glazed windows often become damp due to condensation. This is particularly noticeable in the mornings in unheated rooms in an otherwise well-heated house. However, the same process can take place on any relatively cold surface such as an outside wall. Provided the amounts of moisture are small and infrequent and that they evaporate fairly quickly, this will not usually harm the building. However, if dampness due to condensation persists for lengthy periods, it can damage the building's structure and interior decor. Signs of condensation problems include the following:

- Frequent condensation on windows in winter, with pools of water collecting on window-boards
- Mould growth on walls, ceilings or cupboard spaces located on outside walls
- A musty, damp smell, even though there may be no visible signs of dampness.

Types of condensation

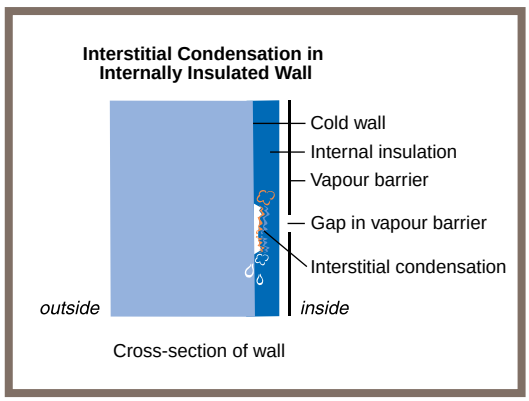
Surface condensation

The type of condensation where moisture appears on visible surfaces within the building is called surface condensation. It may be seen to occur at times when large amounts of moisture are being produced in the house or room, especially during cold weather when windows and vents are closed.



Interstitial condensation

This is condensation that occurs within external walls, floors and roofs. It occurs when warm moist air from inside the house passes through gaps in the internal surface and condenses at colder parts within. Since it cannot be seen, it is more difficult to identify. It may give rise to a damp, musty smell, and possibly mould growth on the inside surface. However, other causes of dampness can produce similar effects. Internally insulated walls with a deficient or damaged vapour barrier are particularly vulnerable to interstitial condensation.



Effects of condensation

Persistent dampness due to condensation can have the following effects:

Decay

Wood and other building materials may decay, giving rise to structural and other damage.

Mould

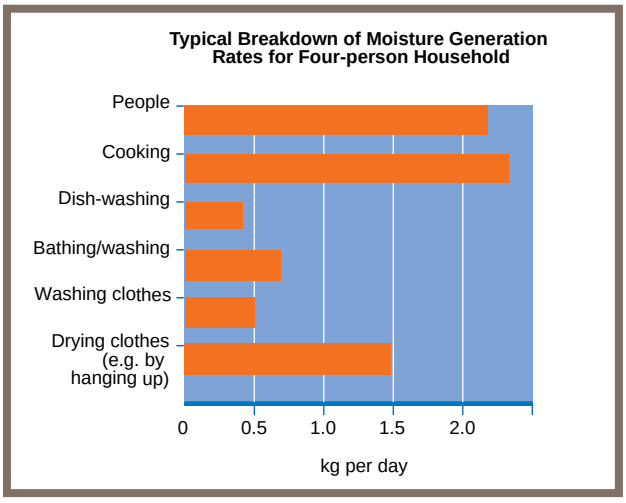
Mould grows in damp, humid, warm conditions. If a wall or ceiling is frequently damp with condensation, mould may form on it. Mould usually appears initially as spots or small patches, usually grey-green, brown or black in colour, which grow in size and number with time.

Heat loss

The effectiveness of some insulation materials will be seriously reduced by dampness. If insulation becomes damp, either through condensation or by other means, heat loss from the house will increase. In addition, the insulation and the room surface inside it will then be colder, increasing the likelihood of further condensation.

Sources of moisture

A typical four-person household (two adults and two children) may produce in the region of 5 to 12 kilograms of water vapour per day. The main sources include breathing (exhaled air contains more moisture than inhaled air), cooking, bathing, clothes drying and the use of free-standing (i.e. flueless) gas and paraffin heaters.



Controlling surface condensation

To reduce condensation, do one or both of the following:

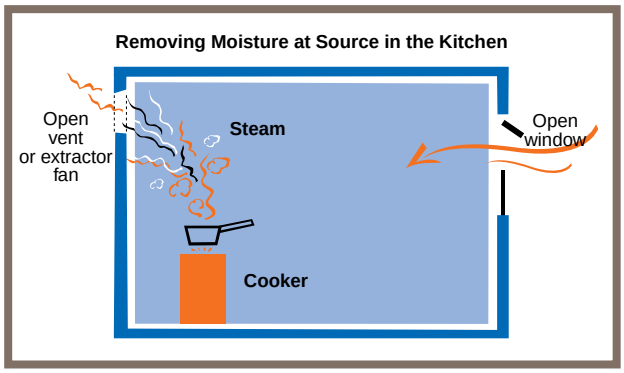
- Reduce the amount of water vapour in internal air, by removing moisture at source and/or increasing overall ventilation rates.
- Increase internal temperatures, by insulation and/or additional heating.

Remove moisture at source

When cooking, particularly when generating lots of steam, open windows and vents in the kitchen to let out the steam and close the kitchen's internal door to prevent the steam from entering the rest of the house. If there are vents or open windows in two walls, this will help to provide ventilation across the room even on days with only a slight breeze.

An extractor fan or cooker hood will help to remove steam and moist air. Since such fans extract heat as well as moisture, closing the kitchen's internal door will prevent heat from being extracted from the rest of the house. Air extracted must be replaced by air intake somewhere else, so another vent in the kitchen may need to be opened to allow replacement air to be drawn in.

When bathing, close the door and open the fly window a little while bathing or more immediately afterwards. In internal bathrooms mechanical or stack ventilation is required. This should be controlled so that it is not left switched on for any longer than required, since it extracts heat as well as moisture.



Dry clothes outdoors whenever possible. If hanging clothes up to dry in a utility room, close the internal door and open a window or vent slightly (not too much, otherwise the room will cool down, reducing the drying rate). Always vent tumble dryers to the outside.

Free-standing heaters (i.e. those with no flue to the outside) burning fuels such as gas or paraffin release water vapour into the room as they operate. Burning one litre of paraffin will produce about one kilogram of water vapour. In rooms with such heaters, adequate ventilation is always required not only to remove water vapour and other combustion products (fumes) from the room, but also to supply combustion air to the heater. In buildings vulnerable to condensation, a heater with a flue to carry fumes to the outside is preferable.

Ensure adequate ventilation

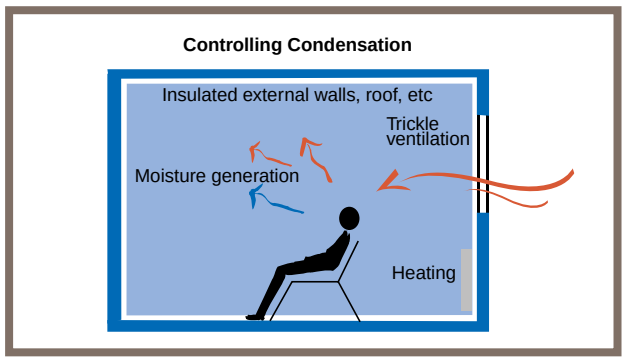
The ventilation rate should be high enough to prevent the build-up of moisture (and pollutants) in the indoor air, but should not be so high that it causes excessive heat loss. The optimum ventilation rate will vary depending on what activity is going on and the weather conditions on the day. In well-sealed houses (e.g. those with draught-stripped doors and windows, blocked-off chimneys, etc.), ventilation should be provided through controllable openings such as trickle vents or windows that can be secured in a marginally open position. These can be adjusted by occupants in response to ventilation requirements. For example, they might be opened on calm days when large amounts of moisture are being generated in the house, and closed on windy days when little moisture is being produced. Signs such as misting up of windows indicate the need for increased ventilation.

Insulation

Insulation of the building will raise internal surface temperatures, reducing the likelihood of surface condensation. Also, whatever condensation does occur will evaporate more quickly. Similarly, the use of double glazing or, better still, low-emissivity double glazing, rather than single glazing, will reduce the likelihood of condensation on windows. If aluminium window-frames are to be installed, these should have a 'thermal break', otherwise condensation may occur on the frame itself.

Heating

Additional heating will have a similar effect to insulation - it will raise internal temperatures and reduce the incidence of condensation. Ventilation will still be needed to prevent the accumulation of moisture.

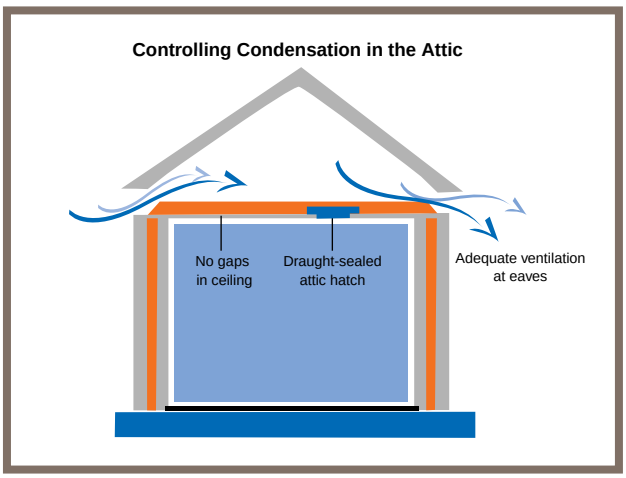


Controlling interstitial condensation

If interstitial condensation is suspected, check for any gaps or holes in the surfaces of external walls, the ground floor and the top-floor ceiling, and seal these to prevent moist air from getting inside. The methods for reducing surface condensation described above will also help. If the problem persists, seek professional advice.

Condensation in the attic

If there are gaps in the ceiling of the top floor, warm humid air from the house may pass through the ceiling into the attic, where it may condense on cold surfaces. This may cause rotting of timber or, if it drips down onto insulation, reduced effectiveness of insulation and increased heat loss.



To avoid attic condensation problems:

(a) Ensure that there is adequate ventilation in the attic. In conventional pitched roofs (unconverted), there should be a gap at the eaves on opposite sides of the roof to allow cross-ventilation above the insulation. It is recommended that the area of these gaps should be equivalent to a continuous opening of not less than 10 mm (about a half-inch).

(b) Seal any gaps in the ceiling below the attic. The attic hatch should be draught-sealed (light-weight hatches may need to be clamped or weighted to ensure adequate pressure against the seal). Gaps around pipes or light fittings penetrating the ceiling and cracks at wall-heads should be sealed.

(c) Ensure that the water tank and pipes in the attic are insulated to avoid condensation on them.

Further tips

- When cooking by boiling, keeping lids on pots will reduce steam generation as well as saving energy.
- Do not allow water that has condensed on cold water pipes to run down to where it may cause damage or present a safety hazard.
- If condensation occurs within cupboards mounted on external walls, leave the cupboard doors open to ventilate the affected surfaces. Insulate the wall at the back of the cupboard to prevent recurrence.
- Some new buildings can take time to dry out. Extra heat and ventilation may be needed to evaporate moisture during the first winter after construction and care may be needed in mopping up condensation.

Other causes of dampness

Apart from condensation, other possible causes of dampness in buildings include

- Rain penetration through walls, roofs or around window and door openings.
- Rising damp, i.e. moisture from the ground rising up within a wall or floor.
- A leaking pipe, tank or gutter.
- Drying out of a newly-constructed house or a house that has recently been flooded.

If the dampness problem is not solved by the measures described in this leaflet, it may be due to a cause other than condensation, and professional advice should be sought on how to deal with it.

The Building Regulations Technical Guidance Document Part L defines two types of U-value, the elemental U-value as detailed below and the overall U-value (Um). The latter is given by:

$$\frac{\text{The sum of each elemental U-value multiplied by its respective area}}{\text{Total building area}} = \frac{\text{Total AU}}{A_t}$$

The heating energy performance of a new building design can be predicted using a standardised method called the Heat Energy Rating Method (HER). The result is usually expressed in kilowatt-hours per square metre of floor area per year (kWh/m²). A U-Value calculator for walls, floors and roofs is also provided in the HER software. The range of energy consumption of a dwelling house under the new 2002 Building Regulations is designed to fall in the range of 80 to 102 kWh/m²y. However, it is possible to achieve a fuel consumption much lower than this through measures referred to in this booklet.

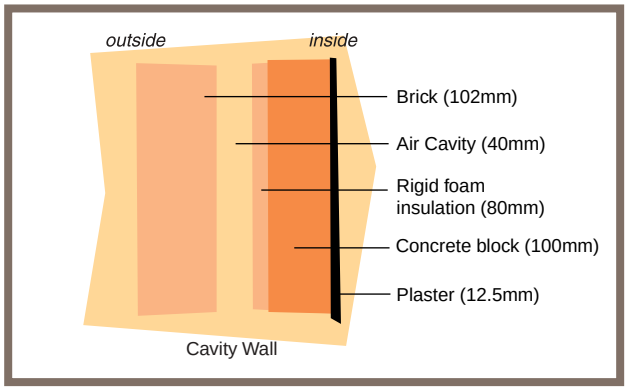
The Technical Guidance Document L incorporates a provision whereby an energy rating procedure can be used to demonstrate compliance.

How to Calculate the U-value of a Wall

The U-value of a building element (wall, floor, roof or window) is simply one divided by the total resistance of that element or:

$$\text{U-value (U)} = \frac{1}{\text{Element Resistance (R)}}$$

By way of example, let us consider a typical wall:



To calculate the U-value of this wall we must first calculate the combined thermal resistance of the various layers to account for heat lost due to conduction.

Thermal resistance or R is:

$$R = \frac{\text{Thickness of the material}}{\text{Conductivity}} = \frac{l}{k} \quad \frac{m}{W/mK} = m^2K/W$$

For a wall made of numerous layers:

$$R = \frac{1_l}{k_l} + \frac{1_2}{k_2} + \frac{1_3}{k_3} + \text{etc.}$$

For our example:

	Brick		Rigid Foam		Concrete		Plaster
R =	0.102 / 0.84	+	0.080 / 0.025	+	0.1 / 1.13	+	0.0125 / 0.16
=	0.12	+	3.2	+	0.09	+	0.08
=	3.49 m²K/W						

Note the difference in the resistance of the insulation when compared to the other materials.

Now we can include the thermal resistance of the surfaces:

Outside surface	0.06 m²K/W
Inside surface	0.12 m²K/W
Air cavity	0.18 m²K/W

The total thermal resistance of the wall is:

R = 3.49 + 0.06 + 0.12 + 0.18

= 3.85

Therefore, the U-value is

$$U = \frac{1}{R} = \frac{1}{3.85} = 0.259 \text{ W/m}^2\text{K}$$

Building Regulations Technical Guidance Document Part L indicates that the elemental U-value of a wall should be a maximum of 0.27 W/m²K. Therefore this wall complies.

Useful contacts for further information

SEI, Glasnevin, Dublin 9. Energy Hotline: 1850 376666
Irish Agrément Board, Glasnevin, Dublin 9. Telephone: (01) 8073800
National Standards Authority of Ireland, Glasnevin, Dublin 9. Telephone: (01) 8073800
Insulating Contractors Association
Irish Home Builders Association
Roofing and Cladding Contractors Association
Irish Window Association
Construction Industry Federation, Federation House,
Canal Road, Dublin 6. Telephone: (01) 4977487

Relevant Standards

Irish Standards

IS 260:1984, Mineral Fibre Material for Thermal Insulation of Buildings

IS 298:1987, Thermal insulation of Pipes, Ducts and
Storage Vessels

Irish Building Regulations 2002

Technical Guidance Document Part L, Conservation of Fuel and Energy
Technical Guidance Document Part F, Ventilation
Technical Guidance Document Part B, Fire
Technical Guidance Document J: Heat Producing Appliances.

Irish Agrément Board Certified Products

The Irish Agrément Board assesses, tests and certifies insulation products for compliance with the requirements of the Building Regulations. An index of certified products is available from the Irish Agrément Board.

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