Action for Warm Homes

NATIONAL ENERGY ACTION

# ENERGY ADVICE IN THE HOME

## A PRACTICAL RESOURCE

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# Introduction

## This booklet is a valuable introduction for anyone wishing to learn about domestic energy use, or in preparation for giving energy efficiency advice.

This course book is a valuable introduction for anyone wishing to learn about domestic energy use or in preparation for giving energy efficiency advice. It is designed to accompany attendance on the NEA Energy Awareness course and helps prepare for the City & Guilds Level 3 Award in Energy Awareness exam (6281-01).

National Energy Action (NEA) is the national charity seeking to end fuel poverty. We work across England, Wales and Northern Ireland, and with our sister charity Energy Action Scotland, to ensure everyone can afford to live in a warm, dry home. In partnership with central and local government, fuel utilities, housing providers, consumer groups and voluntary organisations, we undertake a range of activities to address the causes and treat the symptoms of fuel poverty.

The first edition of Energy in the Home was published in 1988 and was adapted from an Open University short course of the same name, which was published in 1978. Originally written by Julia Green and Wendy Innes, it has been issued to all participants on the NEA Energy Awareness course since 1990.

The domestic energy industry has changed almost beyond recognition since those days, changing from nationalised coal, gas and electricity boards to the independent suppliers we have today and the introduction of ever evolving renewable energy supplies. In response, this booklet has been updated regularly and is now in its 10th edition.

**This booklet is divided into seven subsections:**

1. Heat loss and heat balance
2. Insulation
3. Space & water heating systems
4. Heating controls
5. Energy use, meters, bills, paying & switching
6. Condensation & dampness
7. Renewable energy
8. Glossary of Terms
9. Index

# Heat loss & heat balance

**HEAT LOSS & HEAT BALANCE**

Energy cannot be lost,
it can only be transferred
from one place to another

# Introduction

**This section will look at the forces that move heat and energy and how building fabric affects the rate this happens.**

## Heat Balance

**Nature loves everything to be in balance.**

This law of nature is true for heat, which will always flow from a hot area to a cold area, until both areas are the same temperature; then it stops flowing. Another law of nature to bear in mind is that energy cannot be created or destroyed, rather it transforms from one form to another.
This can happen by different methods: radiation, conduction and convection.

- **Radiation** is how heat travels from the sun. It radiates out in straight lines from the sun and we can also see radiation as light. This is how glowing heaters are designed to work. Note that all hot surfaces radiate heat, even if they are not glowing.
- **Convection** is how heat travels through a gas or a liquid. As the gas or liquid warms, it rises upwards and is replaced by the cooler parts. The air in a home moves around like this, moving heat from one area to another. This is how a radiator mainly heats the air in a room.
- **Conduction** is how heat travels along a material such as a metal bar, as it moves between the molecules inside the bar. This is how heat can travel through glass, bricks, wood and plastic too. Heat moves from the cooker flame through the pan and into the food by conduction.

This means that all heat put into a house on a cold day will leave the house, trying to create this heat balance. The heat may enter a house from the heating system, but it also is added from the people and animals living in it, from the heat of the sun and from all electrical appliances. Note how hot the vacuum cleaner gets when it is being used and this is true of all appliances.

Because of this, every kWh of heat energy that is put into a house must leave the house when it is cold outside. You should be aware that when we turn on our heating to warm the house, it is actually trying to heat the whole planet. Obviously, we want to minimise the heat loss and to do this we resort to insulation.

The heat balance of a property is affected by the efficiency of the heating and the structure, which since the early 1990s has been measured by a Standard Assessment Procedure (SAP) on a scale of 1 to 100. Since 2007 this SAP procedure has been used in a simplified form (RdSAP) to create Energy Performance Certificates, which are required for all properties as they are sold or let. Again this EPC gives a rating of 1 to 100 for energy efficiency and puts the property in a band from G to A. The EPC document also gives information on savings that can be made by improving the energy efficiency of the property.

*See the Energy awareness course notes for an example of an EPC.*

## Heat Loss

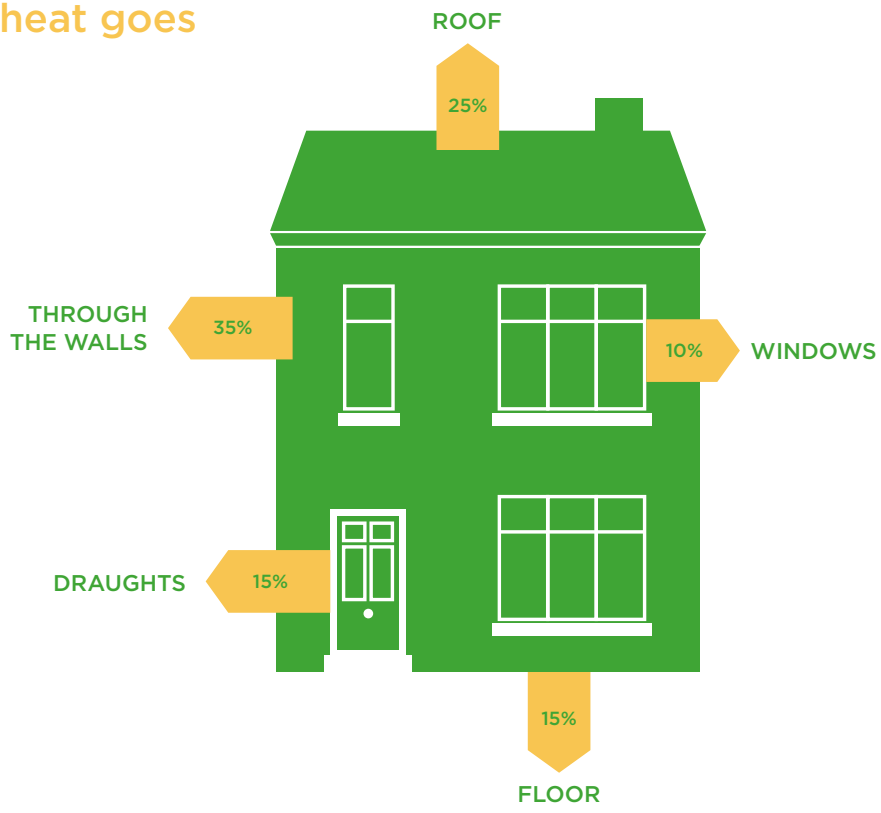
Heat is lost from a property in several ways.

- Fabric heat loss: where heat escapes through the building materials.
- Ventilation heat loss: where heat escapes as air blows through gaps in the building materials.
- Water heat loss: where heat is lost as hot water goes down the plughole or sink.
- Flue heat loss: where heat is lost up chimneys and through flues of fuel burning appliances, which affects the efficiency of the appliance.

The diagram overleaf shows that in a typical un-insulated semi-detached property 35% of heat is lost through the walls, 25% through the roof, 15% through floors, 15% through draughts and 10% through windows. This shows why there is an emphasis on roof and wall insulation, as it can be relatively cheap to install and can reduce the heat loss drastically. In fact, the result of insulating this house properly could reduce heat loss to 42% in comparison to its original condition.

# Heat loss & heat balance

## Where the heat goes




## FABRIC HEAT LOSS

**Fabric heat loss is caused by heat moving through a building element or fabric.**
Heat is lost through the fabric of a property by conduction, so it is measured as thermal conductivity. The rate of thermal conductivity through a fabric of a property depends upon the difference in temperature between inside and outside, as the greater the temperature difference, then the faster heat will flow to the cold area. It also depends upon how quickly heat can travel through the different types of fabric in the property, which can vary greatly.
The rate at which heat can travel through the fabric of a building is measured as a "U-value" in $W/m^2K$ or Watts per square metre per degree Centigrade difference between the outside temperature and the inside temperature. When calculating a U-value of a wall for example, you must account for the area and thickness of each type of building material in the wall; then add them up to find the total heat loss in $W/m^2K$. The lower the U-value, the lower the heat loss.

## Typical U-Values for common building structures:

| | |
|---|---|
| Single glazed metal-framed window | 5.8 |
| Single glazed wood or uPVC window | 4.7 |
| Double glazed wood or uPVC window with argon fill and "low-e" glass | 2.0 |
| Triple glazed wood or uPVC window with argon fill and "low-e" glass | 1.3 |
| Solid brick wall | 2.1 |
| Solid brick wall with 62.5mm insulation | 0.3 |
| Cavity wall brick and brick | 1.5 |
| Cavity wall brick and brick with cavity fill | 0.6 |
| Cavity wall brick and block | 1.0 |

## Typical U-values for common building structures:

| | |
|---|---|
| Cavity wall brick and block with cavity fill | 0.45 |
| Pitched roof without insulation | 2.1 |
| Pitched roof with 50mm insulation | 0.6 |
| Pitched roof with 150mm insulation | 0.26 |
| Pitched roof with 270mm insulation | 0.16 |
| Flat roof without insulation | 2.0 |
| Floor with solid concrete | 0.8 |
| Floor with solid concrete and 90mm insulation | 0.22 |
| Floor with suspended timber | 0.7 |

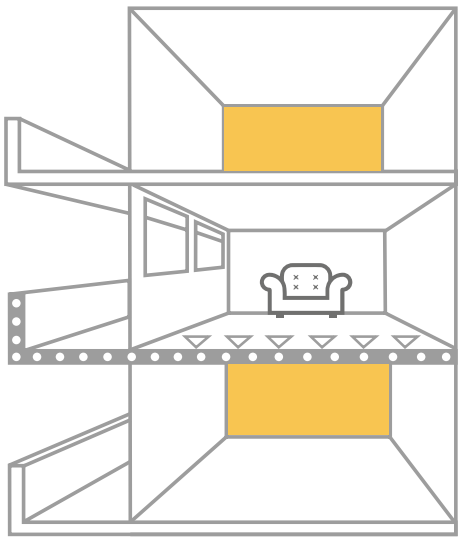
**The actual fabric heat loss depends upon the type of fabric, the area and thickness of the fabric and the temperature difference either side of the fabric.**

The Building Regulations - Part L specify the U-Values that must be achieved for each building element and it is up to the building designer to specify a building method, which meets these standards. The first time this was included in building regulations was 1965 and they are applied to new-build properties and to the renovation or extension of properties.

At the end of this section are tables which compare the U-values of building surfaces pre and post insulation.

## COLD BRIDGES

In some properties a cold area is created on a wall or floor by a cold bridge. This is where a structure such as a concrete or steel lintel or a concrete balcony floor crosses though an insulated surface. It allows heat to travel out of the home by conducting heat quickly from the inside of the home to the outside. This ability to move heat quickly will create a cold surface inside which feels cold to the touch and which can become damp due to condensation in the home.



The concrete floor is causing a cold bridge to the balcony and a cold spot on the floor

## Ventilation Heat Loss

Ventilation heat loss can be wanted or unwanted and is caused by movement of air and it happens mainly as doors and windows are opened or if they are badly fitted. Gaps in building materials allow air to flow in and out of a property too.

Warm air flowing out of a property will take heat with it. At the same time cold air from outside will replace it by entering the building elsewhere, cooling the home. This is caused by convection of the air, which we call draughts or wind.

The gaps can be around window frames or door frames, through loft hatches, behind and under skirting boards, between floor boards, around pipes and wires that leave a building, around joists that are hung on a cavity wall and through cracks in a wall.

Reducing ventilation in a home will reduce heat loss, but it is vital to allow some ventilation because.

- Some carbon burning heating appliances will require a fixed vent to be installed nearby, which is to ensure a supply of oxygen for fuel combustion.

# Heat loss & heat balance

- A little ventilation is required to maintain good air quality in a home, so we have clean air to breathe.
- Appropriate ventilation is required to reduce the risk of condensation dampness.

The rate at which air is lost from a building is measured in air changes per hour (ACPH) and this is now also included in the Building Regulations. Ideally, a home should have between half and one ACPH, to ensure good air quality in a home. [The building regulations measure this as $m^3/(h.m^2)$ at 50Pa, which is cubic metres per hour per square metre at 50 Pascals which is the pressure differential between inside and outside].

**Specific areas of heat loss:**

Windows lose a lot of heat per square metre because the glass is very thin. However, by controlling the area of glass to a modest amount, the actual heat loss is typically only 10%. Windows can lose heat through draughts too of course. By installing UPVC double-glazing, the fabric heat loss is halved and the ventilation heat loss is minimised. Triple glazing, argon fill and low emissivity glass will reduce heat loss further too. Draughtproofing of badly fitting window frames is important to improve comfort and reduce fuel bills.

Doors can be a major source of ventilation heat loss if they are badly fitting. They also lose heat because they are thin, but newer insulated UPVC doors are designed to reduce the U-value from about 3.0 to 1.8 $W/m^2K$. Again, as two external doors are only about $4m^2$ in total, the overall effect should not be too noticeable.

Walls are quite thick, but bricks conduct heat fairly well and they have a large area, perhaps $100m^2$ for a semi-detached house. Therefore, unless they are insulated, they will lose a lot of heat. Traditional brick walls are solid and can allow water to soak through the bricks, increasing heat loss through evaporation. In an effort to reduce this, cavity walls were developed and by 1930s widely built. They have a cavity gap between the inner brick and the outer brick, which is usually 50-75mm wide and it prevents the passage of water from the outer leaf to the inner leaf. In the 1980s the inner leaf of brick was replaced with blocks, which lose heat much more slowly. In 1989 it became a requirement to insulate external walls as they are built, from now on, heat loss from walls has reduced.

Roofs are responsible for a great deal of heat loss because heat rises and the materials in an old original roof are very thin: the ceiling is perhaps only 10mm thick. This is why it is vital to insulate roofs, whether they are flat roofs, empty lofts or they have rooms built into them. A flat roof is exposed to the elements, whereas a pitched roof will have the protection of the pitch, so it may reduce heat loss compared to the flat roof. As warm air rises, the roof will lose a lot of heat through the fabric, but can also lose a lot through ventilation, if the loft hatch is not draughtproofed.

Floors are less of an issue as heat rises, but the ground floor can still contribute to heat loss.

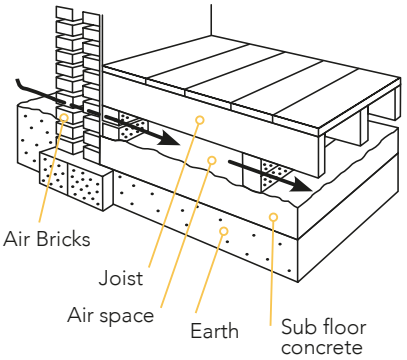
There are three types.

- Suspended timber, which will lose heat by ventilation as well as conduction.
- Solid concrete, which should not cause ventilation heat loss, but has slightly more conduction heat loss than timber.
- Suspended concrete (pot & beam), which has concrete beams suspended between walls.

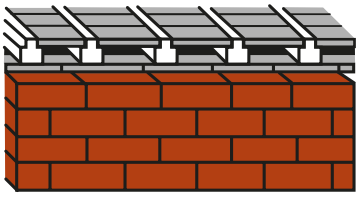
Suspended timber floors are the ones we recognise with wooden floor boards, which are nailed to the strong wooden joists that hold the floor off the ground. Wooden floor boards has been replaced by chipboards for some years. Pot and beam floors emulate the suspended timber floors, but they are made of concrete blocks laid between concrete joists and will normally be insulated when built. Under the suspended floor is a void, which needs to be well ventilated to reduce condensation and damp problems.

Solid concrete floors are merely a mass of concrete laid onto the ground, so they need a vapour barrier to be laid, which prevents damp rising through it. They will lose heat quickly at the edges due to the cooling effect near the outside walls.

*Suspended timber floor:*




*Pot and beam concrete:*



Below is a table with basic details of building regulations part L since 1965, showing the main developments in heat loss requirements up to the 2010 regulations. There are a few notable dates, such as 1989 when walls and floors would need to be insulated and 1995 when double glazing would need to be fitted.

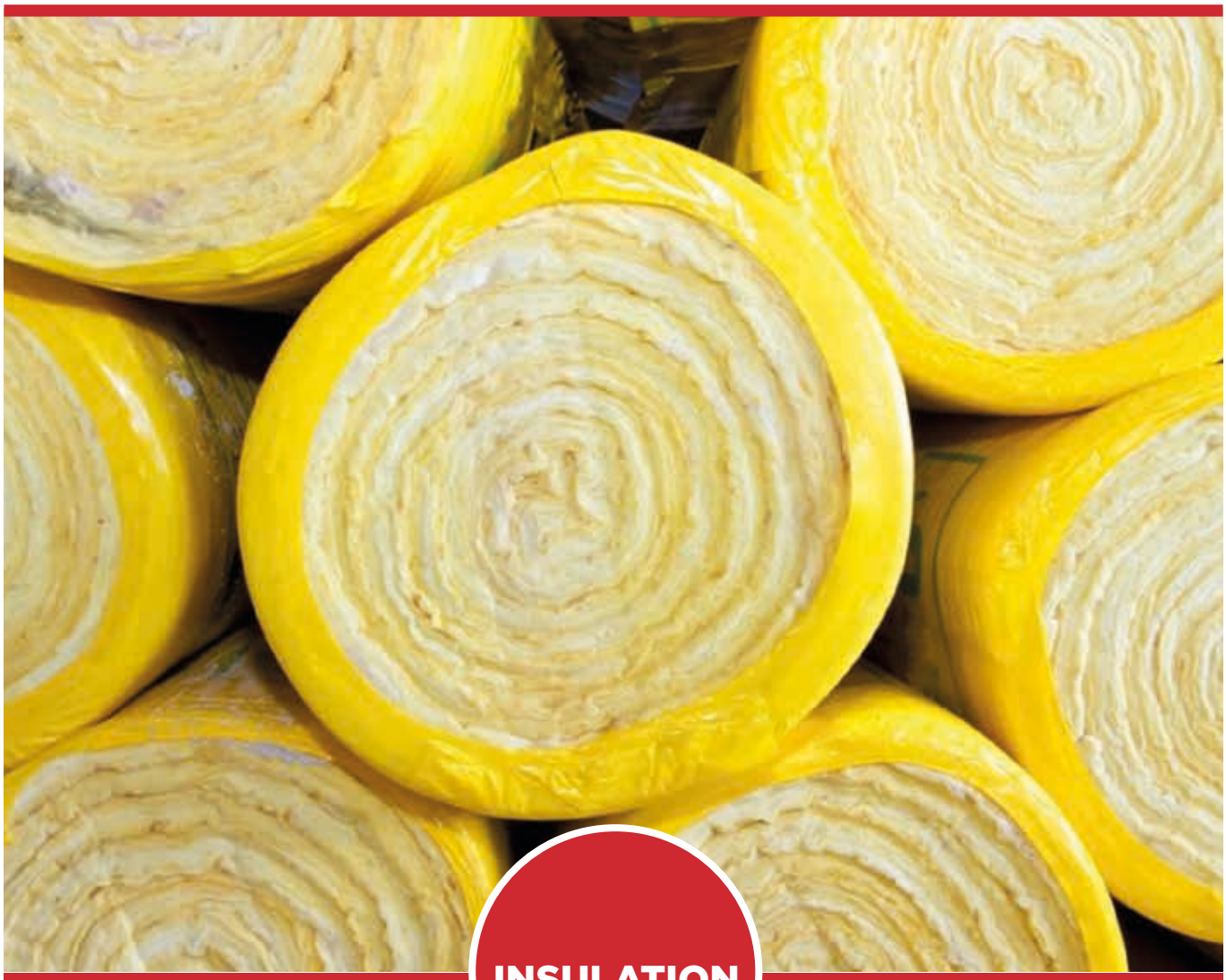
| **Regulation date and number** | **Roof** U-value (Insulation thickness) | **Walls** U-value (Wall type) | **Floors** U-value (Note) | **Windows** Requirements |
|---|---|---|---|---|
| 1965 Regs. No 1373 | 1.42 (25mm) | 1.70 (brick-cavity-brick) | 1.42 (Only if exposed) | Not mentioned in Regs |
| 1976 Regs. No 1676 | 0.60 (50mm) | 1.00 (brick-cavity-block) | 1.00 (Only if exposed) | Average U-value <1.8 |
| 1981 Regs. No 1338 | 0.35 (100mm) | 0.60 (brick-cavity-block) | 0.60 (Only if exposed) | Max 12% of perimeter wall, if single glazed |
| 1989 Regs. No 1119 | 0.25 (150mm) | 0.45 (The wall needs to be insulated) | 0.45 all floors (The floor needs to be insulated) | Max 12% of perimeter wall, if single glazed |
| 1995 Regs. | 0.25 (150mm) | 0.45 | 0.45 | Will need to be double glazed. Max 22.5% of wall area |
| 2000 Regs. | 0.20 (200mm) | 0.30 | 0.25 | 2.0 windows and doors |
| 2006 Regs. | 0.20 (200mm) | 0.30 | 0.22 | 2.0 |
| 2010 Regs. Part L1A for new dwellings page 1 | 0.20 (200mm) | 0.30 | 0.22 | Window & door 2.0 |
| 2010 Regs. Part L1B for renovating existing dwellings | 0.16 at ceiling level. (270mm) 0.2 (In rafters or a flat roof) | 0.30 solid wall (internal or external) 0.55 cavity wall insulation. | 0.22 | No change |

## Energy savings achieved by installing measures

| **Measure** | **Average U-value reduction W/m²K** |
|---|---|
| 80mm hot water cylinder jacket | 6.0 to 0.5 |
| Simple DIY secondary glazing, such as window film | 4.7 to 3.0 |
| Draughtproofing of windows and external doors | Reduced ventilation heat loss |
| Draughtproofing of skirting, floor boards etc. | Reduced ventilation heat loss |
| Loft insulation 50mm topped up to 270mm | 1.85 to 0.16 |
| Cavity wall insulation 50mm mineral wool | 1.5 to 0.6 |
| Cavity wall insulation 50mm foam | 1.5 to 0.3 |
| Solid wall 62.5mm external foam insulation | 2.2 to 0.3 |
| Solid wall 62.5mm internal foam insulation | 2.2 to 0.3 |
| Ground floor insulation concrete with 90mm foam floating floor | 0.8 to 0.22 |
| Suspended timber floor with 100mm foam insulation | 0.7 to 0.22 |
| Double glazing with argon fill and low-e glass in wood or uPVC | 4.7 to 2.0 |

The rate at which air is lost from a building is measured in air changes per hour and this is now also included in the Building Regulations.

# Insulation



**INSULATION**

The more difficult it is for heat to escape, the less heating a house will require

# Introduction

**If a home is to be kept at an even temperature, then all the heat which escapes from it has to be replaced by heat that is being put in, for instance, from fires and heaters.**

So the more difficult it is for heat to escape, the less heating a house will require. In this section we will look at measures for reducing both fabric heat loss and ventilation heat loss.

## Insulating walls

Outside walls lose a lot of heat both by fabric and ventilation heat loss and there are no simple or cheap ways of reducing this. It can only be achieved by insulating the walls which can be expensive.

Older homes in the UK usually have solid walls or cavity walls. As a general rule, homes built before the 1930s have solid walls, and most of the houses built between the1930s and the present day have cavity walls. Those built since the early 1990s tend to have timber frame walls, which had insulation built into them at the time they were constructed. Identifying which type of walls a house has is not always straightforward, but if you know the age of the house, this may help.

In general, cavity walls are around 280mm thick and solid walls are only 230mm. The rule of thumb for distinguishing between the two types of wall in brick-built homes is that if all the bricks are laid side-on, then the house will have cavity walls; and if there is any type of systematic arrangement of side-on and end-on bricks, then this will usually indicate the wall is solid. If the bricks are all side-on and there are weep holes above the windows and doors, then it is likely to be a timber frame cavity wall.

*Solid wall (Some bricks showing their end or header)*

*Cavity wall (All bricks showing their side or stretcher)*

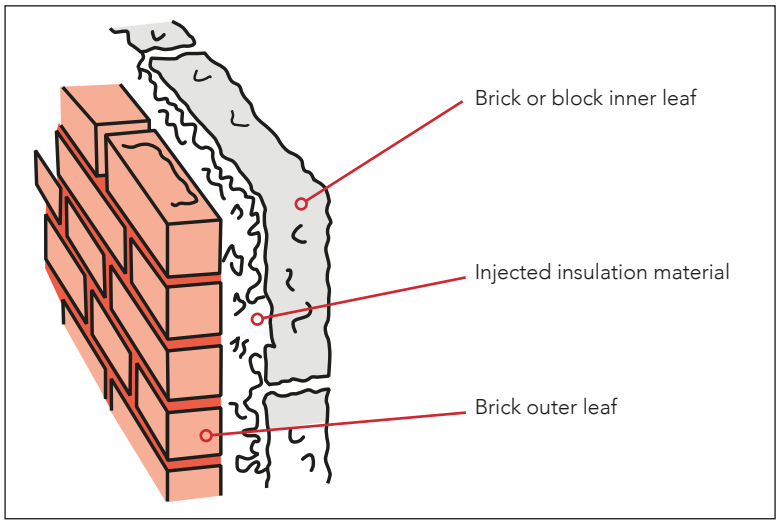
## Cavity walls

Cavity walls can be insulated in a number of ways but the most convenient method is where a series of holes are drilled in the mortar on the outside of the wall and insulation material injected into the gap between the inner and outer walls. Three main types of insulating materials are available.

- Mineral wool fibre, a glass or rock-based fibre, spun very finely and blown into the cavity in a dry state. This is the most popular option.
- Expanded Polystyrene or Polyurethane beads or granules, which are blown into the cavity and coated with a binding agent which holds the beads inside the wall.
- Foam, originally ureaformaldehyde foam was used, but it was banned as it has a 'drying out' period of several weeks and during this time a small amount of formaldehyde gas was emitted. These days polyurethane foam is usually used. The foam is pumped into the cavity in fluid form. Polyurethane foam acts to enhance the structural strength of a wall and is fully water resistant.

All three materials will reduce heat loss to a similar degree by providing a fabric which is a poor conductor of heat. In today's new houses, cavities are insulated as the walls are being built, avoiding the need to drill holes in the walls.

# Insulation



### Points to remember

- The original purpose of cavity walls was to prevent the spread of dampness to internal walls, so it is very important that the material chosen to fill the cavity is moisture-repellent and the cavity is checked prior to installation. Different insulation materials may be suitable for different houses, according to age, condition and location.
- When cavity insulation systems were first introduced a number of performance defects arose related to the spread of dampness across the cavity.
- There is no simple way of checking cavity wall insulation has been installed correctly. For this reason it is always advisable to use a contractor who will issue a cavity wall guarantee certificate.
- This is produced by the Cavity Insulation Guarantee Agency (CIGA) covering work standards and the materials used. Several estimates for the cost of the work should be sought, as the cavity wall insulation business is very competitive and prices may vary significantly.

### Benefits

- Whichever material is chosen, cavity wall insulation should reduce the U-value of the wall on average from 1.5 to 0.45.
- It will make a home feel more comfortable and can substantially reduce fuel bills. Cavity wall insulation probably provides the best value for money of all the medium-cost insulation measures.

## Solid walls

To insulate solid walls effectively, an extra layer of insulation is added to one side of the wall, either on the inside or the outside. Both methods involve a great deal of expense, and so insulating solid walls may not be a priority, unless a wall is on an exposed side of the house or is particularly cold for some other reason. Of the two methods available for insulating a solid wall, internal insulation is usually preferred, because it is cheaper and slightly less complicated. With internal insulation you are also free to choose the number of walls you want to insulate, whereas with external insulation the whole house may have to be insulated at one time. Many stone built properties in conservation areas may only be internally insulated due to planning laws.

## Internal wall insulation

This is sometimes referred to as 'dry lining' and involves insulating the inside of the wall using one of two methods, each using a different type of material.

- Insulation/plasterboard laminates are ready-made insulation boards, which are fixed directly to the wall with plaster dabs or on timber studs. Boards usually consist of plasterboard backed with 12-50mm of insulation. A polythene 'vapour barrier' is built in between the plasterboard and the insulation, to prevent penetration of water vapour.
- Wooden battens fixed to the wall are infilled with insulation. The spaces between the battens are filled with insulation (either mineral fibre or a foam board) and then new plasterboard is fixed to the battens. A polythene sheet stapled directly onto the battens provides a vapour barrier.

**Points to remember**

- There are a number of drawbacks in installing this type of insulation.
- The work can involve a considerable degree of upheaval, as all internal fittings on the insulated wall such as doors and window mouldings, skirting boards and electrical points need to be removed and re-sited.
- The extra layer of insulation in the wall will also mean the size of the room will be reduced; in addition the new wall surface may not be strong enough to support shelves or cupboards.
- If the vapour barrier within the wall is damaged or broken in any way, there may be a risk of condensation occurring within the walls. This is a form of interstitial condensation which occurs within the fabric of a building and, if undetected, can seriously damage building materials.

***Comfort within the home will improve significantly if insulation is added to an outside wall***

If 60mm of foam insulation is added, then the U-value of the solid brick wall will be reduced from 2.1 to 0.3, which is a better U-value than an insulated cavity wall. However, it can be a relatively high cost measure; so depending on how well the house is heated, the payback period might well be several times that of cavity wall insulation. Unless the inside surface of an outside wall is in need of replacement or re-plastering (when insulation can be added for a little extra cost), the work cannot usually be justified in financial terms alone.

*Unless someone is very experienced at DIY jobs, internal insulation work should be carried out by a professional contractor.*

## External insulation

To insulate a wall from the outside, insulation is fixed to the external wall and then a protective weatherproof finish is added to the outside surface. The process is also often referred to as 'thermal cladding'.

The insulation can be mineral fibre or one of the foam products listed earlier. If mineral fibre is used, then a reinforced - wire mesh layer is added, which helps to secure the insulation to the wall by fixing plugs to the wall surface. A cement/sand render is then added as a protective finish. If the foam products are used, the protective render can be applied directly to this.

***Picture:*** *External wall insulation with a mesh layer and fixed to the wall with special nails, then a brick-effect render is fixed with adhesive.*

**Points to remember**

Applying external wall insulation involves major structural refurbishment and may require planning permission. A specialist contractor should always be used. The work may take some time and costs for weather-resistant materials and scaffolding-hire will add to the expense.On the plus side, installing insulation externally will cause the household less disruption than the internal 'dry lining' process. Any problem of rain penetration will be tackled at source by the new waterproof layer around the house, and there will be no risk of interstitial condensation occurring within the wall.
A number of products are available of varying thickness and U-values.
Applying external wall insulation may be useful to deal with cold bridging problems associated with internal wall insulation or cavity wall insulation.

# Insulation

**Benefits**

Installing 50mm of insulation to the outside of an average semi-detached house will result in the same U-value change achieved by adding internal insulation installed to the same depth. This is a reduction from 2.1 to 0.45 W/m$^2$K. The house will be more comfortable to live in and its external appearance may also be improved. Applying 62.5mm of phenolic foam as external wall insulation will lower the U-value of a solid brick wall from 2.1 to 0.3 W/m$^2$K. This is a very expensive process and external insulation will take many years to pay for itself through fuel savings. However, if renovation or resurfacing work is required to the outside of the building, then it will be worthwhile to add a good level of insulation at the same time.

## Timber frame walls

These are normally built in a factory and erected on site. They have insulation built into the internal cavity inside the wooden frame-work and have an outer skin of brick, block or render. A vapour barrier is included under the internal leaf of plasterboard to minimise the risk of moisture getting into the structure, causing interstitial condensation.

A timber frame wall will have window frames set back into the inner leaf, weep holes at vertical joints and the inner leaf of the gable end in the loft will be timber.

*A timber frame wall.*

**Points to remember**

- It is not usually possible to further insulate these walls.
- Care must be taken not to damage the vapour barrier.

**Benefits**

They can have very good insulation giving very low U-values.

## Cutting down heat loss from windows and doors

Windows are responsible for about 10% of the total heat loss from a typical semi-detached house, so they are not as important as people think. However, windows lose heat through fabric heat loss and ventilation heat loss, so both should be addressed to improve efficiency.

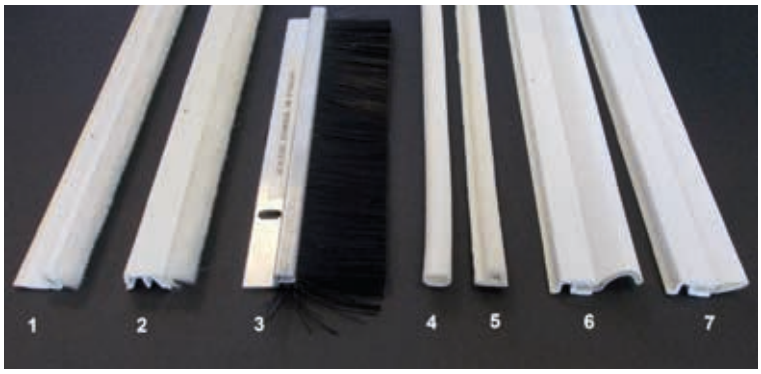
## Ventilation heat loss around windows.

This ventilation loss can be tackled in two ways.

- By ensuring the doors and windows are not left open needlessly.
- By applying draughtproofing.

## Draughtproofing windows and doors

Gaps and cracks around the windows and doors vary in size and width, but a wide assortment of materials are available to fit most sizes and types of gap. Materials are available to fit to the inside and outside of windows and doors. Durable, high quality materials are quite inexpensive and should be chosen over poorer quality materials which may need to be replaced more frequently.




A British Standard (BS7386 (1997)) for draughtproofing materials exists. It sets down criteria for air leakage, compression set, gap-spanning ability and closing force.

## There are three main types of draughtproofing materials.

**Low friction or wiper seals (1-3)**

The draughtproofing material rubs against the closing edge of the window or door, forming a tight seal. Wiper seals are generally made of fine nylon brush pile fixed in a metal or plastic carrier. They are suitable for either uniform or irregular gap sizes.

**Compression seals (4-7)**

The door or window is pushed directly onto the draught strip itself as it is closed, forming a firm seal over the gap. The material which is compressed in this way consists of a plastic covered foam strip, or a rubber tube fixed in a metal or plastic carrier and pinned onto the door or window frame.

**Gun applied sealants (No picture)**

Silicone or polyethylene sealants are sold in tubes and are used for filling gaps which are very small or irregular, or in places where other draughtproofing materials would be ineffective (e.g. metal windows). They can also be used as an adhesive for attaching compression seals to metal framed windows.

**Points to remember**

- A supply of fresh air for fuel burning appliances is very important, so air vents or grilles that provide air for them should not be blocked. If in doubt about this, ask a heating engineer for advice.
- Adequate ventilation is important to minimise dampness or condensation problems.
- Ventilation should be adjustable, to allow background ventilation but also be capable of providing higher levels of ventilation if needed, to maintain air quality in a home.

**Benefits**

Draughtproofing will immediately eliminate draughts and substantially improve the comfort level in the home. Therefore, draughtproofing is a priority when tackling domestic heat loss.

## Fabric heat loss through windows

There are a number of ways of reducing the amount of heat that is lost through windows. The principle is the same with all methods: a sheet of material is placed in front of the pane of glass, creating a layer of motionless air between two surfaces to provide a good insulating barrier.

Some of the different ways of achieving this are discussed below, beginning with the simplest methods.

## Curtains, blinds and shutters

If curtains are used within the home, it is worth getting the maximum insulation benefit from them. If there isn't a radiator or other heat source underneath a window, curtains should be slightly longer than floor length. This will trap the cooler air behind the curtains and help stop draughts coming into the room. If radiators or other heat sources are present beneath the window, curtains should be placed behind them to allow the heat to stay in the room. Householders should also consider selecting heavier curtain fabric and extra linings because they play a part in keeping the heat in.

Blinds and shutters provide another way of reducing heat loss through windows but it's important to ensure they fit tightly around the window area to prevent the cold air from circulating through them.

## Secondary glazing

There are a number of ways of applying secondary glazing to an existing window. Some systems are inexpensive which almost anyone can install. Others are more costly and have to be installed by a contractor. All types of secondary glazing will have the same insulating effect provided they are well fitted.

The cheapest and simplest way to secondary glaze a window is to attach some form of plastic sheeting or film over it. Kits can

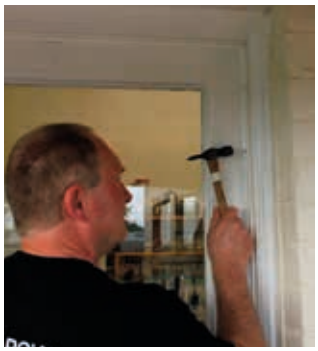
# Insulation

be bought from DIY shops and some department stores.

The material is available in a variety of widths and is attached to the inner face of the window frame with double-sided tape and then heat is applied to make the plastic tight. Ensuring the window frame is thoroughly cleaned before attempting to apply the double-sided tape is important.

Kits consisting of rigid or semi-flexible plastic are more expensive because they are durable. They can be taken down in spring and re-used as the outdoor temperatures start to fall in autumn. Magnetic strips or Velcro are attached to the window frame to keep the glazing material in place.

The most expensive forms of secondary glazing are where the second pane is glass and is placed in a wood, plastic or aluminium frame. It is installed on the window with either hinges or runners allowing the windows to be opened easily.



**Points to remember**

- With cheaper secondary glazing systems, it is sometimes difficult to open the insulated window without removing or breaking the secondary glazing.
- When applying secondary glazing, it is essential to ensure that at least one window in the room is either left uninsulated or is easily opened in order to allow adequate ventilation and provide a possible escape route in case of fire.
- Well fitted secondary glazing stops air leaking behind the inner pane preventing condensation from occurring and the gradual deterioration of the wooden frame.
- Secondary glazing may be the only option to insulate windows in listed buildings.

**Benefits**

Secondary glazing can provide similar heat loss reduction to that achieved by installing professional double glazing.

## Sealed unit double glazing

This is the most expensive way of insulating windows. A sealed unit consists of two panes of glass fixed with a frame at a set distance apart. The optimum distance between panes is 17 to 20mm. Frames for this type of window are usually made of uPVC, wood or aluminium.

**Points to remember**

- Some of the expensive versions of secondary glazing and sealed unit double glazing can have noise cancelling properties.
- Installing sealed unit double glazing may add to the market value of the house.
- They can also improve security.

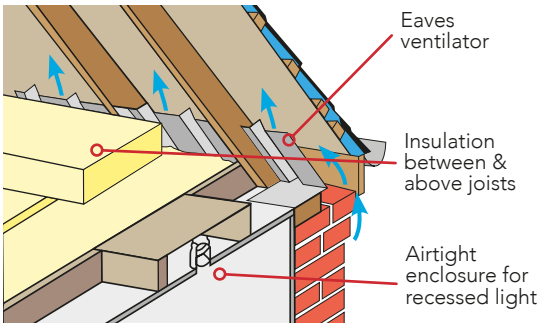
**Benefits**

England's current Building Regulations specify that new and replacement windows should include low-emissivity glass. This has a coating on the inner pane of glass, which reflects heat back into the room whilst also letting in free heat from the sun. The gap between the panes of glass in modern double glazing is also filled with a gas, usually argon to further reduce heat loss. The improvement in insulation value for double glazing can help combat condensation problems.

## Insulating the roof area

A high proportion of heat is lost through roof areas because warm air rises. Pitched roof insulation is easier and cheaper to install than flat roof insulation because there is usually a space between the ceiling and the roof to give access where insulation can be placed. It is vital to insulate all tanks and pipes in a roof whilst insulating the roof to avoid the risk of freezing water in cold weather.

## Insulating pitched roofs




## Loft floor

To reduce the rate of heat loss through the ceiling area into the loft space and then through the roof, insulating material needs to be laid between the wooden joists directly above ceiling level. The most frequently used material to insulate lofts is mineral fibre quilt. It is sold in rolls and normally is laid to a recommended thickness of 270mm - 300mm. The depth of this type of insulation means that it is also laid across the wooden joists. To achieve the best thermal performance, nothing should be laid on top of the insulation. This can pose a problem for some households where they previously used the loft space for storage.

A thinner material can be used to remedy the issue above. A thinner foil-type material can be purchased which has similar thermal properties. The thickness of this material is considerably less than that of the quilt, but it is more expensive to insulate the loft in this way.

A third way to insulate the loft is to ask a contractor to install loose-fill mineral fibre materials by a mechanical 'blowing in' process. This method is useful if the loft is an irregular shape or has awkward corners. Unfortunately, this type of material tends to move in the loft if the area is draughty causing some places to be inadequately insulated. Alternative and more environmentally friendly insulation materials are cellulose based and wool based.

A high proportion of heat is lost via roof areas because warm air rises

Installing sealed unit double glazing may add to the market value of the house

# Insulation

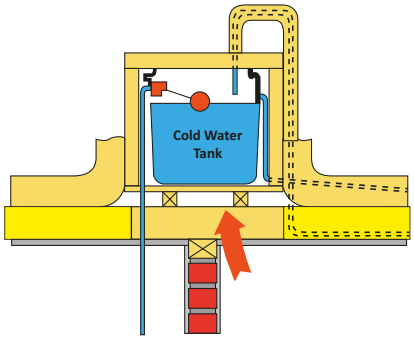
**Points to remember**

- Although loft insulation is regarded as one of the simplest DIY jobs, it has to be installed properly to ensure maximum effectiveness.
- It is very important to wear protective clothing and a face mask when installing mineral fibre quilt and loose-fill because these materials give off harmful dust particles which can be irritating for the eyes, throat and skin.
- The loft area needs to be well ventilated to keep the roof timbers free of damp. Gaps must be left at the eaves or tile vents installed to allow free flow of air.

## Cold water tank

After insulating the loft floor, the loft will be colder because heat takes longer to rise from the rooms below. If there is a cold water tank present in the loft, it needs to be insulated. Several materials are available to do this. Mineral fibre tank jackets covered with polythene can be purchased and strapped around the tank. Alternatively, expanded polystyrene sheets can be fixed in place or a box constructed around the tank which can be filled with loose fill insulation. The insulation is intended to prevent any risk of the tank freezing over in winter. The tank must be fitted with an insulated lid.

Insulation should not be placed directly beneath the cold water tank because this will increase the likelihood of the water freezing in cold weather. However, if it is on a trestle, it must be insulated at its base.




## Pipes

All pipes in the loft should be insulated. This avoids any risk of pipes freezing and bursting in cold weather. There will also be a lower level of heat loss from pipes which carry hot water. Pipes can be insulated with lengths of rigid foam tubing, which simply clip into place around the pipe. The materials are inexpensive. Pipes should always be checked for leaks first - damp materials conduct heat well, so if the insulation is allowed to become wet, it will have negligable insulating effect.

## Loft Hatch

To complete the insulation job in the loft area, the door to the loft (the loft hatch) should also be insulated by covering it with a piece of insulation board or mineral fibre roll sealed inside plastic to keep it in place and prevent the spread of fibres.

The hatch should then be draughtproofed thoroughly from below to prevent any ventilation heat loss up into the loft. The use of catches can ensure a tight fit onto the draughtstrip.

**Benefits**

Insulating the loft floor to a depth of 270mm with mineral fibre insulation will reduce the U-value of the roof area from 2.1 to 0.16. This is a substantial reduction, improving the comfort level in the home. Bungalows and other dwellings where the living areas are directly beneath the roof space will feel considerable benefit. The installation can be done by the householder or by a contractor.

## Insulating flat roofs

Insulating a flat roof is both more difficult and more costly than laying insulation in a pitched roof. Insulation can be installed above or below the roof surface - known as the 'roof deck'.

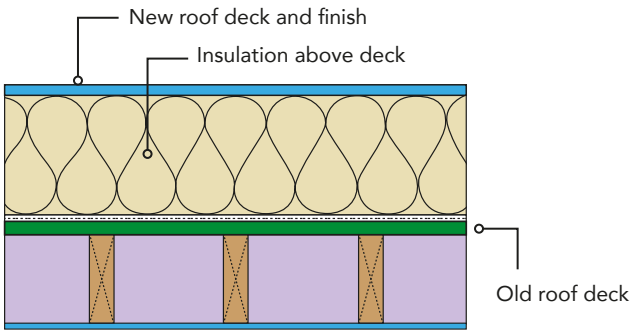
## Warm deck insulation

This method involves laying rigid insulation boards on top of the roof deck with a vapour check between the insulation and the deck to avoid any risk of condensation. A weatherproof finish with a layer of chippings or reflective paint has the advantage of ensuring that the surface does not suffer extreme temperature changes which may cause it to deteriorate.

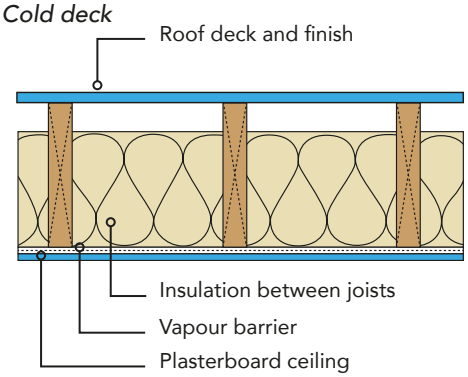
## Cold deck insulation

Here the insulation is added below the roof deck in the hollow roof space just above the internal ceiling. The insulation work involves removing the ceiling, fitting mineral fibre or rigid insulation boards between the joists, fitting a vapour barrier then adding a new plasterboard ceiling. A gap of at least 50mm in depth must be left between the top surface of the insulation and the surface of the deck above to allow an adequate flow of air through the roof structure.

*Warm deck*




*Cold deck*




### Points to remember

- Warm deck insulation should be the more economical of the two options especially if repairing or replacing the roof finish.
- The risk of condensation occurring within the roof space of any flat roof is quite high, so cold deck insulation may be the less practical of the two options.
- The householder should seek expert advice before any renovation work is carried out on a flat roof.

### Benefits

Heat loss reduction will be the same for both types of flat roof insulation if 100mm of insulation is added. Both methods involve considerable structural work and are quite expensive with a lengthy payback period. The costs of insulation can be mitigated if the ceiling or roof is in need of repair or replacement, because the price of insulation materials is a relatively small additional cost.

## Insulating round a room in the roof

It is particularly important to insulate round a room in the roof and it is easiest to do this whilst it is being constructed. You will have to consult the local authority for planning permission and so that they can check the room and the rest of the house comply with the building regulations. If there is an existing room in the roof and you want to insulate it, then insulation can be applied between the rafters and across the rafters, but it is very important to allow an air flow between the insulation and the rafters. The foam boards are twice as effective as mineral wool, so 130mm of phenolic foam insulation should meet the current standards for the U-value in 2017.

# Insulation

## Hot water cylinder insulation

Insulating the hot water cylinder is a priority measure because uninsulated cylinders lose a lot of heat and it is easy and inexpensive to fit a cylinder jacket. Cylinders can be found in the loft where heat escapes to the outside or they may be in the house, usually with an airing cupboard built around them to help dry clothes. This practice brings with it the risk of condensation problems, which are discussed later.

**Points to remember**

- A cylinder jacket should be at least 80mm thick and approved to British Standard BS5615:1985.
- All new cylinders come pre-insulated with spray foam applied at the factory.
- Insulate the accessible parts of the pipes that enter or leave the cylinder.

**Benefits**

Fitting a cylinder jacket will immediately reduce the U-value from 6 to 0.5, which is a substantial reduction. The low cost of a jacket may make it worthwhile to buy a second jacket to cut heat loss even further. The first metre of pipework to and from the cylinder should be insulated.

## Insulating floors

Ground floors of houses built before 1989 did not require insulation and adding insulation to a floor can be both complex and costly. There are separate techniques for insulating solid concrete floors and suspended timber floors, but since insulation is not a simple task, it is usually worthwhile trying to remedy the problem of a cold or draughty floor in some other way before considering insulation as a realistic option. Since 2006 Building Regulations state that ground floors in new buildings must be thermally insulated as they are built with a U-value not exceeding 0.22. However, this is complicated by the need to know the exposed perimeter/floor area ratio, to allow for the cold bridge effect near to the outside walls.

Any floor will feel warmer if it is covered up in some way, for instance with rugs, carpets, laminate flooring with underlay or cork tiles. With suspended timber floors, gaps between floorboards and at floor edges are common. As well as causing draughts, these gaps could be letting a lot of warm air escape. Therefore they should be filled using draughtproof sealants. Measures like these will make a floor feel less cold and in many cases may be all that is required. With very cold floors, particularly those over an open space however, insulation may be the only effective way of cutting heat loss.

## Suspended timber floors

Insulating a wooden floor involves laying insulation material between the joists that support the floorboards. This is usually done from above the floor, but if there is a cellar underneath the ground floor then the job might be carried out more easily from below.

When insulating a floor from above, the floorboards will need to be lifted and then replaced after the work is complete. The most common method is to lay mineral fibre insulation quilt between the joists, supported by plastic meshing. Another method is to fit insulation boards tightly between the joists, supported underneath by wooden battens or nails. When insulating from below, the same materials are used, but here the mineral fibre is pushed up between the joists and held in place with plastic netting stapled to the underside of the joists; or insulation boards can be 'friction-fitted' between the joists, and held in place with nails. When insulating a timber floor no vapour check is required; it is important, however that the space below the insulation is kept well ventilated, with any air vents or grilles kept free of blockages.

**Points to remember**

- Insulating the floor from below is the less expensive of the two options because only the insulation materials will need to be bought.
- Insulating a suspended timber floor is only practical if floorboards require attention, or there is easy access to the under-side.
- When insulating from above there can be the added cost of taking up and then re-laying the floor if a contractor is used.

**Benefits**
Insulating a suspended timber floor with 100mm of foam insulation would typically achieve a change in U-value from 0.7 to 0.22.

## Solid floors

Solid concrete floors can only be insulated from above, so a simple way of insulating a solid floor is by laying a 'floating floor'. This involves fitting a layer of load bearing foam insulation board, (followed by a sheet of polythene to act as a vapour check if required) then placing plywood or chipboard on top to form an even, firm floor covering. This is called a floating floor because the new floor is not actually fixed in any way to the original floor but is simply placed on top. Alternatively, a similar effect can be achieved by laying 'composite' panels consisting of rigid insulation attached to a chipboard floor finish.

One disadvantage with this type of solid floor insulation is that because the floor will be slightly higher after insulation, doors may need to be altered, and skirting boards and other fittings re-sited to the new floor level. In addition the floor may need to be reinforced in places where it is likely to be subject to particular compression. It is a job which requires specialist DIY knowledge and is often best referred to a flooring specialist.

**Points to remember**

- Solid floor insulation is of greatest benefit in rooms with two or more outside walls. This is because solid floors lose a great deal of their heat through the edges of the floor that are next to outside walls.
- The floor will feel much more comfortable as a result of the insulation but fuel savings will be small.
- The measure is likely to take a long time to pay for itself.

**Benefits**
Insulating a solid concrete floor with 70mm of foam insulation would typically achieve a change in U-value from 0.7 to 0.22.

Based on EST information in 2017 a typical semi-detached house, built in the 1960s would save:

- Loft insulation saves 3500kWh
- Cavity wall insulation saves 4000kWh
- Double glazing saves 1500kWh
- A hot water cylinder jacket saves 2200kWh

Multiply this by the price of fuel per kWh to calculate the savings.

According to BEIS a household in 1990s used 18000kWh of energy for heating space and water, but now they would only use 15000kWh of energy for heating space and water. Using RdSAP information a home in the 1970s could use as much as 36000kWh, but fuel costed less then.

Insulating a wooden floor involves laying insulation material between the joists that support the floorboards

Solid concrete floors can only be insulated from above, so a simple way of insulating a solid floor is by laying a 'floating floor'

Any floor will feel warmer if it is covered up in some way, for instance with rugs, carpets, laminate flooring with underlay or cork tiles.

## SPACE & WATER HEATING SYSTEMS

Methods of heating homes are becoming more sophisticated all the time

## Introduction

**This section looks at the variety of space and water heating systems an adviser may encounter whilst on a home visit.**

Both central heating and individual heater systems are explained, though this booklet only looks at the commonly encountered systems, rather than some of the newer technologies. Systems utilising renewable energy sources are included later in the booklet.

Methods of heating homes are becoming more sophisticated all the time and new homes are normally fitted with full central heating. This section looks at a range of systems and appliances for heating and hot water currently in use in UK homes.

## Heating standards over the years

In local authority housing a minimum standard was set when the Parker Morris report Homes for Today and Tomorrow (1961) laid down minimum acceptable standards for heating. The report stated that the following temperatures should be achieved:

| | |
|---|---|
| Living and dining areas | 18°C |
| Kitchens and hallways | 13°C |
| Bedrooms where daytime and evening use are considerable | 18°C |

During the house construction boom in the 1960s and 1970s many local authorities interpreted these as standards and not as minimum temperatures. This resulted in thousands of homes being built with partial central heating; typically without any in the bedrooms. The systems installed then were cheap to install but subsequently caused many problems due to breakdowns and high running costs.

Since then the accepted standard for heating a dwelling is that the heating system must be able to maintain 21°C in the living room and bathroom, whilst the rest of the house is at 18°C. This is a requirement of the Housing Health & Safety Rating System of 2005, where it is included as one of the 29 hazards that would prevent a home being classed as decent.

### Identifying heating systems

Before making any calculations on the cost of heating or attempting to sort out any problems with a heating system, it is important to be able to identify it and how it works. In social housing estates, there may be experimental or obsolete systems which are no longer installed.

To identify a heating system, inspect the heat emitter in the room. The appliance that gives out heat could be an individual room heater or part of a central heating system.

For the purpose of this booklet, heating systems and heaters are described in five broad categories:

- Wet central heating systems
- Warm air central heating systems
- Storage heating systems
- Underfloor heating
- Individual heaters

### Wet central heating

A wet central heating system means that heat is carried around the home by water.

This water is heated up in a boiler and travels around pipes to radiators or 'underfloor', which give out the heat to the rooms they are in. The fuel most commonly used for central heating is natural gas, but some central heating systems also run on oil, off-peak electricity, solid fuel, liquid petroleum gas (LPG) or biomass.

Despite their name, radiators give most of their heat out by convection, that is, warm air rises from them. However, radiators do give out some heat by radiation.

If there are radiators in a home, there must be a boiler to heat up the water. This boiler will most commonly be found within the home except in the case of group or district heating, where a very large boiler, usually situated in a special boiler house, serves a group or an estate of properties. This booklet will concentrate on small domestic boilers.

### Gas fired boilers

Gas boilers can be floor or wall mounted. They may also be fitted in a fireplace behind a gas fire (also known as a 'back boiler'). Most modern domestic boilers are wall mounted and incorporate a fan which moves air and combustion products through the boiler. Burning gas creates hot products of combustion which pass over the heat exchanger inside the boiler casing. The heat exchanger transfers heat from a hot substance to a cooler one without the substances coming into contact with one another. It is made from a

# Space & water heating systems

good conductor of heat (frequently aluminium, copper or stainless steel) and has a large surface area across which heat can flow. In a central heating boiler, the heat is transferred to the much cooler water in the central heating system.

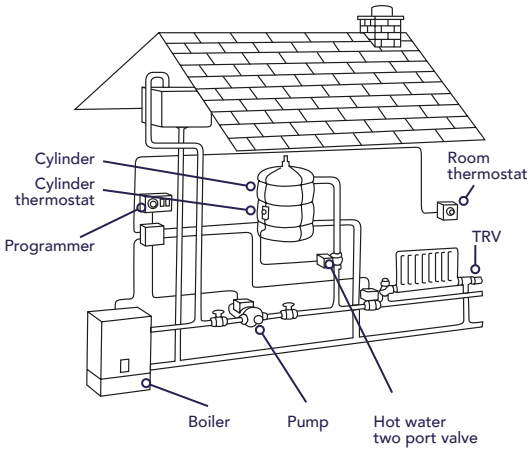
The water in a central heating system must never be allowed to boil. Boilers and heating systems are fitted with controls and safety devices to ensure this does not happen. The gas and air mixture in a boiler may be ignited by a permanent pilot light on old boilers but modern boilers have electronic spark ignition.

### Conventional (system) boilers

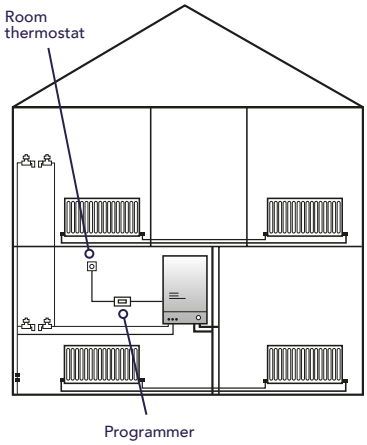
These boilers produce hot water for space heating and for bathing and washing. Hot water used by householders for bathing and washing is stored in a hot water cylinder. The hot water in the cylinder is heated indirectly via a heat exchanger within the cylinder. This type of system is ideal for families who are able to use up the hot water on a daily basis.

See the 'Map' of the wet central heating system below.

Conventional system




Combination or 'Combi' boilers




### Combination 'Combi' boilers

These boilers provide wet central heating but also provide instantaneous hot water in the same way as a multi-point water heater. They do not require a storage cylinder.

### Condensing boilers

Condensing boilers extract more heat from the same amount of gas as non-condensing models. This is possible because they have a much larger surface area which may take the form of two heat exchangers or one large one. If the products of combustion are cooled sufficiently the water vapour in the products will condense on the surface of the heat exchanger. This condensate is collected within the boiler casing and is ejected as a slug of warm water from time to time. Under current Building Regulations, typically any new boiler must be a more efficient condensing type boiler. It is possible in exceptional circumstances to fit a non-condensing boiler. Condensing boilers can be of the system type or the combi type.

### Oil-fired boilers

The most popular fuel here is kerosene. The oil is pumped from a holding tank through a high pressure fuel line to a burner nozzle. The nozzle injects the oil into a fire or combustion chamber, where it is atomized into a fine spray and is usually ignited by an electric spark. An air intake blower provides air into the fire chamber to aid combustion. Hot gases from the burning oil pass through metal tubes, known as a heat exchanger, heating them in the process. These hot pipes in turn heat the water in the boiler up to the safe maximum temperature of the system.

Pending use the oil is stored in a large tank outdoors, which must be installed by a qualified professional. The installation will include measures to protect against leaks and spills, to comply with Building Regulations. Since 2007 the Building Regulations have also required all oil boilers to be condensing.

Oil-fired combination boilers are available, providing hot

water on demand without the need for a hot water cylinder. However, they are a bit slower to provide hot water than some gas combi boilers, and are usually recommended for smaller households.

### Solid fuel boilers

There are several different types of solid fuel boiler. Some are fully enclosed and resemble oil and gas boilers. Some solid fuel boilers have a hopper with a fuel feeding mechanism, into which the fuel is loaded so that it drops down into the fire as needed. These are known as gravity feed boilers.

Others combine the boiler with a room heater, which provides radiant and convected heat into the room. The heater can be an open fire or an enclosed one in which case it is usually visible through a glass window.

In a solid fuel boiler the solid fuel is supported on a grate. The waste gases are led away through a flue and air is drawn in underneath by the draught. Ash falls through the grate into a tray below, which has to be cleared periodically. The heat exchanger is usually cast iron and either surrounds the fire (as in a free standing boiler) or is located at the back of the fire (as in a back boiler of an open fire).

There are several types of solid fuel available. The main ones are.

- Bituminous - a relatively cheap smoky coal, which cannot be used in smoke-controlled areas except in special smoke-reducing appliances. It is commonly known as housecoal.
- Anthracite - a naturally occurring smokeless coal, more expensive than bituminous coal, that gives more heat per unit of weight.
- Smokeless fuels - coal that has been processed in various ways to remove the smoke-producing ingredients.

### Electric boiler

This type of boiler operates a 'wet' central heating system. There are two types:

- One uses the principle of heat stored overnight when the cheap rate tariff is in operation. The heat is stored in water. Heat is drawn off the storage medium during the day and circulates around radiators. This boiler is considerably larger than other domestic boilers.
- The other uses on-peak electricity to heat water, the same way a gas boiler works in central heating. This is expensive to run and should only be considered if mains gas is unavailable.

### LPG boiler

LPG (liquid petroleum gas) boilers work in the same way as gas boilers - by using LPG to heat water for space heating and water heating. The fuel is delivered in the same way as oil but the tank has to be rented from the supplier. LPG is a cleaner burning fuel than other fossil fuels, producing less carbon emissions than coal and oil.

### Warm air central heating

If a house has warm air central heating, the heat emitters will be the grilles in the walls or floors. These are where the warm air is distributed into the rooms via ducts from the heating unit which is located centrally in the home.

Fuels for warm air central heating may be natural gas, off-peak electricity or bottled gas. Group or district heating sometimes provide warm air central heating to homes and flats.

This type of system warms the air in the house very quickly. This is an advantage over radiator systems which take longer to warm up. However, warm-air systems may not keep room temperatures as constant as radiator systems. Some people find the dry air created by warm air systems uncomfortable,

especially if they have respiratory disorders or allergies.

Older types of warm air systems are often noisy because of the fan. Modern systems have largely overcome these problems. Warm air central heating is normally installed in houses whilst they are being built. However, there are certain types of warm air heaters that can be installed in existing houses. See the image opposite on the configuration of a warm air system.

### Gas warm air heating

The gas flame warms a heat exchanger through which air is driven by a fan. The flame is lit by pilot light or electronic ignition. Gas warm air systems have similar safety devices to gas boilers. It is possible to heat water using a gas fired hot water circulator fitted within the outer casing of the warm air heater. A circulator is a small water heater connected to a storage cylinder or tank. It runs constantly and is controlled by a thermostat.

### Electric warm air heating

Electric warm air central heating works on the same basic principle as a storage heater but there is a large heating unit located centrally in the house.

It consists of a heat storing core within a well-insulated case. At night an electric current flows through the elements heating the core. During the day, a fan draws the air through the ducts passing it over the hot core of the heater. This warmed-up air is then blown into the rooms. When the fan is off, the core stays warm because of the thick layer of insulation around it.

Some models have a second set of heating elements which are switched on in the afternoons on very cold days to give the core a boost of heat.

### Storage heating

In a storage heater, electric elements heat up a dense, high thermal capacity block which releases the heat during the course of the following day. Storage heaters need to be installed in adequately insulated houses, or they will have lost most of their heat before the evening when it is most needed. For a correctly designed system, it is assumed that 90% of the electricity used for heating is provided at off-peak times.

### Electric underfloor heating

Electric underfloor heating consists of a set of heating wires located below the surface of a concrete floor.
The heating elements are switched on and off automatically overnight at off-peak electricity rates and warm the surrounding concrete. The heat stored is gradually dissipated during the day. These systems were commonly fitted in blocks of flats in the 1960s and 70s when the attitude to fuel prices was that electricity was a cheap fuel. This form of heating can be as effective as other systems when properties are insulated to a high standard.

### Wet underfloor heating

Wet underfloor heating works on the same principle as a standard heating system, the only difference is instead of radiators the hot water from the boiler is pumped through a series of plastic pipes under the floor.

The main benefit of this form of heating is that there is an even distribution of heat. However, the system is slow to respond to temperature change and a cold snap may result in initial low temperatures within the home.

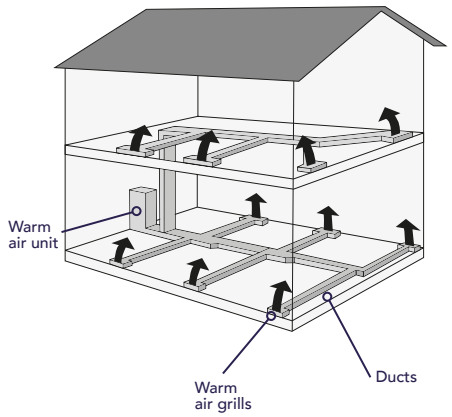
Underfloor heating is fully utilised in well-insulated houses and where the heating system is not switched on and off several times a day.

## Individual heaters

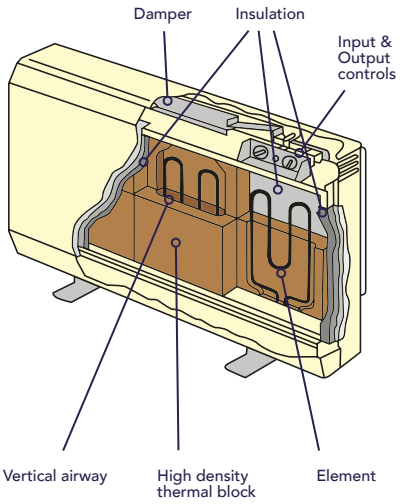
Before the introduction of central heating, the only way of heating the rooms in a house was by individual fires or appliances. If gas was unavailable a lot of effort was required to obtain reasonable levels of comfort in all rooms using coal or wood. Although some people still use coal fires, a wide range of individual heaters are used in addition to central heating. These heaters can be divided into room heaters which are installed permanently and portable heaters.

Modern room heaters burn gas, solid fuel or use electricity. Individual heaters of these types have a number of advantages. Gas and solid fuel heaters are sometimes built with back boilers to form a combined unit for room heating and central heating. The use of individual room or portable heaters to supplement central heating adds considerably to the flexibility of the heating system. In mild weather, or if the house is only being used for a few hours, the central heating system may not need to be used.

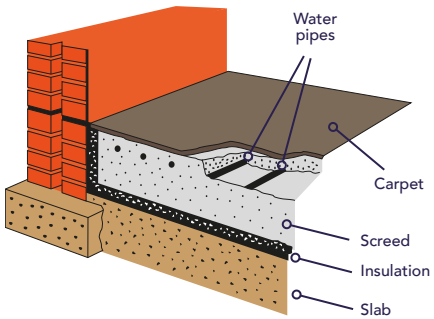
Ducted warm air heating




Storage heater




Under floor heating




Older types of warm air systems are often noisy because of the fan

Modern room heaters burn gas, solid fuel or use electricity

| | Electric individual room heaters | Gas individual room heaters | Bottled gas individual room heaters |
|---|---|---|---|
| **How to identify the appliance** | Plug-in heaters, for example,<br>• fan heater, convector heater<br>• oil-filled radiators<br>• bar/ radiant fire<br>• infra-red or halogen | • Open fronted gas convector/ radiant fire<br>• Gas decorative effect fire - open fronted and close fronted<br>• Gas heaters (room sealed) | • Portable gas room heater containing a bottle of liquid petroleum gas (LPG) |
| **Controls usually available** | • On/off switch<br>• Temperature settings (for example, 1kW, 2kW or 3kW)<br>• Thermostat<br>• Timer | • Ignition<br>• Temperature setting | • Ignition<br>• Temperature setting |
| **Pros and cons** | • Portable<br>• Useful for providing a short period of additional heat<br>• Using on-peak electricity they will be expensive to run<br>• Not appropriate as the main heat source | • Provides instant heat<br>• Provides a focal point<br>• Gas convector/ radiant fires and sealed room heaters can have high efficiencies<br>• Decorative effect open fronted gas fires have a lower efficiency and higher running costs<br>• Need to be checked by a Gas Safe registered engineer | • Provides instant heat<br>• Portable<br>• Produces water vapour<br>• Requires adequate room ventilation<br>• Bottles of gas needs to be replenished |

# Space & water heating systems

### Calculating the efficiency of a heater.

The efficiency of a heater can be calculated using the equation below:

***Efficiency % = Output ÷ Input x 100***

For example two decorative gas fires that look similar have very different efficiencies, caused by the way they are designed.

| | Gas Input (kW) | Heat Output (kW) |
|---|---|---|
| Fire No.1 | 5.0 | 3.0 |
| Fire No.2 | 9.0 | 3.0 |

Fire No. 1 is a radiant gas fire, which is 60% efficient. Fire No. 2 is a coal effect gas fire, which is only 33% efficient, and is designed more for decoration than for efficiency.

You can use this formula together with information on the back of manufacturers' leaflets on specific fires to work out the efficiency of the fire. Note that this does not account for the action of a thermostat, which may turn a heater on or off automatically.

## Hot water systems

### Systems with a hot water cylinder

There are different types of hot water system with the common feature that the hot water is stored in a cylinder made of copper. As the hot water is used, cold water feeds into the bottom of the cylinder to keep it full. Cylinders must be well insulated with a good jacket, though modern cylinders are insulated during manufacture.

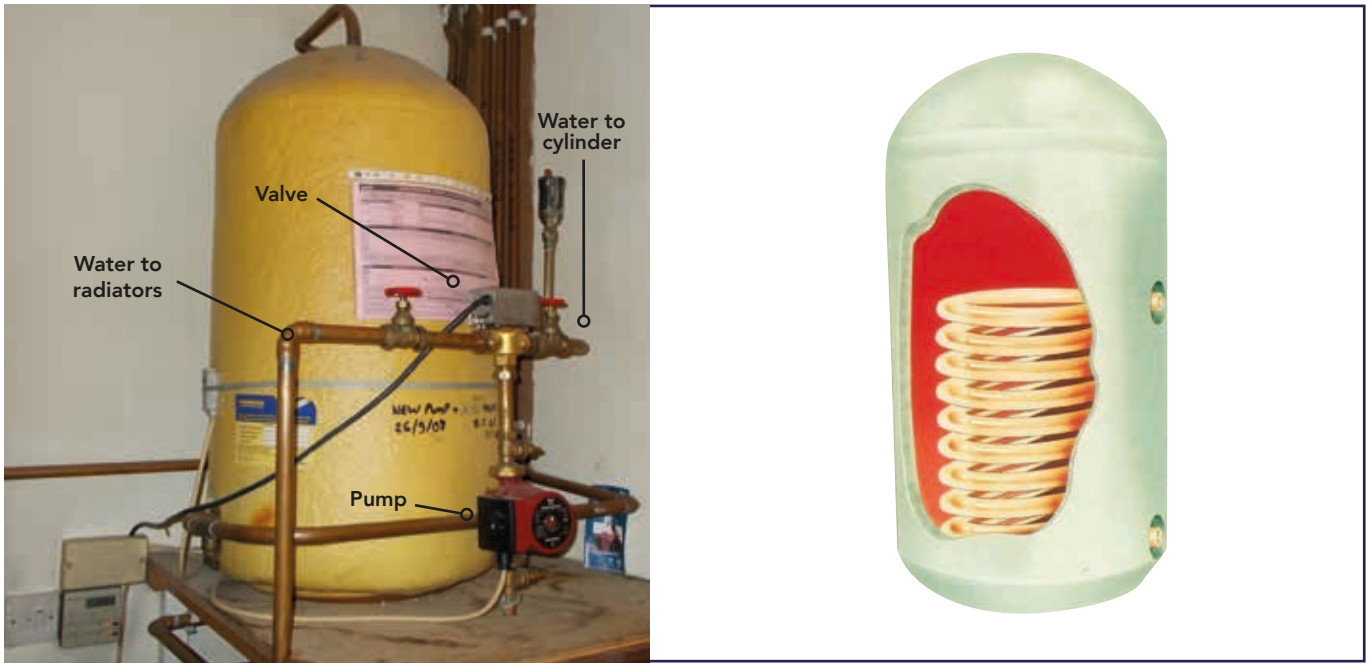
### Central heating plus hot water

In most common types of central heating and hot water systems with a cylinder, the boiler heats up water which passes through pipes to a heat exchanger in the cylinder (a copper pipe coil).

The water in the cylinder never comes into contact with the water from the boiler.

*See figure below hot water from a central heating boiler.*

Hot water cylinder




### Electric immersion heaters

Electric immersion heaters are found in many homes often as a supplement to back boilers and wet central heating systems. In off-gas areas they are sometimes the only source of hot water heating.

An element projects into the water in the cylinder and is heated using electricity. The power rating is normally three kilowatts (3kW). The positioning of the element in the cylinder is important because the temperature of the water is not the same throughout. Hot water rises by convection because it is less dense, so the water at the top of the tank will be hotter than that at the bottom. If the element is placed near the bottom of the cylinder it will heat the whole tank before the thermostat switches off. If the element is placed near the top of the tank, the thermostat will switch off sooner - when the top part of the tank is hot. This uses less energy, but an element

at the bottom of the tank is necessary if using large amounts of hot water or if the hot water is heated overnight on the off-peak tariff and stored for use during the following day.

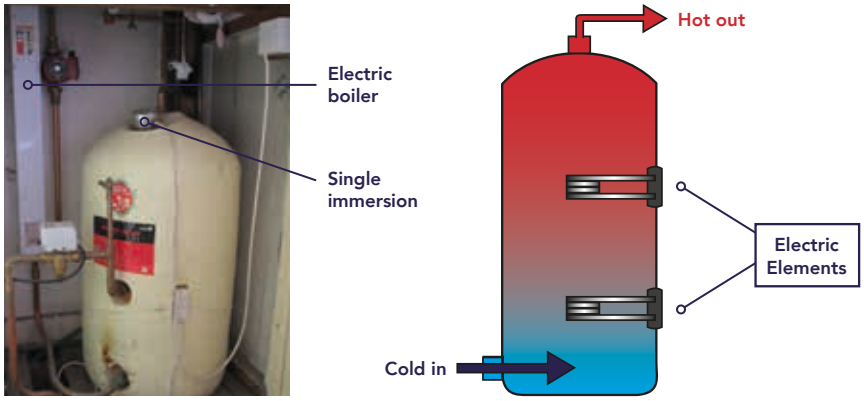
### Dual immersion heaters

Dual immersion heaters can be identified by their two electric elements (rather than the standard single). These are used in conjunction with the on-peak/off-peak tariff. The element at the bottom of the tank operates during the cheaper off-peak rates, providing the householder with a full tank of hot water for the next day.

The element positioned at the top of the tank operates during the on-peak tariff. This is used when the boost option is chosen on the on-peak/off-peak programmer for additional hot water. It is situated near the top of the cylinder to provide a smaller volume of hot water rather than having to heat the whole cylinder. This saves both money and energy.

It is important to choose the correct cylinder size to meet the property's domestic hot water requirements. The dual immersion cylinder holds around 200 litres.

Electric boiler and single immersion  Dual immersion




### Back boilers

A back boiler is a heating appliance located behind the fire in a fireplace. Solid fuel systems may use back boilers to supply domestic heating and hot water. Gas back boilers operate independently of the gas fire. They are located in a fireplace so they can use the chimney as a flue. Condensing back boilers are now available.

### Water heating without a hot water cylinder

Water heating systems without a cylinder for storing hot water are called instantaneous heaters. The gas or electricity is switched on by a flow of water, to heat the water as it flows through the appliance. Since there is no hot water stored in the instantaneous heater, they are cost effective to operate as the only heat loss is through the hot pipes. Insulating pipes can help to reduce heat loss.

There are two types of instantaneous water heater, single-point and multi-point.

- Single-point appliances have a single outlet - for example an electric shower or a small water heater with a long outlet arm, which can swivel over a sink.
- Multi-point appliances have a central unit with several outlets. The unit is operated by turning the tap on at any of the outlets. A multi-point water heater will generally have longer hot pipe runs and consequently will be more prone to loss of heat.

There are different types of hot water system with the common feature that the hot water is stored in a cylinder made of copper

A back boiler is a heating appliance located behind the fire in a fireplace

# Space & water heating systems

### Gas instantaneous water heaters

Gas instantaneous heaters are widely used where no hot water storage system exists. Gas water heaters are connected to the cold water mains. When the hot tap is turned on, the flow of water operates a pressure-sensitive switch, which opens the main gas valve. The gas is lit by a pilot light or electronic ignition. The water runs through pipes in a heat exchanger above the burners and is heated by the hot gases. The exhaust gases are taken away by a flue.

### Combination 'Combi' boilers

These boilers provide wet central heating but also provide instantaneous hot water in the same way as a multi-point water heater. They do not require a storage cylinder.

### Electric instantaneous heaters

They operate with a slow flow rate of water and consequently are suitable only for spray taps or showers. When the tap on the instantaneous heater is turned on, it operates a pressure switch, which turns the current on through an electric element. The water is heated as it runs over the element. A normal safety feature is an over-heat cut-out, which switches the appliance off if something goes wrong e.g. if the outlet becomes blocked.

## Flues

Burning fossil fuels such as gas in air creates a number of harmful by-products - also known as the products of combustion. Flues are used to remove these harmful gases to the outside air where they are dispersed.

Generally the products of combustion from heating appliances must be cleared to outside the house effectively and without spillage into the room. If harmful gases leak into the room and back into the appliance, carbon monoxide may be formed - this is very dangerous and can kill people by asphyxiation.

There are two main types of flue:

### Open flue

Open flued appliances take air from inside the room and use it in the combustion process. Heating appliances such as fires or back boilers can be fitted into a chimney opening.

The chimney used must be large enough to take away the flue gas and be in a good condition. If an open flue becomes blocked or damaged, the products of combustion may return to the room where carbon monoxide may be produced. Appliances with an open flue will often require a fixed vent to supply air for combustion.

### Balanced flues

There are two types of balanced flue - natural draught and fan assisted.

A natural draught balanced flue comprises a metal duct in which there are two tubes. One tube draws air from outside into the boiler with the other tube taking the products of combustion back outside. The design means that these waste gases cannot enter the room, making this a safer flue type. Gas, oil and LPG systems can all use this type of flue.

Within a fan assisted balanced flue the rate of flow of exhaust gases and incoming air is regulated by a fan resulting in higher efficiency being achieved by the appliance. All condensing boilers will use this flue. Gas fires/ room heaters can also use fan-assisted flues

*Electric shower*

*Gas multi-point instantaneous water heater.*

*'Combi' boiler*

*Chimney/ open flue*

*Balanced flue*

*Fan flue*

Burning fossil fuels such as gas in air creates a number of harmful by-products

Open flued appliances take air from inside the room and use it in the combustion process

## Carbon monoxide

When any carbon-based fuel such as mains gas, LPG, oil, solid fuel, wood or charcoal is burned, it uses the oxygen in the air in the process of combustion. If there is a good supply of fresh air, then the combustion process will produce fumes including carbon dioxide. This gas is safe for the householder in small amounts. If for some reason there is not a good supply of fresh air, the combustion process will produce fumes including carbon monoxide. This is a deadly poison, which can cause harm or even kill quite quickly.

Carbon monoxide (CO) is a problem if it is produced in an area that has poor ventilation, as the level of CO will build up in the air. To exacerbate this, CO is absorbed in the blood, where it concentrates even more. By replacing oxygen in the blood, CO suffocates and poisons cells in muscles, vital organs including the brain.

Minor exposure to CO causes general symptoms such as headaches, nausea and dizziness. To help doctors diagnose it, they are trained to spot the danger signs.

Medical professionals ask four questions:

- **C**o-habitees: Do other people feel ill too?
- **O**utside: Do people feel better when they go outside?
- **M**aintenance: Have you had fuel burning appliances serviced by a competent engineer?
- **A**larm: Do you use an audible Carbon Monoxide alarm?

To minimise the risk of carbon monoxide poisoning, always:

- Have appliances serviced by a qualified engineer.
- Use appliances according to instructions.
- Make sure you provide enough ventilation in the room.
- Don't use cookers as heaters, as they have no flue. Don't use portable gas heaters unless you have good ventilation.
- Use an audible carbon monoxide alarm.

The risk is not just at home; boats, caravans, tents and workplaces can all be places where individuals are exposed to carbon monoxide poisoning. A common example of exposure to carbon monoxide may be a disposable barbeque (even a cold one), which should not be taken into an enclosed space such as a tent, boat or caravan.

For advice and help in an emergency, see:

- Gas Safe Register for gas engineers www.gassaferegister.co.uk
- HETAS for solid fuel (Heating Equipment Testing and Approval Scheme) www.hetas.co.uk
- OFTEC for oil. (Oil Firing Technical Association) www.oftec.org
- HSE (Health & Safety Executive) www.hse.gov.uk
- CO-Gas Safety (Charity run by volunteers) www.co-gassafety.co.uk
- www.co-bealarmed.co.uk/resources/
- http://www.gassafetytrust.org/ with the CO Portal

**HEATING CONTROLS**

In general, only occupied rooms need to be kept warm

## Introduction

**All heating needs to be controlled to ensure the right amount of heat is delivered at the right time in the right place.**

This section looks at the variety of heating controls an adviser would encounter whilst on home visits and suggests the best way to use them.

## Strategies for heating

Many people are not in a position to choose their ideal heating and hot water system from new; they have to make the best use of what they already have. Even if they are in a position to have a new system, a number of factors affect their choice, such as what fuels are available, the amount of money available to spend on a system and the structure of the house they live in. Factors about the way they live also determine the most suitable choices. Some people spend more time at home and need more heating and hot water than others.

### Getting heat where, when and at what temperature you want it

Effective control of heaters means that the home is warm when and where you want it, whilst the average house temperature is kept comfortable and condensation is avoided.

The control of heating will be discussed under three headings.

- The temperature of the rooms.
- Where to heat.
- When to heat.

### Temperature

It is generally recommended that young babies and elderly people, particularly if they are not very active, are provided with room temperatures of 21°C to avoid the risk of cold-related illnesses. However, thermal comfort at home can differ from one individual to another. People who are fit and healthy may well be comfortable with lower temperatures. The generally accepted standard for heating is that a home should be able to be heated to 21°C in the living room, but 18°C is suitable for the rest of the home.

Regardless of what temperature people choose to live at, it is advisable to have heaters that can easily be adjusted to give only as much heat as necessary. Many heaters or heating systems have a thermostat to switch the heat off and on, according to the temperature of the air around the thermostat.

A thermostat is a device which senses the temperature and automatically turns heating appliances on and off when a chosen temperature is reached. Therefore setting it to a higher temperature will not heat a home more quickly; it will only make the heating system stay on longer, until it raises the room temperature higher, resulting in higher bills.

Thermostats may be fitted to appliances such as gas fires or electric heaters. They may be mounted separately on a wall or they may be portable and can be carried round the home. They can also be built into individual radiators as thermostatic radiator valves.

### Where to heat

In general, only occupied rooms need to be kept warm. Some residual heat is necessary in other rooms to prevent condensation, though this heat can be kept at a fairly low level. Fitting thermostatic radiator valves and keeping internal doors closed will help to achieve this.

### When to heat

#### Warming up and cooling down

At first sight it seems obvious that you simply turn on the heaters when you are at home and want to be warm. However, it is slightly more complicated than this because homes take time to heat up and cool down.

The time it takes a house to warm up depends on the type and construction of the house (including its insulation), the power of the heaters and the outside and inside temperatures. Similarly the cooling down time depends on the type of heating, the construction of house, the insulation and the outside and inside temperatures. Cooling down time is therefore the time it takes for a warm home to cool to a temperature that is uncomfortable, after the heating has been switched off. Note that the warm up time and the cool down time are not necessarily going to be identical.

The times taken to heat up and cool down are important because they affect the average inside temperature and hence the heat loss. There is a

# Heating controls

delay in reaching the desired temperature (when heating or cooling) because of the thermal capacity of the walls, furniture and the size of the property.

### Timing your heating

If you want a home warm for two hours in the morning and six hours in the evening, what is the best way to do it?

In a manually controlled system, the first rule is to warm the house as quickly as possible by turning all the heaters on fully. Automatically controlled systems will do this anyway.

Once the house is at the desired temperature the heaters should be turned down to maintain this temperature. A thermostatically controlled system will also do this automatically.

A house will take time to reach a desired temperature and also to cool down, and these times can vary. The only way to find out how long warm up and cool down times are in a home is by trying it. An efficient house will warm up quickly but cool down slowly, and the speed will depend upon:

- How sensitive the occupants are to temperature.
- What kind of clothing they wear.
- The type and efficiency of the heating system.
- The size and efficiency of the home.
- The weather outside.

As a general rule, the hotter a home is heated and the longer it is heated, then the higher the fuel bills will be.

### Using heating controls

People often find heating controls confusing, especially knowing which controls perform which task. The controls fitted to any one system will vary depending on the age and sophistication of the system and the way it is designed to operate.

## CONTROLS ON WET CENTRAL HEATING SYSTEMS

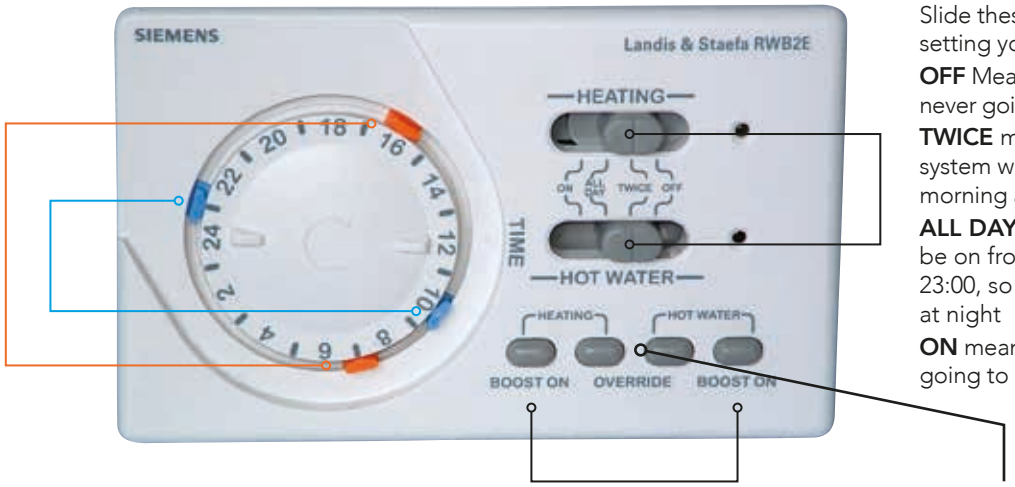
### Time

Time switches or programmers set on and off times. Timers control one function such as heating hot water in a cylinder. Programmers control more than one function, for example, space heating and hot water heating for a central heating system with a hot water cylinder.

There are many programmers available and some of them can be confusing to set, but all follow the same basic principles.

**ORANGE**
tappets switch the system **ON** at 7:00 and 16:00

**BLUE**
tappets switch the system **OFF** at 9:45 and 23:00




Slide these to the setting you want:
**OFF** Means the system is never going to switch on
**TWICE** means the system will be on in the morning and evening
**ALL DAY** means it will be on from 07:00 to 23:00, so it is not on at night
**ON** means it is never going to switch off

**BOOST** will switch the system **ON** for one hour and it will return to automatic control afterwards

**OVERRIDE** is an **ON/OFF** switch, so you press it to switch the system **ON or OFF** as required, but it will still follow the automatic functions after you press it.

Some important general points to remember when setting up a programmer include making sure that:

- the **ON** and **OFF** periods are set as required (many have 24 hour clocks)
- the clock is telling the correct **TIME** of day
- you have selected an appropriate programme. For example 'twice a day' or 'hot water only'
- if it is a 7-day programmer, each day has been programmed as required.

Most programmers have **OVERRIDE** and **BOOST** facilities

that allow you to temporarily override pre-programmed instructions. For example, if the programmer has switched the heating **OFF**, using the override switch will switch the heating **ON** and vice versa. The **BOOST** facility bypasses an **OFF** period programme, to switch ON the water heating or central heating, or both, for a set time, usually one hour.

**OVERRIDE** or **BOOST** are temporary, so the programmer will return to automatically obeying the times and functions set in the programme.

Digital programmers do the same job as the mechanical programmer above, but they may be able to set different times each day and they may be able to accept different times for heating the water and for heating the home. You will need the instructions to know how to set them. The manufacturer's instruction booklet can often be found on the internet.

Programmable room thermostats are a combination of a programmer for setting **ON** and **OFF** times, with a room thermostat for setting the room temperature. The principle for setting these is slightly different, because you set times and temperatures to suit your lifestyle. You don't actually turn the heating **ON** and **OFF**, you just set high and low temperatures at the times required.

## Temperature

### Room thermostats

Homes generally only have one room thermostat which is either placed in the hall or the living room.

It responds to the temperature of the air around it. When the room temperature reaches the temperature set on the thermostat, it turns off the electricity to the boiler and the pump. As the room temperature drops by a few degrees, the thermostat re-connects the electricity to the boiler and the pump. This way the room temperature should vary between about 18°C and 21°C.

Room thermostats should not be placed where other sources of heat may affect them, for example in direct sunlight or near cookers. Similarly they should avoid very cool places, for example close to a draughty outside door. Typically if it is in the hall, set it at 18°C and if it is in the living room, set it at 21°C. You may need it warmer than this if someone is very young, elderly or sick and they are affected by cold conditions.

**Thermostatic radiator valves**

It is possible to control the temperature of a room by using thermostatic radiator valves (TRVs) on the radiators. TRVs incorporate a thermostat which senses air temperature inside of itself. They can be set to a desired temperature and will work automatically to maintain that temperature. The valve works by controlling the rate at which hot water flows through the radiator, so they can also turn the radiator completely off.

Some existing systems were fitted without a room thermostat, but include TRVs on all radiators except one, so that all rooms could be controlled independently. A TRV should not be located in the same room as a room thermostat, as they will work against each other.

Once a temperature has been set on a TRV that feels comfortable, for example this one is set at 5, then adjust it between 4.5 and 5.5 to get the temperature of the room just right.

### The boiler thermostat

The boiler thermostat is located on the boiler. It controls the temperature of the water going from the boiler to the radiators and hot water cylinder. It also stops the boiler from overheating. The boiler thermostat marking is usually vague, such as 1-9 or min-max, which corresponds to a water temperature of approximately 50°C to 90°C.

A combi boiler has two thermostats as shown in the picture above.

# Heating controls

One controls the temperature of the water supplying the taps and the other the temperature of the water flowing through the radiators.

### Controls on a solid fuel system

Controls on a 'wet' solid fuel system are basically the same as those for other 'wet' systems with a couple of exceptions. Because the fuel source cannot actually be switched off, there is always hot water available. The hot water cylinder also acts as a heat sink for the excess heat produced by the back boiler. Furthermore, in automatic systems when the thermostat or the timer calls for heat, a fan draws air over the coals to make them burn more vigorously. However, the vast majority of systems are simpler and have a 'damper' which can be adjusted manually to alter natural air flow rate to the coals.

### Controls on gas fired warm-air systems

Time switches and room thermostats are also used on warm-air systems. Warm air is supplied to the house only when called for by the room thermostat. Thus, the temperature in the room where the thermostat is located will be maintained at the thermostat setting. Individual room control is generally limited with warm-air systems. Temperatures depend on the relative amounts of warm air reaching each room through the ducts and can be controlled by louvres or grilles on each of the air outlets.

## CONTROLS FOR ELECTRIC HEATING SYSTEMS

### Storage heaters

Night storage heaters use cheaper off-peak electricity overnight. A common tariff for this is called Economy 7 which provides cheap electricity for seven hours through the night. The price of the electricity for each tariff rate can be seen on the fuel statement.

Basic manual night storage heaters have two controls, often called INPUT and OUTPUT.

The INPUT control is sometimes called charge control and it controls a thermostat, which is usually located in the heater. The householder selects an INPUT level before they go to bed and the thermostat measures the temperature of the thermal blocks inside the heater and turns off the electric current when they have been charged up to the level selected by the householder. Used correctly, a storage heater can provide less heat on mild days and more on cold days.

Some modern storage heaters have sensors which detect the room temperature overnight and automatically adjust the overnight charge accordingly. This is a great help, as the overnight temperature gives a better prediction of the following day's heat demands.

The OUTPUT control is sometimes called boost and it determines the rate at which heat is emitted from the heater the following day. It is connected to a flap or damper. Opening the damper allows the heat from the thermal bricks to escape from the storage heater more quickly. To obtain the most even temperature, adjust the output control to the minimum setting before going to bed and leave it closed during the day. On more modern models this flap is operated automatically by a thermostat, so that as the room cools down during the day, the damper opens to allow heat to escape.

Storage heaters are best suited to small, well insulated properties where the occupants can make use of the heat throughout the day. They are an alternative if mains gas is not an option.

With fan-assisted storage heaters, better output control is achieved by using a fan to control the air flow over the bricks. On warm days, the fan can be left off, so that very little heat is released. If some heat is still in the thermal bricks, then less electricity will be needed to bring the bricks up to full temperature during the following night.

A combination of models with different controls can be fitted into a house to take account of the heating needs (and possible other heat sources) in each room.

### Electric warm-air

Electric warm-air central heating uses an off-peak tariff. Warm-air heating has a room thermostat, which controls the fan that draws the air over the hot core of the large central heating storage unit (like a large storage heater). This acts as an output control along with the louvres on the outlet vents in each room. The other control on a warm-air central heating unit is the core thermostat. This can be adjusted to alter the amount of heat stored overnight. The daytime boost operates only when the core thermostat is set to its maximum.

### Electric underfloor heating

The main method of control is a time switch that turns the electrical current on and off during the overnight off-peak period. There is also a thermostat to shut off the electrical current when the room reaches the desired temperature. The thermostat thus controls the amount of heat stored overnight.

There is no way the heat output can be reduced if the house is empty for part of the day, so the occupant may end up paying for heat they don't need. Underfloor heating is therefore normally only used for background heating.

For the best results the thermostat should be in the hall rather than the lounge. A better method of control is to install an outside controller, which sets the amount of heat stored according to the outside temperature.

### Controlling room heaters

Room heaters usually have a thermostatic control, but occasionally it is a matter of controlling the heat output manually.

Mains gas and bottled LPG gas heaters normally have a range of heat output settings, but these have to be controlled manually. Portable LPG room heaters are not recommended for use in a home as the heaters are expensive to run, they have no external flue and the fumes contain a large amount of water vapour.

Most electrical portable heaters have a thermostatic control. Fan heaters, oil-filled heaters, and convector heaters can be set by trial and error, which will show what setting is appropriate for any room. Some models of electric convector heaters and radiators have built-in time switches so that they can be timed to come on and off when required. Using on-peak electricity for long periods will be expensive for the householder, whether it is for room heaters or on-peak central heating.

### Controlling water heating

Focusing on controlling hot water systems which have storage cylinders. Instantaneous water heaters are not considered here, because they only heat up the water as it is used.

The way in which to control hot water heating depends on the 'usage pattern' - i.e. how often and how much water is used.

### Timing - off-peak electric immersion

If you are using an off-peak tariff to heat your hot water, the timing may be controlled automatically by the electric meter or controlled by a time clock similar to the one in the picture. When switched to "Timed" the clock controls the off-peak hours used for heating water through the night.

When extra hot water is needed, the "Boost" dial is used, which acts like an egg timer, rotating the dial to give up to one hour of water heating during the day time on-peak hours.

The hot water storage cylinder should be large and have a dual immersion heater. The whole tank will be heated up overnight by the lower element. Just the top of the cylinder will be heated by the top element if boost is used, remember that the boost will use the more expensive on-peak electricity.

Thermostats are found under the cap of each immersion element and should be set at 60°C to prevent Legionnaire's disease spreading.

If the electricity supply is being adapted to use the off-peak tariff, but the existing hot water cylinder is retained, it is advisable to replace the old top-entry immersion heater with a new dual immersion heater plus controller. At the very least, a timer must be fitted to the immersion heater to take advantage of the off-peak tariff.

### Controlling hot water in a wet central heating system.

Controlling the timing of water heating in a wet central heating system is covered above. You can select to heat the water at the same time as the radiators are heated, or you can select different times on some programmers.

Controlling the cylinder water temperature will reduce the

# Heating controls

storage and pipe heat losses quite substantially, saving money and avoid the risk of scalding. The cylinder and the main pipes should be insulated, though the pipes are uninsulated for clarity in the photograph. The thermostat setting for domestic hot water should be 60°C, shown in the photograph.

A cylinder thermostat should be strapped to the cylinder, at about one third of the way up the side and it should be in contact with the copper cylinder wall. The thermostat monitors the temperature of the stored water and when 60°C is reached, the thermostat stops the electricity reaching the valve, which closes and therefore stops hot water from the boiler travelling to the cylinder.

Do not set it to below 60°C due to the risk of water-borne diseases such as Legionnaires' disease.

A thermostat is a device which senses the temperature and automatically turns heating appliances on and off when a chosen temperature is reached

It is possible to control the temperature of a room by using TRVs

**ENERGY USE, METERS, BILLS, PAYING AND SWITCHING**

The rate of electrical use can be seen in watts or kilowatts

## Introduction

**This section will look at understanding energy consumption, from looking at how much is used to how to pay for it and how to get a good deal. The sections are:**

- Typical energy use of appliances and by households
- Fuel meters
- Fuel bills or statements
- Paying for fuel
- Switching fuel suppliers

## Energy use by appliances

Each electrical appliance will use electricity at a different rate, which can be seen on the rating plate. The rate of electrical consumption can be seen in watts or kilowatts and this can be used to calculate energy use over time.

To calculate energy use over a given time, use the formula: **(Watts ÷ 1000) x (Minutes ÷ 60) = kWh.**
You can then multiply the kWh consumed by the price per kWh to give the running cost over the given time.

Note this will not account for a thermostat switching a heater on and off.

**Russell Hobbs**
Model No: 3274
220-240V - 50Hz
2400 watts

An example of this calculation is in the table below. (2400 ÷ 1000 x 5 ÷ 60 = 0.2). The Russell Hobbs kettle, used for five minutes will consume 0.2kWh. If the tariff is 12p per kWh it will cost 2.4p to boil the kettle. Check the current price per kWh on the electricity statement to get an accurate cost.

| Appliance | Rating (W) | ÷ 1000 = KW | x Mins | ÷ 60 = kWh | x price per kWh | = cost to run |
|---|---|---|---|---|---|---|
| **Kettle** | 2400 | 2.4 | 5 | 0.2 | 12p | 2.4p |

Examples of electricity rating are below. Try doing the calculation to compare the cost of running these appliances.

| Appliance | Wattage |
|---|---|
| Microwave | 650W |
| Hairdryer | 1200W |
| Tumbledryer | 2500W |
| Coffee maker | 800W |
| Immersion heater | 3000W |
| Dishwasher | 2000W |
| Fan heater | 2500W |
| Chest freezer | 150W |
| Electric cooker grill | 1500W |
| Electric shower | 10000W |
| LCD TV 32” | Switched on 31W On standby 0.5W |

# Energy use, meters, bills, paying and switching

## Energy use for an average home

Predicting the average gas and electricity usage for a household is not easy and Ofgem, the industry regulator, has been using switching site data to attempt to quantify typical consumption. They have reviewed consumption figures and put them into categories of low, medium & high usage.

In the table below it can be seen that Ofgem estimate that from 2017 onwards a medium sized household might use 12,000kWh of gas per year and 3,100kWh of electricity per year.

Typical energy use in a home:

| Fuel | Usage pattern | Pre 2017 kWh | 2017 onwards kWh |
|---|---|---|---|
| Gas | Low | 9,000 | 8,000 |
| | Medium | 13,500 | 12,000 |
| | High | 19,000 | 17,000 |
| Electricity: Profile Class 1 (single rate meters) | Low | 2,000 | 1,900 |
| | Medium | 3,200 | 3,100 |
| | High | 4,900 | 4,600 |

## Fuel meters

### Gas meter

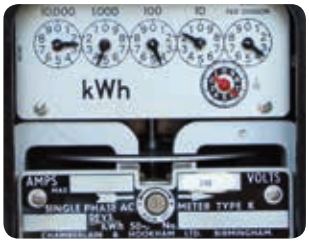
This is used to measure the volume of gas passing into the property, which is usually measured in units of one cubic metre ($m^3$) although some older models measure in units of one hundred cubic feet ($ft^3$). The units measured will be indicated on the meter. It is important for the accuracy of the statement that whichever measurement is being used by the meter corresponds with the statement.

Gas is charged in kilowatt-hours (kWh) and a formula for converting between volume of gas and number of kWh is included in the bill.

### Electricity meter

Electricity meters measure electricity consumption in kWh. Older mechanical meters can either have one or two rows of numbers and really old ones will still have dials.

Newer electricity meters will have digital displays and to see the reading a button may have to be pressed.



**Some common types of electricity meters include:**

**Standard electricity meters**

A standard electricity meter measures the electricity consumption in kilowatt hours. A kilowatt hour is the amount of energy used by a load of one kilowatt over the period of one hour. With this type of meter all electricity units are charged at the same rate, 24 hours a day. It can have dials, mechanical numbers or electronic digital numbers.

**Variable rate electricity meters**

Variable rate meters operate on the same principle as standard meters, except that they give meter readings for each electricity rate within the tariff being charged.

**Economy 7**

Economy 7 has two rates; one for day time electricity usage, and one for night time electricity usage. It typically gives cheaper electricity for 7 hours during the night.

**Economy 10**

Economy 10 is a special 10 hour service metered on a discontinuous basis on 3 registers, called afternoon, night and boost. Effectively this means the home gets low rate electricity through the night, a boost of low rate electricity in the afternoon and all other times will be at the more expensive normal rate. The Economy 10 option is available only for approved, systems and only in combination with the standard domestic plus Economy 7 option.

Consumers supplied on this tariff may encounter problems when trying to switch (as not all companies offer this tariff). Furthermore, to change to a different tariff, they may need to pay to have their meter changed.

**Meter serial numbers**

The serial number is unique to each meter; it is always made up of a series of letters and numbers and will appear on the meter and the fuel statement. When there is a query with a bill it is important to check the meter serial number matches the one on the statement. Note this is different to the supply number, which is also found on the statement.

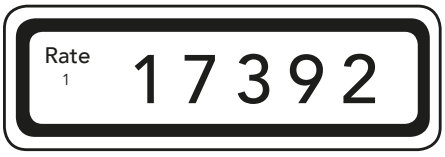
**How to read a digital meter**

(Showing numbers).

- Read all digital meters from left to right (ignore red numbers) and record them left to right.
- Gas meters show 4 or 5 numbers (excluding the red).
- Electricity meters show 5 numbers (excluding the red).
- Some electricity meters show two rows of numbers, for Economy 7 tariffs so remember to note which reading is for the normal rate and which is for the low rate.

**Single screens showing multiple rates**

Some meters have a single digital screen, which switches to show different rates. In the top left hand corner next to the screen, the word 'rate' can be seen; this means the rate for the tariff used, usually normal rate and low rate. You need to know which rate is number 1 and which is number 2. On some meters a different rate and reading may appear every 30 seconds, which means you have to watch the screen carefully in order to record the readings correctly. The reading will not be accurate without all of the rates being recorded. Some meters require you to press a button to scroll from one rate and reading to the next.

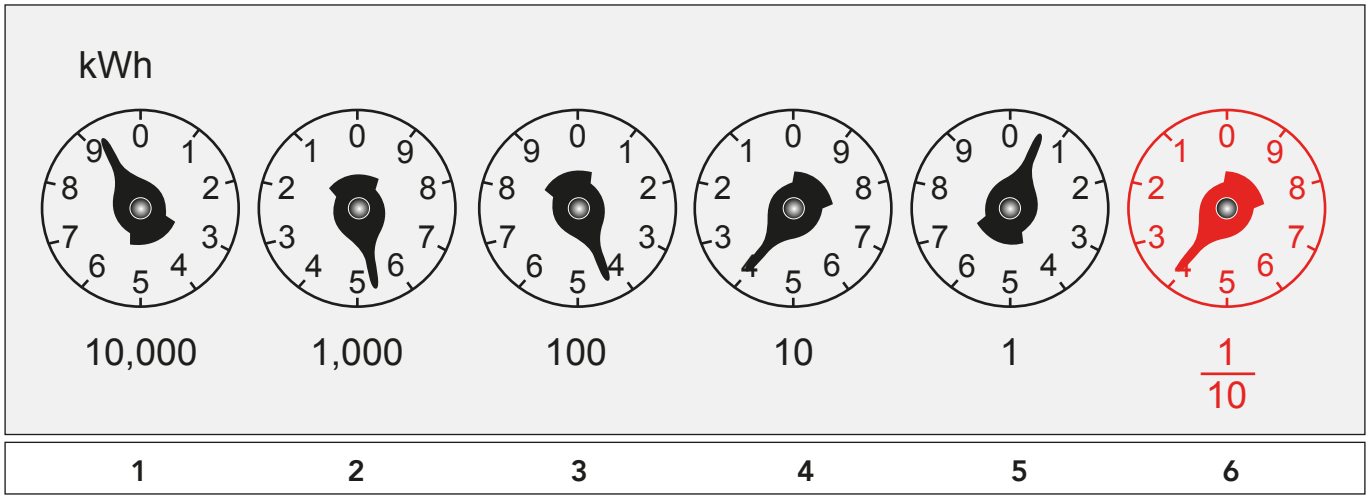


On some meters a different rate and reading may appear every 30 seconds, which means you have to watch the screen carefully in order to record the readings correctly.

# Energy use, meters, bills, paying and switching

### How to read a dial meter

- Read the black dials starting with 1 and working to 5 and ignoring the red dial 6.
- Establish the direction the pointer is moving - clockwise or anti-clockwise.
- Write down the number the pointer has passed.
- If the pointer is directly over a number, underline it then check the next dial to the right.
- If the pointer to the right has not passed zero then take 1 away from the number underlined.
- If the pointer to the right has passed zero, leave the underlined number as it is.




### In the picture above:

**Dial 1 -** The pointer is travelling clockwise and has passed 9. The reading is 9.
**Dial 2 -** The pointer is travelling anti-clockwise and has passed 5. The reading is 5.
**Dial 3 -** The pointer is travelling clockwise and has passed 4. The reading is 4.
**Dial 4 -** The pointer is directly on the number 4. Note the pointer on dial five has passed 0 therefore the correct reading for dial four is 4.
**Dial 5 -** The pointer is travelling clockwise and has passed 0. The reading is 0.

**You will have written down 95440.**

N.B. If dial five had read 9, then dial four would really be reading 3. You are deciding, "do dials four and five read 39 or 40?"

### Prepayment or Pay-as-you go meters

Credit can be bought or topped up prior to using gas or electricity. If the customer stops paying for fuel, the fuel supply will be cut off by a relay fitted into the meter.

The main advantage of this kind of meter is that by paying in advance, the customer can manage consumption to avoid worrying about accidentally building up high fuel bills. The disadvantage is that if the meter is not kept in credit the supply will be cut off by the meter. This can cause problems if the occupier goes away.

Also, there is a standing charge applied to the meter each day, which means payment (credit) has to be added to the meter whether or not any fuel has been used.

### Reading a digital prepayment or pay-as-you go meter

Visual displays are available usually by pressing a button on the meter, each time the button is pressed you can 'scroll' through different screens to show.

- Units of fuel consumed.
- Standing charge per day.
- Rate per kWh of fuel.
- Credit inserted.
- Current credit.
- Outstanding debt.
- Debt repayments rate per week.
- Emergency credit available.

This list is not exhaustive and other information may also be displayed depending on the model of the meter. There is a second button on some meters which allows an emergency credit supply when it has not been possible to buy or top up credit. This will be repaid when the meter credit is next topped up.

Any changes in fuel prices or customer payments are carried out within 48 hours of a change, because all the information necessary is programmed onto the machine at the PayPoint or Payzone, which transfers the change from the supplier to the key. Once the key is inserted into the meter, up-to-date information is registered and the necessary settings are changed in the meter. The meter will then request the correct amount of payment, so preventing debt.

## Smart meters

Every home in Wales, Scotland and England is being offered smart meters at no extra cost by 2020; one for mains gas and one for mains electricity. They will replace the existing meters.

A smart meter is different from a conventional meter in two major ways.

- The smart meter will send meter readings to an independent Data Communications Company (DCC) regularly, using a mobile phone type signal, which means bill payers will no longer receive estimated bills. The DCC is overseen by Ofgem.
- The gas and electric smart meters both communicate with an In-Home Display (IHD), which tells the householder a variety of information to help them control their gas and electricity consumption.

The DCC will send meter readings to the supplier and the energy network operator, either, monthly, daily or half-hourly, depending on the householder's preference. This information may be shared with price comparison websites and can be used by the supplier for marketing activities, but only with the permission of the householder.

**The IHD can give information such as:**

- How much energy is being used, in near real time.
- How much energy was used in the last hour or week or month and what it cost.
- Whether the electricity consumption is high, medium or low.
- Updates in near real time for electricity and every half hour for gas.

**For people with pre-payment meters, the IHD also can show:**

- How much credit is left on the meter.
- How much emergency credit is left.
- How much the debt balance is if there is one.
- When the credit is getting low.

Every home in Wales, Scotland and England is being offered smart meters at no extra cost by 2020

# Energy use, meters, bills, paying and switching

## Bills and Statements

The layout of fuel bills and statements vary greatly, but they all follow the principles below.

For all statements:

- Subtract the previous reading from the present reading to give the units used.
- Then multiply the units used by the price per unit to give the cost of fuel used.
- Then multiply the standing charge number of days by the price per day to give the cost of the standing charge for this bill.
- Then add the fuel cost to the standing charge cost to give a sub-total.
- Then add VAT at 5% to give the total bill.

For examples of current statements, see the Energy Awareness course manual.

### Electricity statement for a tariff with a single unit rate and standing charge.

This statement does not include details of any payments made or the account balance. Follow the procedure above to check the calculations.

Electricity statement

Charges for electricity
Tariff type Standard Rate

| Reading | Present | Previous | Units | Amount |
|---|---|---|---|---|
| | 25/01/2017 | 25/10/2016 | | |
| | 34990E | 34370 | 620 at 18.00p per unit | £111.60 |
| Standing charge 97 days at 14.56p per day | | | | £14.12 |
| Sub total | | | | £125.72 |
| VAT at 5.00% on £125.72 | | | | £6.28 |
| **Please pay** | | | | £132.00 |

### Gas statement for a tariff with a single unit rate and a standing charge.

Note that for gas statements, it is necessary to convert from gas units in $m^3$ to kWh using the equation on the bill; in this case changing 701$m^3$ to 7845kWh. (701 x 1.02264 x 39.4 ÷ 3.6 = 7845)

This statement also includes details of payments made and the account balance. Also the customer receives a discount for paying by direct debit.

| | | | |
|---|---|---|---|
| For the period 29 August – 04 December 2016 | | | |
| Meter Point Reference 1273508701 | | | |
| **Debit balance brought forward** | | | **£16.96** |
| 01 December 2016 | £65.00 | | |
| 01 November 2016 | £75.00 | | |
| 01 October 2016 | £75.00 | | |
| 01 September 2016 | £75.00 | | |
| **Total payments – Thank you** | | | **£290.00cr** |
| **Gas used – Your meter readings** | | | |
| | **Units** | | **kWh** |
| Present reading | 06882 | 02 Dec 2016 | |
| Previous reading | 06181 | 29 Aug 2016 | |
| **Total gas used $m^3$** | **701** | | **7845.75** |
| We convert your units to kilowatt hours in the following way: gas units used X volume conversion factor (1.022640) X calorific value (39.4) divided by kilowatt hour conversion factor (3.6) = kilowatt hour used | | | |
| **Charges** | | | |
| **Cost of gas used** | | | |
| 7845.75 kWh at 4.682 pence per kWh | | | |
| **Total cost of gas used** | | | **£367.34** |
| **Cost to supply gas (standing charge)** | | | |
| 100 days at 30.00 pence per day | | | |
| **Total cost to supply gas** | | | **£30.00** |
| **Monthly Direct Debit discount** | | | **£15.08** |
| **Total charges excluding VAT** | | | **£382.26** |
| VAT 5.00% of £382.26 | | | **£19.11** |
| **Total charges** | | | **£401.37** |
| **Summary** | | | |
| **Debit balance brought forward** | | | **£16.96** |
| **Total payments** | | | **£290.00** |
| **Total charges** | | | **£401.37** |
| **Your current balance is in debit by** | | | **-£128.33** |
| **This balance will be carried forward.** | | | |

Gas statement

### Electricity statement for an on-peak and off-peak tariff (e.g. Economy 7)

For Economy 7 statements the only difference is that there is a row for low rate readings with a lower price per kWh, plus a row for normal rate readings and a higher price per kWh. These are added up with the standing charge and the VAT as usual.

Credit meter customers can expect to receive a statement once every quarter. If they pay by direct debit and have an online account, they will get monthly statements too. Prepayment customers should receive a statement once every twelve months.

The statement should include the following information.

- Contact details of the supplier.
- Customer's name and address.
- The dates of the billing period
- The customer reference number or account number – this should be prominent on the bill and should be quoted when contacting the supplier.
- The previous and present meter readings.
- How many kilowatt hours of gas or electricity have been used during the billing period.
- How much the supplier is charging per kilowatt hour for gas or electricity.
- Cost of the daily standing charge (if applicable).
- The current outstanding balance is usually in bold type
- The specific supply reference number (MPAN/ MPRN).
- Emergency contact details – should there be a loss of supply or any other emergency.
- Tariff Information Label (TIL) setting out the main features of the tariff.
- If the supplier offers a better tariff than the current tariff – the cheapest tariff message.
- Contact details for Priority Service Register.

### Supply numbers

**What is the 'S' number on the electricity statement?**

Your Electricity Supply Number

**Supply Number**

| | | | |
|---|---|---|---|
| S | 123 | 456 | 789 |
| | 11 | 2345 | 7891 | 120 |

Each electricity supply has a reference number, which relates to the property and stays the same even if the meter is changed. This is called the Meter Point Administration Number (MPAN) and it is laid out as illustrated, left. This number is not written on the meter itself. To find out what the MPAN is for a particular property, check the statement or contact the local Meter Point Administration Service (MPAS) who can provide the number.

**What is the 'M' (MPRN) number on the gas statement?**

Each gas supply has a reference number, which relates to a specific domestic property and stays the same even if the meter is changed. This is called the Meter Point Reference Number, or 'MPRN' or 'M' number for short. This number is not written on the meter. It is simply a string of up to ten numbers with no letters and will be on the statement.

## Paying for fuel

### Tariff options

There are a number of tariff options that suppliers could offer. The main types offered in the market include.

- Standard variable tariff (a single rate with a standing charge).
- Time of Use (e.g. Economy 7, White Meter or Economy 10).
- Prepayment.
- Fixed term (of a finite duration).
- 'Green'.

### Standard variable tariff

Standard variable tariffs do not have a fixed duration and are open-ended. Because they are open-ended, the prices of a standard tariff can go up or down. This can mean that they are more expensive than some fixed term products. Similarly, they are not allowed to include an exit fee, so consumers are free to leave a standard tariff at any point in time without paying a cancellation charge. Standard variable tariffs are offered as single fuel tariffs or can be dual fuel (gas and electricity), with the supplier typically giving a discount for

taking two fuels together.
and stays the same even if the meter is changed.

Potential benefits:

- No exit or cancellation fees
- The customer can benefit from any price reductions

Potential drawbacks:

- Can be more expensive
- Prices can increase

**Time of Use (e.g. Economy 7, Economy 10 or White Meter in Scotland)**

With Economy 7 for example, the consumer receives seven hours of electricity at an off-peak or low rate. Any electricity consumed at other times is at the higher on-peak or normal rate. The timings vary between different areas, but the off-peak period will be a seven hour period, falling somewhere between the hours of 10pm and 8.30am.

Potential benefits:

- May be better for households using electric storage heaters or heating water using an electric immersion heater.
- It is estimated that the consumer ought to use approximately 55% of their electricity at night for it to be cost effective (this figure does vary according to the supplier).

Potential drawbacks:

- It can be expensive if the consumer does not use a high proportion of their electricity during the off-peak period to make it cost effective.
- Some consumers may have a legacy Economy 7 meter despite a change in heating arrangements (i.e. a new gas boiler instead of an electric storage heater) so it may be worth checking to see if this is still an appropriate meter. Most time of use meters can be run as a "standard" meter.

**Prepayment tariff**

A prepayment tariff will require a prepayment meter to be installed.

Potential benefits:

- Makes it easier for the consumer to budget as they know what they spend.

Potential drawbacks:

- The tariff is expensive and direct debit discounts will not apply.
- Limited number of prepayment tariffs to choose from.
- Self-disconnection will occur if credit is not maintained in the meter.
- Confusion is caused when the customer is paying for the fuel, standing charge, arrears and emergency credit all through the meter.

**Fixed term tariffs**

With a fixed term tariff, the customer will be in a contract with their supplier for a defined period of time. Some suppliers may also fix prices at one level for the duration of the tariff. Typically, fixed term tariffs have a termination fee if the consumer leaves the contract early.

Customers on a fixed term tariff will be given 42-49 days before their contract ends to decide if they want to stay with their supplier or switch. They will get details of the tariff they will be moved onto by default, if they stay with the same supplier and do not agree to a different one. To avoid customers unwittingly being rolled onto a more expensive contract at the end of a fixed term tariff, suppliers must put the consumer onto the cheapest standard tariff they offer if the consumer does not choose a new tariff. Standard tariffs however tend to be more expensive. If the consumer does not want this to happen, they can contact their supplier before the fixed term tariff comes to an end and choose a better tariff, or move to another supplier. If the consumer is happy being put onto the cheapest standard tariff but want to choose something else later on, they can move without being charged an exit fee.

Potential benefits:

- Certainty on price.

Potential drawbacks:

- Possibly a high cost, depending on the tariff. Some fixed rate tariffs can be more expensive than the supplier's standard tariff; this is particularly the case with a fixed price tariff.
- If fuel prices fall the consumer will continue to pay the set rate until the end of the contract.
- Exit or cancellation fees.

**Green tariffs**

A number of suppliers offer 'green' energy tariffs, but what is offered can vary. Green tariff means that a proportion, or all of the fuel the customer purchases is 'matched' by the supplier buying renewable energy on behalf of the customer. Furthermore, some green tariffs are nuclear-free.

Ofgem, the industry regulator, requires any supplier offering a green tariff to prove it through adherence to the following principles.

- Providing evidence: Electricity

suppliers need to know and show exactly where they are sourcing electricity from.
- Going above and beyond: Providing a green tariff does not just mean sourcing sustainably, it means investing money into sustainable technologies and schemes.
- Transparency: The supplier is obliged to let customers know regularly what their money is doing to help the environment. They also need to tell them if it is not being invested in green projects.

Potential benefits:
- It helps to protect the environment.
- It supports renewable technologies.
- It helps meet the government environmental targets.

Potential drawbacks:
- Green tariffs can be expensive.

**Discounts**

In 2017 suppliers are allowed to offer two cash discounts to customers.
- Dual fuel: Where there is a discount for taking gas and electricity from one supplier.
- Online: Where a discount is given for managing the energy account online and receiving bills electronically.

**Dual fuel discount**

Most suppliers offer dual fuel discounts for taking both fuels from them. Under Ofgem's Retail Market Review, changes to the amount of the dual fuel discount will be clearer. It will no longer be expressed as a percentage amount, but as a £ per year figure.

Potential benefits:
- Usually cheaper than getting each fuel from a separate supplier.
- More convenient for the consumer as they receive bills from one company and there is only one point of contact for any queries, requests for help or complaints.

Potential drawbacks:
- Some tariffs have dual fuel discounts that look appealing, but may not be cheaper than taking single fuels from separate suppliers.

**Online discount**

With online tariffs the consumer will need to sign-up and manage their account online and receive their bills electronically. The tariff name will usually refer to 'online' or 'web'. In many cases, suppliers give discounts for taking an online tariff.

Potential benefits:
- May be more convenient to manage for the consumer
- The discount will reduce the cost of the tariff (but there may be cheaper non-online tariffs on the market).

Potential drawbacks:
- Only available to consumers with internet access.

## How to pay the statement

There are a number of different ways of paying gas and electricity statements, and a number of different places where it can be done.
- **Direct debit -** paying gas and electricity statements monthly or quarterly by direct debit from a bank account.
- **Standing order -** paying gas and electricity statements monthly or quarterly by standing order from a bank account but this needs to be arranged with the supplier first.
- **Debit or credit card -** to pay gas and electricity statements over the phone.
- **By post -** when paying gas and electricity statements by post, make the cheque payable to the supplier as worded on the statements and write the gas and electricity account numbers on the back. Send the cheque to the address printed on the gas and electricity statements.
- **Post Office -** paying the gas and electricity statements at the Post Office, but there may be a charge for this service.
- **Bank or Building Society -** paying the gas and electricity statements by cash or cheque at the bank or building society, but there may be a charge for this service. Cheques should be made payable to the supplier as named on the statements and the gas and electricity account numbers should be written on the back.
- **Payment cards** - the supplier issues the consumer with a

payment card (sometimes referred to as an 'Energycard') that enables them to pay their energy bills at any PayPoint or Post Office. Payment cards differ between energy suppliers. Some enable consumers to make flexible payments throughout the year (even before receiving a statement); others are used to make set regular payments. Payment cards can be a good option for those looking for a convenient way to make cash payments.

- **Prepayment meters** - the supplier will have an arrangement for their customers to buy electricity or gas, using a key or card from any of the following.
  - PayPoint (www.paypoint.co.uk) – check the postcode finder on the PayPoint website to find the nearest one. Look for the yellow and mauve PayPoint signs.
  - Payzone (www.payzone co.uk) - look for the pink, blue and white Payzone signs.
  - Post Offices (www.postoffice.co.uk).
  - The consumer may not be able to top up the key or card at all outlets – if in doubt, contact the supplier for advice.
  - Consumers should only top up at official outlets and be aware of scams. See: www.top-upsafe.com
- Third Party Deductions (TPD) – Fuel Direct

An arrangement can be made, with the consumer's permission, for a fuel debt and on-going consumption to be paid for from benefits.

This can be arranged between the Department for Work and Pensions (DWP) and the supplier.

To qualify, a consumer must be claiming the relevant benefit and the arrears must be greater than the Income Support rate for a single person aged 25 and above. It must also be in the consumer's, or their family's, best interests for direct payments to be made. The debt recovery rate is an agreed amount per fuel a week. Deductions are made before the consumer receives their benefit.

The qualifying benefits are:

- Income Support
- Income-based Jobseeker's Allowance
- Pension Credit
- Income-related Employment and Support Allowance
- Universal Credit

To apply for Fuel Direct contact Jobcentre Plus (or the pension centre if the person is on Pension Credit).

## Switching suppliers

Any action to reduce household fuel bills will have a beneficial effect on fuel poverty. In a competitive market, savings can often be made by switching to another electricity or gas supplier. This should be a relatively easy process but some people may find it confusing. The key to making switching easier is gaining access to good quality, independent information.

Customers who have never switched supplier are most likely to be able to reduce their bills significantly, but most consumers can reduce their existing fuel costs if they shop around to get the best deal.

Switching does not necessarily mean changing supplier; the consumer can switch tariff and payment method with their existing supplier to get a better deal. Suppliers must make customers aware if they offer a tariff that is cheaper than the customer's existing tariff. This information is shown on the fuel statement.

Information required before changing tariff or energy supplier:

- The name of the current tariff. This is on the fuel statement, Tariff Information Label or Annual Statement Summary.
- How much electricity and gas was used in the past year. This can be found on the current fuel statement. The Annual Statement Summary will also indicate how much has been spent on energy in pounds and how much consumed in kilowatt hours (kWh) for the previous year. Using the annual consumption in kWh will give a more accurate

price comparison.

- The current payment method: cheque, direct debit, online or prepayment meter.
- The preferred payment method with the new energy supplier.
- Postcode of the property.

**How to find the best deals**

There are a number of ways to find out about the best deals.

- Search an accredited internet price comparison website.
- Contact energy suppliers directly.

Always use a comparison website that displays the Ofgem Confidence Code logo, to show that the website is approved and reliable.

Ofgem has created a guide 'Go Energy Shopping' to show how consumers can get the best deal on their gas and electricity statements.

The website includes:

- Tools to help people compare the different tariffs.
- A glossary explaining the language used on statements.
- Links to other useful sites.
- A downloadable guide to switching.

Accessible at: **http://www.goenergyshopping.co.uk/en-gb**

There are a number of different ways of paying gas and electricity statements, and a number of different places where it can be done.

The rate of electrical consumption can be seen in watts or kilowatts and this can be used to calculate energy use over time

Predicting the average gas and electricity usage for a household is not easy and Ofgem has been using switching site data to attempt to quantify typical consumption

Economy 7 electricity meters show two rows of numbers, so remember to note which reading is for the normal rate and which is for the low rate

Any action to reduce household fuel bills will have a beneficial effect on fuel poverty

# Condensation and Dampness

**CONDENSATION AND DAMPNESS**

The black mould that is a result of moisture production can be detrimental to health

## Introduction

**Condensation is included in the Energy Awareness course because it is closely associated with fuel poverty.**

The black mould that is a result of moisture production, cold homes and poor ventilation is not only unsightly, but it is detrimental to health, as the spores from the mould irritate lungs.

This section looks at the types of damp, the causes of condensation dampness and actions to minimise the condensation problem.

## Types of dampness

There are four main types of dampness that can occur in a property.

**Plumbing problems**

Dampness problems can arise due to a small amount of leakage from appliances or pipes over a lengthy period, or as a result of a sudden rush of water, for example following a burst pipe. It gives rise to well-defined patches of damp, which can be localised close to the source of the problem. Note that the damp patches can be found away from external walls too.

**Rising damp**

This type of dampness occurs only on ground floor walls and is usually identifiable by a well defined tidemark 600-1000mm above ground level which may persist for some time. White salt often appears under wallpaper and the paper tends to peel off the wall. Rising damp is caused by the wall soaking up water from the ground below, so it is not noticeably affected by the weather. It can occur on internal and external walls. Occasionally, walkways to tower blocks may also provide areas of standing water and so cause rising damp.

The problem of rising damp occurs because there is no damp proof course (DPC), or it has failed in some way or it has been bridged. For example a mound of earth piled up against an external wall will bridge the DPC, allowing moisture to get above the DPC and rise up the wall.

To prevent rising damp, a DPC is usually installed as a building is constructed. This is a moisture proof barrier created by the physical insertion of a layer of slate, plastic or bitumen substance into the mortar layer as the wall is built. In existing buildings remedial work can include creating a new DPC by drilling holes into the bricks along the base of the wall and injecting a solution of water repellent material.

**Rain penetration and faulty rainwater disposal**

This is also known as penetrating damp and occurs when there is a defect in the outside skin of the wall, for example when rendering or mortar is cracked. If gutters are blocked or drain pipes broken, rainwater will overflow and pour down the outside wall surfaces and it can find its way to the inside of the wall.

It gives rise to random well-defined patches which, because damp can move horizontally, may occur some distance from the actual source of the problem on the outside wall. The problem tends to get worse when the weather is wet and may disappear after a long dry spell.

**Condensation dampness**

Condensation dampness tends to occur in rooms where lots of moisture is produced, and on cold surfaces in other rooms. It does not form the well-defined patches that are characteristic of other forms of dampness and the problem will tend to be worse in cold weather.

Black mould on walls and ceilings, also green mould on or behind furniture may be found as a result of condensation dampness.

# Condensation and Dampness

## What is condensation

All air contains a certain amount of 'invisible' water vapour. The higher the temperature of the air the more water vapour it can hold. Condensation frequently occurs when warm air carrying water vapour comes into contact with a cold surface and becomes cooler. At this new low temperature it is unable to hold as much moisture and so deposits the water vapour as droplets on the cold surface.

People who wear glasses know what happens when they come into a warm house from the cold outside; their glasses steam up. The same effect can be seen on the bathroom mirror when they have a hot bath; warm moisture-laden air chills on contact with a cold surface. This process can occur anywhere in the home: for instance, moisture-laden air from the kitchen may travel through the house and condense on a cold bedroom wall. In this case it may not be visible as water droplets since it can often soak into the wall, but over time a patch of black mould can develop.

Condensation not only occurs on the inside surface of a building's external structure, but may take place within the fabric of an external wall due to moisture moving outwards through the wall and condensing when it reaches a cold layer. This is known as 'interstitial condensation'.

### Where do you find condensation?

The following areas are particularly prone to condensation:

- Cold surfaces such as mirrors, single glazed windows and metal window frames.
- Kitchens and bathrooms.
- Walls of unheated rooms.
- Cold corners of rooms where two outside walls meet.
- Wardrobes, cupboards (particularly built-in cupboards) and behind furniture that is placed against an outside wall.

### Relative humidity

The term 'relative humidity' is used to describe how much water the air contains at a given temperature, that is, how 'saturated' it is.

When the air is completely saturated the relative humidity is 100%, that is, the air is holding as much water vapour as it can at that temperature. The higher the temperature of the air, the more water it is able to hold. The Building Research Establishment (BRE) have found that mould growth is likely to occur in a home if the relative humidity indoors remains at 70% or more for a prolonged period of time.

The level of the relative humidity can be reduced by removing some of the water in the air or by raising the temperature of the air or by a combination of the two.

### What can be done to avoid condensation?

The main factors involved in the production of condensation are the amount of moisture in the air, the temperature of the air, and the presence of cold surfaces.

In order to avoid condensation, the following actions should be taken.

- Reduce the amount of moisture produced in the home.
- Provide adequate ventilation for the home.
- Increase the heating to raise the temperature of the air and to warm the cold surfaces.
- Insulate the home to warm up cold surfaces and keep heat in.

Each of these factors will be examined one by one. In reality, however, these factors are seldom dealt with in isolation and a more comprehensive approach is usually required to tackle a serious condensation problem.

It is almost always necessary to look at both the physical structure of the building and the heating system to see how design faults may make condensation more likely, and to look at how the residents use their heating systems, ventilate their homes, and deal with moisture production.

### Dealing with moisture in the air

Normal activities such as washing, bathing, cooking and simply breathing produce moisture. These activities cannot be avoided, but it may be possible to reduce the effect of some of them by thinking about our actions while we are doing them.

According to research undertaken by BRE, the average UK household puts about 12 litres of moisture into the air in their home every day, through normal activities such as cooking, washing clothes and bathing; breathing alone contributes

about 1 litre per person every 24 hours. In homes where clothes are dried indoors, or that use bottled gas heaters, the total can be over 20 litres a day.

About half this moisture is slowly produced throughout the day in different rooms of the home. The remainder is produced over short periods of time and in large quantities, mainly in the kitchen and bathroom.

There are a number of practical steps that people can take to reduce the amount of moisture being produced in the home.

- Lids should be kept on saucepans when cooking.
- Clothes should be dried outside if possible.
- Tumble driers should be vented to the outside.
- Unvented bottled gas heaters should be avoided, as water vapour is produced when the fuel is burned.
- Baths produce a lot less steam than a shower, especially if the water is not too hot.

**Ventilation**

Inadequate ventilation will mean that moist air cannot escape and so condensation may occur. Ventilation is needed for a number of other reasons too.

All gas appliances need fresh air to burn, people need fresh air to keep them healthy and fresh air is needed to replace moisture-laden air in the home. A suitable level of ventilation fulfils these needs without making the occupants uncomfortable by causing draughts and making the room cold. It may be quite difficult to get this balance right.

If a home has condensation, opening the windows alone will not solve the problem because although the ventilation is increased, the home may become cold as a result and this in turn will increase the risk of condensation.

What is needed, then, is an adequate amount of ventilation in the right places.

The Building Research Establishment suggests the ideal rate of ventilation is between 0.5 and 1.5 air changes per hour. Less than this and the relative humidity is likely to rise. More than this and the house is likely to get colder, also causing the relative humidity to rise.

Background ventilation may be achieved in rooms by the provision of a range of airbricks or adjustable vents, some of which are fixed open and some of which can be opened or closed to suit needs.

Higher levels of ventilation are suitable for removing moisture from the areas of high moisture generation, usually the kitchen or bathroom, and can be achieved by opening windows or using extractor fans, or doing both. However, internal doors should be kept closed to help prevent moist air from circulating round the home.

Extractor fans need to be fitted to kitchens and bathrooms as part of the Building Regulations.

**Draughtproofing**

In homes with too much ventilation through gaps around doors and windows, draughtproofing can successfully reduce heat loss from these areas. However, too much draughtproofing can reduce the flow both of fresh air into the house and of moisture-laden air out of the house. This can make condensation problems even worse.

Bedrooms or living rooms with severe condensation problems should not be draughtproofed. If, however, the problem is a minor one then these rooms can be draughtproofed, but only if there is a permanent ventilation opening to allow air flow.

Rooms with fuel burning appliances should not have the windows draughtproofed unless there is a fixed vent in the same room. A heating engineer will advise on which appliances this applies to.

**All air contains a certain amount of 'invisible' water vapour**

Inadequate ventilation will mean that moist air cannot escape and so condensation may occur.

**Rooms with fuel burning appliances should not have the window draughtproofed, unless there is a fixed vent in the same room**

# Condensation and Dampness

**Heating**

Condensation is most likely to be a problem in homes that are under heated.

The under heating of homes may be due to the inadequacy of the heating system, or the inability of the occupants on low incomes to afford to use enough fuel to keep their homes warm, or they may not understand how to control their heating system.

Adequate heating is important because it warms up the air, allowing it to hold more moisture, and it warms up the internal surfaces of walls and windows, thus reducing the risk of condensation.

Maintaining low levels of heating for longer periods in rooms which are used infrequently is better than intermittent heating for the avoidance of condensation. For example, when a heating system is turned off and the temperature drops, condensation is more likely to occur. Unheated bedrooms are often sites for condensation, as cold walls and windows attract condensation. Keeping heating on for longer allows more time to get the water vapour to blow out of the house by ventilation. However, this pattern of heating is not always appropriate for the householder's lifestyle or budget.

People who are unable to afford to install a heating system may opt for individual fires or heaters. However, bottled gas heaters are not advisable if condensation is a problem. For every litre of fuel burned, heaters like these release an equal quantity of water vapour and so can in fact make a condensation problem worse.

Heating systems should always be affordable to run, otherwise householders may resort to the heaters described above or not heat their home at all.

**Insulation**

Insulation is important in the treatment of condensation problems because it has a threefold effect:

- It helps to retain heat within the home.
- It will help keep the surface temperature of walls, ceilings and windows warmer.
- It helps reduce heating bills and enables people to heat their homes longer for the same cost.

Current Building Regulations should now ensure that houses are properly insulated, but many older homes, including those built in the 1960s and 1970s, contained design defects which make them prone to condensation. Those built before 1990 did not require the walls to be insulated. Uninsulated walls, concrete floors and ceilings are examples of areas with high U-values, which lose heat quickly and provide cold surfaces for moist air to condense on. In remedying condensation problems, such areas are often insulated.

Cold bridges occur where the same building material from the outside is also on the inside, such as a balcony. They are also areas prone to condensation and sometimes require complex insulation solutions.

**Dehumidifiers**

A dehumidifier is an electrical device designed to remove water vapour from homes. A dehumidifier draws in warm moist air from the room and passes it over a cold metal coil. This causes water vapour to condense out of the air and drip into a moisture collector. A dehumidifier is not the ideal answer to condensation problems in cold homes.

Dehumidifiers are useful in homes which are well-heated, but unfortunately, the majority of condensation-prone homes are poorly heated. They are expensive to run.

**Positive Input Ventilation (PIV)**

Adequate ventilation plays a major role in the eradication of condensation.

PIV is a system that provides whole house ventilation in one continuous cycle. Air is removed from the loft space, filtered and introduced into the house at a low volume.

The electricity consumption rate of the appliance is extremely low (estimated to cost around 1p per day) with minimal maintenance required (changing filters between 1-5 years). PIV can reduce moisture levels to a point that assists in the reduction of condensation and dampness as well as improving living conditions for householders who suffer from respiratory problems. PIV can also be used in dwellings with no loft space by transferring air from the outside to the inside either directly or via ducting.

**Dealing with mould growth problems**

Mould may be found in the cold parts of a room if the humidity is constantly or regularly high. This takes the form of black spots, or

in particularly bad cases, solid black areas. This mould can be removed by fungicidal washes. Some products may be effective in keeping the mould away, but in most cases the mould will grow back unless the cause of the condensation dampness is dealt with.

**To sum up**

Rising damp, rain penetration and faulty plumbing can cause dampness.

Condensation can be a complex problem to tackle because it does not have a single clear-cut cause or remedy. Condensation dampness is usually caused by a combination of four factors. These are excessive moisture production, inadequate ventilation, inadequate insulation and inadequate heating.

In the case of rented property, tackling condensation is the responsibility of the landlord and the tenant working together. The landlord should provide good heating and a property with good insulation and adequate ventilation. The tenant needs to use the heating appropriately, provide suitable amounts of ventilation and think about reducing the amount of moisture they produce day to day.

Possible solutions which should be considered are:

- Taking care to minimise moisture production in the home.
- Providing sufficient ventilation to remove moisture-filled air, but not so much that the air temperature falls.
- Providing insulation to help the surfaces stay warm longer and cut down the cost of heating.
- Providing adequate heating to warm up the home, with longer heating times being beneficial.

## FURTHER INFORMATION

**Keep your home free from damp and mould.**
One Scotland Scottish Executive
http://www.gov.scot/Publications/2005/05/10103020/30217

**Keep your home free from damp, condensation and mould**
Gateshead Council
http://www.gateshead.gov.uk/Housing/helpsupportadvice/HousingComplaints/Damp-condensation-and-mould.aspx

Adequate heating is important because it warms up the air, allowing it to hold more moisture.

When a heating system is turned off and the temperature drops, condensation is more likely to occur.

**Keeping heating on for longer allows more time to get the water vapour to blow out of the house by ventilation.**

A landlord should provide good heating and a property with good insulation and adequate ventilation.

# Renewable Energy

Renewable energy is generated from natural sources that are continuously at work in the environment

## Introduction

**Renewable energy is generated from natural sources that are continuously at work in the environment and is not depleted by being used.**

Domestic renewable technologies utilise flowing water, the movement of air, sustainably grown vegetation and energy from the sun.

Instead of buying all of their energy from suppliers, customers can fit renewable technology (also called microgeneration and low-carbon technology) to generate their own space heating, domestic hot water and electricity.

## Potential benefits of installing renewable technologies

A householder will be:

- Reducing their need for non-renewable energy i.e. fossil fuels.
- Reducing their fuel bills.
- Possibly generating income by selling their surplus energy back to their energy supplier.
- Making use of natural resources to produce their energy.
- Reducing the production of carbon dioxide and greenhouse gases.

Before installing a renewable technology, a householder needs to become more energy efficient and reduce demand for energy. This allows the renewable technology to make a greater contribution towards the overall energy use of the home.

Changes in behaviour can lower the amount of energy used within the home. For example, switching off lights and appliances when not in use or turning down room thermostats and thermostatic radiator valves. Using energy more efficiently includes insulating the home as much as possible, then using space and water heating appropriately.

**Renewable Electricity**

There are a number of technologies available for generating electricity at home. These include.

- Solar photovoltaics (PV).
- Wind turbines.
- Hydro.
- Micro-CHP (Combined Heat and Power).

**Solar Electricity/Solar Photovoltaic (PV)**

**Overview**

Solar photovoltaics technology (PV) works by capturing the sun's energy using photovoltaic cells.

The cells convert the light into electricity and this can be used to power household appliances and lighting.

To generate electricity the cells do not need direct sunlight, they will still produce a little electricity on a cloudy day.

**How it works**

The PV cells are made from layers of semi-conducting material, usually silicon. When light hits the cell it is absorbed and creates an electric field across the layers. The more intense the light, the more electricity is produced.

Individual cells only provide a small amount of electricity so they are generally grouped together, usually 36 or 72 but more recently 50 or 60 are connected in series to form a module or panel and a number of modules form an array. PV modules are connected in series (called a string) to generate the required output voltage.

There are four types of solar cells: monocrystalline, polycrystalline, amorphous or hybrid. Each has different levels of efficiency and cost. Monocrystalline and hybrid cells are the most efficient at converting light into electricity; however, they are the most expensive.

The cells produce Direct Current (DC) electricity; using an inverter this is converted into Alternating Current (AC) for use within the home or exporting to the grid.

The array is usually mounted on a roof but can be mounted on the ground. The householder also has the option of roof integrated PV in the form of solar tiles or slates.

PV systems are rated in kilowatts peak (kWp). That is the rate at which the system generates electricity during ideal conditions, usually facing south in direct sunlight during the summer.

The actual output of the array will depend on a number of

factors including the time of day and year, the efficiency of the cells, the amount of shading, the temperature of the cells and location of the property within the UK.

The Energy Saving Trust (EST) suggests for every kWp installed, output could be between 800-850kWh per year if the array is unshaded, facing south and with a tilt of 30-50°.

Battery storage is an option available to householders with PV. Rather than export excess electricity to the grid, it can be stored until required. This could be used when the PV system is no longer generating electricity.

**Maintenance and life expectancy**

Solar PV should require little maintenance. The panels need to be kept clean and free from shading as this will affect output.

The PV installer will leave written details of any maintenance checks the householder should carry out.

The panels will probably last at least 25 years or more. However, the inverter is likely to need replacing some time during this period.

## Wind Turbines

**Overview**

Wind turbines convert the power of the wind into electricity. The UK is ideally placed to take advantage of wind to generate electricity as approximately forty per cent of all wind energy in Europe blows over the UK.

A well located system in a favourable site can easily generate more electricity than a typical household can use for its lighting and appliances.

**How it works**

Wind turbines use large blades to catch the wind. When the wind blows, the blades are forced round, driving a turbine which generates electricity. The stronger the wind, the more electricity is produced.

Domestic wind system technology can be sub-divided into two categories:

- Micro wind turbine
- Small wind turbine

Micro wind turbines can be installed on the roof of a property. These are around 1kW to 2kW in size.

Small wind turbines are usually pole mounted. They are free standing and are about 5kW to 6kW in size.

Wind turbines convert the energy in the air (kinetic energy) into mechanical energy. The blades of a wind turbine are connected to a rotating shaft which passes into an electricity generator where mechanical energy is converted into electrical energy. The amount of electricity the turbine can generate depends on the wind

speed at its specific location.

Assessing wind speed is critical before considering installing a wind turbine. For a wind turbine to be viable it needs an average wind speed of at least five metres per second (5m/s) and to be free from confused air flow or turbulence caused by nearby obstacles, such as trees or buildings.

An inverter will be required to convert the DC electricity produced by the turbine into AC electricity for use within the home or export to the grid.

**Maintenance and life expectancy**

Maintenance checks are necessary every few years, and will generally be around 1% of installation costs per year, depending on turbine size.

A well-maintained turbine will probably last more than 20 years, but it may be necessary to replace the inverter at some stage during this time.

An off-grid system will require battery storage and these will need replacing, typically every 6 to 10 years. The cost depends on the design and output of the system. A back-up generator will have costs associated with its fuel and maintenance.

## Hydropower or Micro-Hydro

**Overview**

The flow of water from a stream or a river can be used to generate electricity. Also referred to as a hydropower system or just micro-hydro, it can generate enough electricity for lighting and electrical appliances in a typical household.

**How it works**

Streams and rivers flow downhill. Hydropower systems convert the kinetic energy produced by the flowing water into mechanical energy and then into electricity, using a turbine.

Micro-hydro is very site specific. Assessing a potential hydro site can be time consuming and expensive.

To be suitable for electricity generation, a river or stream needs to have a combination of:

- **Head or fall** is the height difference between the point where the water is taken from the water source and the point where it is returned to the source after passing by the turbine. Head height is measured in metres.
- **Flow** is the amount of water that can be passed through the turbine. It is measured in cubic metres per second or litres per second.

When assessing the feasibility of a site it is important to consider what happens to the river during drier periods in the year. The minimum flow during dry periods is often the deciding factor.

Most householders will not have access to a water resource so hydropower is often more of a community energy project, rather than an option for the individual householder.

The installation of a hydro system will require the permission of a number of agencies including the Environment Agency and planning authorities.

**Maintenance and life expectancy**

There is potential for damage by debris carried downstream at times of flood so maintenance is important. Maintenance costs vary but are usually around 1-2% of capital costs.

The life expectancy of a hydropower system can be in excess of 50 years.

# Renewable Energy

## Micro-Combined heat and Power (Micro-CHP)

**Overview**

Micro-combined heat and power (micro-CHP) is a technology which generates heat and electricity at the same time, using the same energy source. The main output of a micro-CHP system is heat, with some electricity generation, at a typical ratio of about 6:1 for domestic appliances according to the Energy Saving Trust (EST).

**How it works**

Current domestic micro-CHP systems are similar in size and shape to ordinary domestic boilers and can either be floor-standing or wall mounted. The only difference between the two is that micro-CHP generates electricity as well as heating water for space heating and washing and bathing.

At present, domestic micro-CHP systems are powered by mains gas or LPG. Although these are fossil fuels rather than renewable energy sources, micro-CHP is considered to be a 'low carbon technology' because it can be more efficient than using fossil fuels for heat, and electricity is generated onsite rather than imported from the grid.

A typical domestic system will generate up to 1kW of electricity once it has been operating for a short time: the amount of electricity generated over a year depends on how long the system is able to run.

**Maintenance and life expectancy**

It is suggested that Micro-CHP will have the same maintenance requirements as a domestic gas boiler; that is an annual check. Life expectancy is thought to be equivalent to a domestic central heating boiler.

## Renewable Heat

The following renewable technologies will generate heat for use within the home:

- Solar thermal hot water
- Biomass
- Heat pumps – air source heat pump and ground source heat pump

## Solar thermal hot water

**Overview**

Solar thermal hot water or solar water heating systems use the heat from the sun to warm domestic hot water used for washing and bathing.

The system will not produce all of the household's domestic hot water needs throughout the year so a conventional boiler or electric immersion heater can be used either to make the water hotter, or provide hot water when solar energy is not available.

**How it works**

Solar thermal hot water systems use solar panels, often referred to as collectors, fitted to the roof. The panels collect heat from the sun and use it to heat up water which transfers the heat to a hot water cylinder.

There are two types of solar panels or collectors:

- Flat plate collectors
- Evacuated tubes

Systems with flat plate collectors are typically cheaper and can be fitted to the roof or integrated into it. Evacuated tubes are fixed to the roof and can produce hotter water, have lower heat losses and perform better in winter. The collector is typically between two and four square metres in size. The system will

produce more hot water over the year if the roof faces south at an angle of about 30 degrees.

The most common type of solar thermal hot water system is a pressurised system. A heat transfer fluid (containing anti-freeze) in the solar collector is heated by the sun. As the temperature rises, the fluid is pumped (using an electric pump) through the solar collector and then used to heat water in a conventional hot water cylinder.

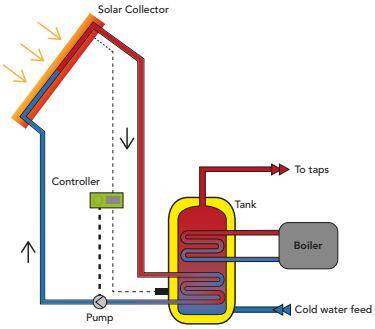
As can be seen in the diagram below, the hot water cylinder (which will be larger than a standard cylinder) contains two heat exchangers. The lower is part of the solar thermal hot water system. The upper heat exchanger is connected to the alternative heat source.

A solar thermal system can provide much of the water heating requirements in summer. An additional form of water heating is necessary for around six months of the year when there is limited solar gain.

**Maintenance and life expectancy**

Maintenance costs are generally low. The installer should leave written details of any maintenance checks the householder needs to carry out to ensure everything is working properly. It is likely that the pump and anti-freeze will need replacing.

A well maintained system should last twenty-five years or more.




## Biomass

**Overview**

Domestic biomass or wood-fuelled heating systems burn wood pellets or logs to provide space heating for a single room or to produce heat for central heating and domestic hot water. Biomass systems can provide an attractive alternative to oil and Liquid Petroleum Gas (LPG) boilers or electric heating in off-gas grid areas.

Biomass is often referred to as being 'carbon neutral' because the carbon dioxide produced when the wood is burning is the same amount that was absorbed over the time that the plant was growing. The process is sustainable as long as new plants continue to grow in place of those used for fuel and absorb the carbon dioxide emitted by the burning wood.

**How it works**

***Wood burning stoves***

A stove burns logs or pellets to heat a single room. Some models have a back boiler to provide water heating as well for heating radiators and domestic hot water stored in a cylinder. Stoves are much more efficient than an open fire; the operating efficiency of wood burning stoves can reach up to 80%. This is because of improved combustion of the wood due to the controlled air flow and higher operating temperatures.

It is best to season the wood for a period of months, allowing it to dry out. A seasoned log can produce up to twice the heat output of a freshly cut log.

***Biomass boilers***

Biomass boilers can burn wood chips or pellets to provide space heating via a wet central heating system and heat domestic hot water.

# Renewable Energy

A typical domestic property will probably use a wood pellet boiler.

Pellets are manufactured from compressed sawdust. Compared to other biomass fuels, pellets have a high energy density, low moisture and ash content. It is more expensive buying pellets in 10kg bags and labour intensive refuelling the boiler. If a pellet store can be built next to the boiler, larger deliveries can be made by lorry. A typical store can accommodate several tonnes of pellets, supplying the boiler for a few months. Bulk buying will reduce the cost of the pellets.

Biomass boilers tend to operate more continuously than a gas, LPG or oil fired boiler and can have a large accumulator tank installed for storing hot water. This can supply the extra water required during the peaks in demand. However, the space required by the boiler, fuel store and accumulator tank means biomass boilers are better suited to larger dwellings or locating in an outbuilding.

Any wood burning appliance must be installed by a qualified HETAS (Heating Equipment and Testing Approval Scheme) installer.

### Maintenance and life expectancy

Biomass stoves and boilers need be kept clean and swept regularly to remove ash. Ash quantities can be very low (less than one per cent of fuel volume), but it is still necessary to empty the ash bin on a weekly basis. A log fire will require ash removal before every use. If the ash is not cleaned out regularly, it will build up and affect combustion, which can cause boiler failure and shut down.

Some boilers have self-cleaning systems which will collect ash from the combustion grate and the heat exchanger tubes. Where there is no automatic ash cleaning mechanism, the boiler needs to be shut down periodically so it can be done by hand.

Flues will need to be swept to prevent the build-up of deposits which can cause corrosion of the metal lining.

## Heat Pumps

### Overview

Heat pumps operate on a similar basis to refrigerators and air conditioning units. They capture heat from outside a property, either from the air, the ground or nearby water and concentrate it for use inside.

The process works by evaporation and condensation of a refrigerant fluid in a closed loop system, with the process driven by a compressor powered by mains electricity.

In effect, heat pumps convert low temperature (low grade) heat to a higher and more useful temperature. A heat pump absorbs heat where it is plentiful and transports and releases it in another location where it is required.

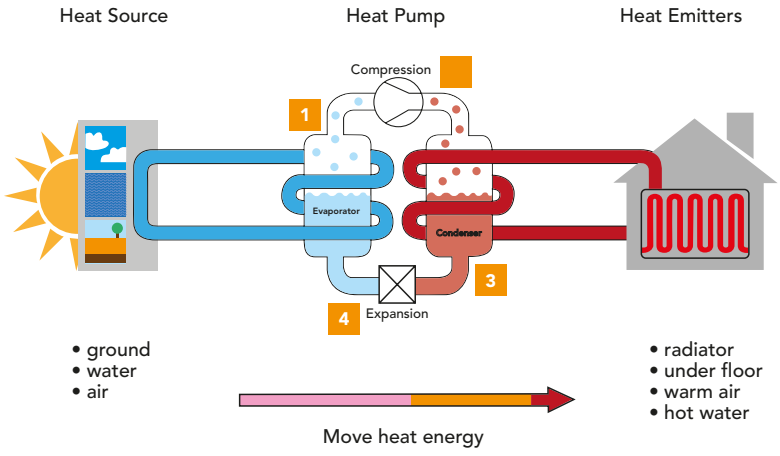
### How it works

A heat pump has a heat exchanger (the evaporator) containing a refrigerant that absorbs the incoming low grade heat. The refrigerant boils from a liquid into a vapour. Heat pump refrigerants have very low boiling points, typically -25°C to -45°C.

The vapour is then compressed from a low pressure to a higher pressure in a compressor. As a result, the temperature of the refrigerant is increased to temperatures around 40-55°C.

The high pressure vapour then moves into a second heat exchanger (the condenser) where it condenses and releases its heat and turns back into a liquid. This heat can then be used to provide space heating and heat domestic hot water.

The refrigerant liquid then passes into an expansion valve and cools rapidly, ready to



absorb more heat and the above process is repeated.

Heat pumps use mains electricity to operate and in suitable homes can produce heating costs per kWh similar to using mains gas. For each unit of electricity that the compressor of a heat pump consumes, between 2 and 4 units of heat are released.

The coefficient of performance (CoP) is a measure of the system efficiency and is the ratio between the heat output and the electricity input. The heat pump will operate more efficiently if the temperature difference between the heat source and the emitters is lower.

While gas boilers are often run in short bursts, heating up a property fairly quickly, a heat pump will operate more continuously and take longer to reach a set temperature. Because heat pumps produce heat at a lower temperature than a boiler, they will typically be used with under-floor heating or larger radiators which operate at lower temperatures than with a typical boiler system. A house needs to be well insulated and free from draughts otherwise a heat pump system may be expensive to run.

### *Air source heat pump*

Air source heat pumps absorb heat from the outside air. It is claimed they can get heat from the air even when the temperature is as low as -15° C.

Air to water source heat pumps are the most common type of heat pump installed in the UK and transfer heat from the air into a wet central heating system. The main unit, sited outside the home, looks similar to an air conditioning unit.

Within the house, the heating system will look similar to a standard wet central heating system, with underfloor heating, radiators or fan units acting as heat emitters.

In off-gas network areas they can be a cost effective option for smaller well-insulated properties. The heat pump is more efficient in summer when the outside temperature is warmer. Air source heat pumps are the cheapest heat pump technology.

Air-to-air source heat pumps transfer the heat by the air. Most systems consist of one external unit and between one and four indoor units which are mounted high on the wall. These are individually controllable and take the place of radiators. The system will also remove excess moisture from the home.

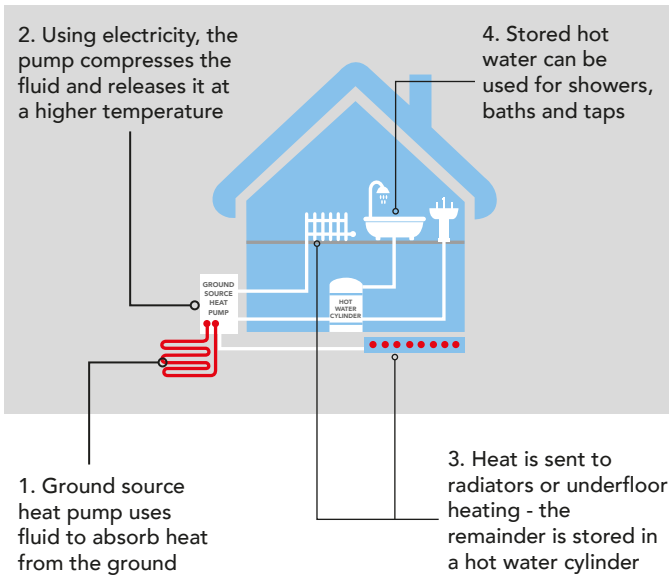
### *Ground source heat pump*

A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe, called a ground loop, which is buried in the ground. Heat from the ground is absorbed into the fluid and then passes through a heat exchanger into the heat pump.

Typically the ground loop is laid flat or coiled in trenches about two metres deep. The length of the ground loop depends on the heat demand of the property and the soil type. If there is not enough space to accommodate a horizontal ground loop it can be installed in a vertical loop down into the ground to a depth of up to 100 metres for a typical domestic home.

Ground temperature decreases less in the winter than air temperature. This makes a ground source heat pump more efficient than most air source heat pumps in winter and cheaper to run.

### Ground source heat pump



**Maintenance and life expectancy**

Heat pumps should be fairly low maintenance but a detailed check by a professional installer every three to five years is recommended.

The heat pump installer should leave written details of any maintenance checks the householder should undertake to ensure all is working properly.

In the case of an air source heat pump it is advisable to carry out an annual check to see that the air inlet grille and evaporator are free of leaves or other debris. Any plants that have started to grow near the heat pump unit will also need to be removed.

The life expectancy of a heat pump is likely to be twenty-five years or more.

## Support for renewable technologies

**Feed-in tariffs for electricity generating technologies**

The Feed-in tariff (FIT) provides financial incentives to households to install electricity generating technologies, by guaranteeing a payment for electricity generated as well as the electricity exported to the grid. The FIT is paid for a certain length of time depending on the technology. For example, solar photovoltaic tariffs will be paid for 20 years.

The electricity generator is paid for every kilowatt hour generated: this is known as the generation tariff.

The export tariff is paid for any electricity not used on-site and which is exported to the electricity grid. This can be metered or in the case of small scale generation it is deemed, where it is assumed to be a proportion of the electricity generated, without the requirement of additional metering.

The generator can also benefit by using the electricity as it is generated rather than importing electricity from the grid.

Technologies eligible for the FIT are.

- Solar photovoltaic (PV).
- Wind turbines.
- Micro-hydro.
- Anaerobic digestion.
- Micro-combined heat and power (CHP).

FIT only applies to England, Wales and Scotland.

To find out more about the Feed-in tariff and the current tariffs for each technology visit the Ofgem website.

**Renewable Heat Incentive (RHI) for heat generating technologies**

The Renewable Heat Incentive (RHI) is a UK Government scheme set up to encourage uptake of renewable heat technologies amongst householders, communities and businesses through financial incentives.

The domestic RHI provides financial support to the owners of the renewable heating systems. The scheme covers England, Wales and Scotland and is targeted at, but not limited to, off-gas households.

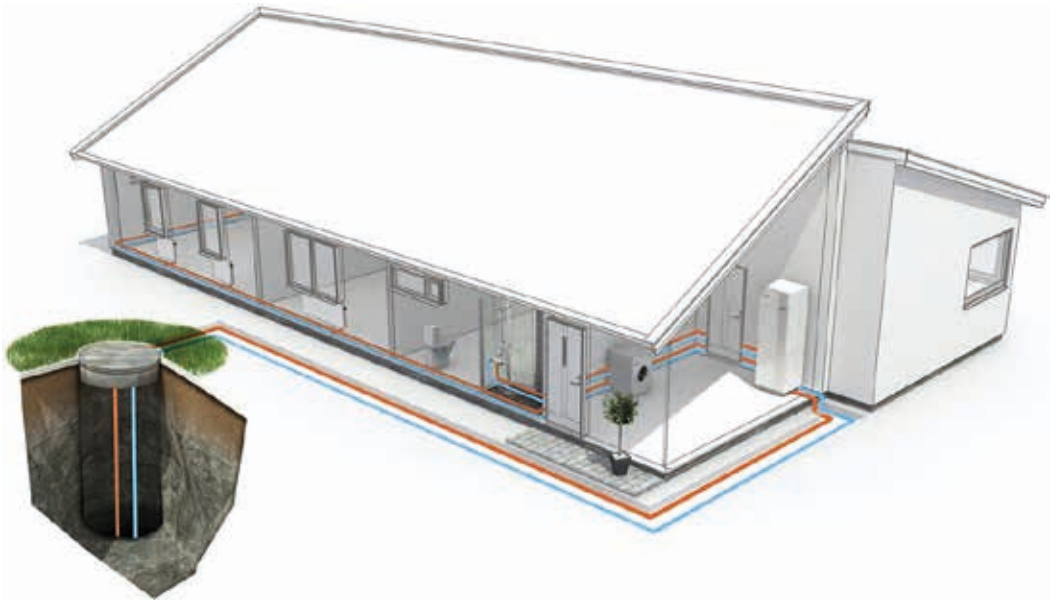
Qualifying technologies:

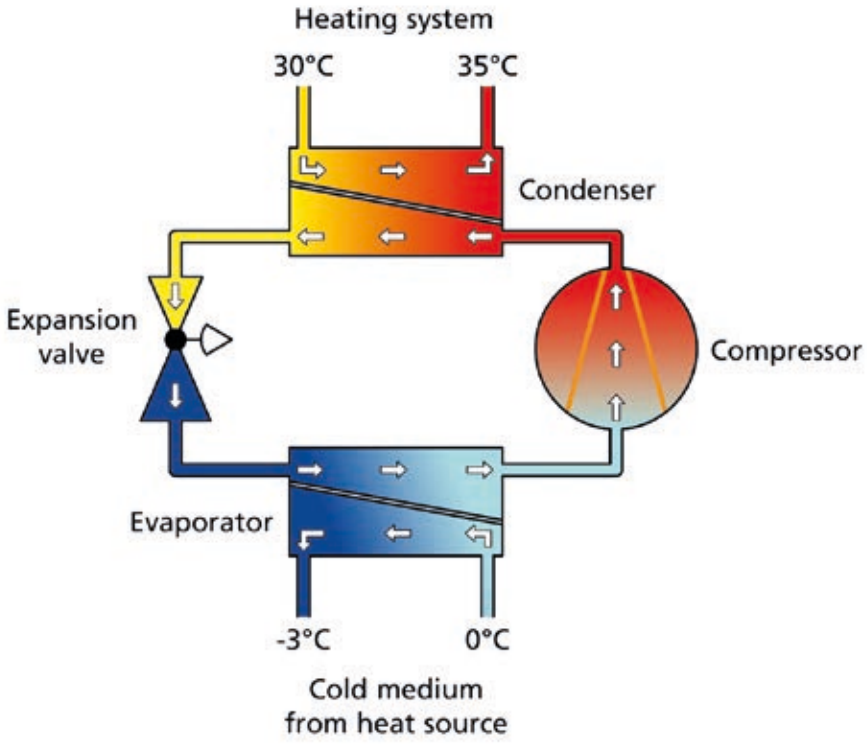
- Biomass (wood fuelled) boilers
- Biomass pellet stoves with integrated boilers providing space heating
- Biomass "cooker stoves"
- Ground source heat pumps
- Air source heat pumps
- Solar thermal hot water (flat plate or evacuated tube only) providing hot water for the home

RHI cash payments are made quarterly over seven years. The amount a householder receives will depend on a number of factors, including the technology they install, the latest tariffs available for each technology and in some cases metering.

***For more information about RHI and the current tariffs visit the Ofgem website.***

## Ground source heat pumps





# Glossary of Terms

**A**

**Anthracite**
A naturally-occurring smokeless fuel, which is slow burning and particularly suited to room heaters, boilers and cookers.

**Air leakage**
Air leakage occurs where fresh air enters a property through gaps in the building fabric. Air leakage is essential and beneficial where it provides ventilation for fuel-burning appliances and removes moisture-laden air, but excess leakage will result in loss of heat from a dwelling.

**B**

**Back boiler**
A central heating boiler located behind a gas or solid fuel fire or room heater, providing hot water for the storage cylinder and/or for central heating radiators.

**Balanced flue**
A duct which links the boiler with the outside of the property and where the inlet (for air coming in) and the outlet (for waste products going out) have the same or balanced, pressure. An appliance using this type of flue is completely sealed off from the room, greatly reducing the risk of fumes affecting internal air quality.

**Biomass**
Biomass is defined as plant material or animal waste used as a source of fuel.

**Boiler thermostat**
A device that controls the temperature to which water is heated in the boiler.

**Bottled gas**
Liquid petroleum gas (LPG), supplied in a metal bottle or cylinder. See LIQUID PETROLEUM GAS.

**Budget Payment scheme**
A method of paying for fuel whereby the consumer makes regular fixed payments and receives a rebate or a surcharge, in line with the amount of fuel used over a whole year.

**C**

**Calor Gas**
A company which supplies liquid petroleum gas, which is often called Calor Gas (in the same way as a vacuum cleaner is known as a hoover). See LIQUID PETROLEUM GAS

**Calorie**
A standard unit used to measure an amount of energy or heat. It is technically defined as the amount of energy required to raise one gramme of water through one degree Celsius (centigrade). They are small units and we usually use kcal - Kilocalories, which is 1000 calories.

**Calorific value**
The quantity of heat produced per unit of fuel burned. It is used as a way of measuring the quality of a fuel in terms of the amount of heat it can provide.

**Cavity wall**
A wall consisting of two layers of building material with a gap between, such as brick and brick or block and brick.

**Central heating**
A heating system, which provides heat to the whole home from a central source, such as a boiler.

**Circulator**
A small boiler for supplying hot water indirectly to a storage cylinder.

**Cold bridging**
A 'cold bridge' is a continuous path for heat loss from a building, provided by a material which conducts heat relatively well (i.e. lets heat out quickly) bridging a material which conducts heat less well.

**Combi**
A 'Combi' is a combination boiler which provides space heating and instantaneous hot water, without the need for a hot water storage cylinder.

**Combined heat and power**
A type of power station which uses the waste heat from the generation of electricity to provide heating and hot water. Now available in micro-CHP units for domestic use.

**Compact Fluorescent Lamp (CFL)**
This is an energy efficient lamp used commonly throughout the home. It is a small version of the fluorescent strip light found in offices and industry. It is about 5 times as efficient as a conventional incandescent bulb and can last 10 times as long.

**Condensation**
A change of state from gas to liquid (e.g. from water vapour to water).

**Condensing boiler**
A type of gas or oil boiler. It is more efficient than a conventional boiler mainly because it recovers heat from the flue gases, as water vapour in the gases condenses into water, releasing energy as it changes state. Condensing boilers can work as system boilers or combi boilers.

**Conduction**
The passage of heat through or along a material, or from one material to another in contact with it.

**Citizens advice**
Citizens Advice provides free, confidential and independent advice to help people overcome consumer problems. They are a voice for clients and consumers on the issues that matter to them.

**Convected heat**
Heat which is transported by the movement of a heated substance, such as air or water.

**Convection**
When air is heated it will become lighter and so rise and be replaced by cooler air. This movement of a hot substance is known as a convection current. It happens in liquids too.

**Cubic feet/cubic metres**
A measurement of the volume of gas used in your home. (Cubic metre is simply a metric conversion from the old imperial system of cubic feet).

**D**

**Dehumidifier**
A machine which removes moisture from the air. It works along the same lines as a refrigerator by creating a very cold surface for moisture in the air to condense onto.

**Domestic hot water cylinder**
(DHWC) is a hot water storage tank, which is heated by a separate boiler, usually as part of a central heating system.

**District/group heating**
A large heating system where one central boiler serves a group of dwellings.

**Double glazing**
Two panes of glazing sealed with a gap between them. The double glazed glass reduces heat loss though windows or glass doors. More modern types utilise low emissivity glass and inert gas to further reduce heat loss.

**Draughtproofing/ draughtstripping**
Filling in unnecessary gaps in the fabric of a building to avoid heat loss and discomfort through draughts.

**Dry central heating**
A heating system which uses air to distribute heat throughout a building through a system of ductwork.

**Dry lining**
Insulation of a wall from the inside.

**E**

**Economy 7 Meter/Dual Tariff meter**
Economy 7 is a tariff providing lower cost electricity at off-peak times. An Economy 7 meter therefore records consumption at two different rates. Typically the lower cost period lasts for seven hours during the night.

**Energy efficiency**
The relationship between energy input and energy output, expressed as a percentage.

**Energy Performance Certificate**
(EPC) a certificate which denotes the energy performance of a dwelling, required at point of sale or re-let.

**Expansion pipe vent pipe**
A necessary safety measure to be found on a wet central heating system to allow for expansion of hot water in the system.

**F**

**Fanned flue**
A fan in a heating appliance flue that draws in air for combustion and expels waste products to the outside. Typically called a room sealed flue.

**Floating floor**
A wooden floor laid for sound or thermal insulation above a solid floor. It is usually insulated and is not fixed to the solid floor.

**Flue**
A duct through which the waste products of burning fuel can escape to the outside atmosphere. See

# Glossary of Terms

BALANCED, OPEN AND FANNED FLUE.

**Fuel poverty**
The inability to afford sufficient warmth to ensure health and comfort.

## G

**Gas safe**
Gas Safe Register is the official gas registration body for the United Kingdom, Isle of Man and Guernsey, appointed by the relevant Health and Safety Authority for each area. Gas Safe ensures that 120,000 gas engineers on the register are qualified to work with gas safely. The Gas Safe registration of each engineer is broken down into categories such as boilers, fires or cookers and shown on the reverse of their ID card, like a driving licence.

**Ground Source Heat Pump (GSHP)**
Pumps which utilise temperatures beneath the ground to provide additional domestic hot water or background heating. (Up to a max of 55°C).

**Group heating**
See DISTRICT/GROUP HEATING

## H

**Heat balance**
In this context heat balance is a comparison of all energy flowing into a building compared to all the energy flowing out, expressed as an amount of heat.

**Heat exchanger**
Anything that transfers heat between two materials without those materials coming into contact. The most common use of a heat exchanger in a domestic heating system is in the hot water cylinder. Here, very hot water from the boiler passes through a coil of pipe inside the cylinder and transfers heat into the water stored in the cylinder. The water in the boiler circuit never mixes with the water in the cylinder, which is the water that comes out of the taps.

**Heat transmission**
See CONDUCTION - CONVECTION - RADIATION.

**Home Energy Conservation Act (1995)**
Makes local authorities more accountable for developing strategies and policies to improve their housing stock through energy efficiency measures.

**Hopper**
A specially made store for solid fuel, usually wood pellets or smokeless fuel, which is attached to a boiler by a feed mechanism, such as a conveyor belt or an Archimedes screw. The hopper should protect the fuel from bad weather and pests.

**Hot water cylinder**
A cylindrical tank in which water is heated and/or stored before being drawn off to the hot taps. The tank may contain a heat exchanger which is fed with hot water from a boiler, or an electric immersion heater.

**Hot water cylinder thermostat**
A device which controls the temperature, to which water is heated in the hot water cylinder, (should be set at 60°C).

**Hot water tank jacket**
A thick covering of insulating material around the hot water tank (or cylinder).

**Housing benefit**
Housing Benefit is a scheme administered by local authorities to assist householders on low incomes with payment of their rent.

**Hydro power**
The conversion of energy contained in masses of water (river, wave or tidal) into useful power.

**Hypothermia**
A condition caused by an abnormally low deep inner body temperature, defined by the Royal College of Physicians and the British Medical Association as a core temperature of 35°C (95°F) or below.

## I

**Immersion heater**
An electric heater element is immersed inside a hot water storage tank, which heats up the water stored around it. The heater takes time to heat up the water rather than producing hot water instantly. This can stand alone or it can be included as a back-up for a central heating DHWC.

**Incidental heat**
The term describes the input of heat into a building

from sources other than the heating system. Examples of incidental gain include heat generated by the occupants of the building, by electrical appliances and lighting and also by the heat of the sun.

**Individual heater**
An individually controlled heater which is not part of a central heating system.

**Instantaneous water heater**
A type of water heater, which produces hot water instantly when a tap is turned on, rather than storing hot water in a cylinder. It can serve one outlet or many.

**Insulation**
Material which is a very poor conductor of heat, used to minimise the rate at which heat is lost from inside a warm building to a cold environment outside. A good standard of insulation may be built into a property when it is constructed, or alternatively can be added at a later date using a variety of techniques and materials.

**Interstitial condensation**
Interstitial condensation occurs when vapour pressure in the air in a building builds up to such an extent that water vapour is forced through the walls and ceilings, creating moisture within the fabric of the building by condensing as it reaches a cold surface within the structure.

**K**

**Key meter**
See PREPAYMENT METER

**Kilowatt (kW)**
A rate of flow of energy equal to one thousand watts. This power rating is applied to heating appliances to define the rate at which they are able to give out heat. It is applied to machines to define the rate they use energy. See WATT.

**Kilowatt hour (kWh)**
A unit for measuring amounts of energy. An appliance with a power rating of one kilowatt, running for exactly one hour will use one kilowatt hour of energy. The electricity suppliers use this unit to measure the amounts of electricity they supply.

**L**

**LED light bulbs**
Use semi-conductors that emit light using 90% less electricity than incandescent bulbs, but give the same amount of light.

**Liquid Petroleum Gas (LPG)**
This is a gas made liquid under extreme pressure. Two types are commonly used for heating - butane and propane. Butane is usually supplied in cylinders (or 'bottles') and is the type used in free-standing room heaters. Propane is used for central heating; the liquid is stored in a high pressure vessel.

**M**

**Mains gas**
Gas provided through a gas main. This is methane, which we call NATURAL GAS.

**Mould**
A type of fungus propagated by spores which grows on some surfaces where dampness is present.

**Multi-point water heater**
A type of instantaneous water heater which provides hot water to a number of outlets (such as sinks, baths and basins) rather than just one.

**MPAN**
MPAN is the supply number for electricity. Each electricity supply has a reference number, which relates to the property and stays the same even if the meter is changed. This is called the Meter Point Administration Number

**MPRN**
MPRN is the supply number for gas. Each gas supply has a reference number, which relates to a specific domestic property and stays the same even if the meter is changed. This is called the Meter Point Reference Number.

**N**

**Natural gas**
This type of gas is provided via gas mains. It is naturally occurring, rather than manufactured and is essentially methane with other hydrocarbons.

**O**

**Off-peak electricity**
Electricity used during the night or mid-afternoon and charged at a rate lower than the on-peak or standard rate. A special meter records consumption, usually on an Economy 7 or White Meter tariff. See ECONOMY 7 METER

# Glossary of Terms

**On-peak electricity**
Electricity charged at the standard or daytime rate, usually at a higher price per kWh than off-peak electricity.

**Open flue**
This type of flue is open to the room it serves; the best example is a chimney. The heater takes air from the room and mixes it with the fuel to aid combustion. The fumes go outside through the open flue. For larger heaters or boilers, a fixed air vent may be needed to supply enough air.

**P**

**Prepayment meter**
A method for paying for gas or electricity. This involves charging a key, card or token to add credit to the meter and means that the customer is always paying in advance for fuel used.

**Programmable room thermostat**
A device which controls the overall temperature of a dwelling at set times, by regulating the source of heat. The desired heating times and temperatures are programmed into the device.

**Programmer**
A device that controls the times at which radiators and water are heated by central heating.

**R**

**Radiation**
This is one of the three ways heat can travel. In heating terms, thermal radiation is electromagnetic radiation generated by the thermal motion of charged particles in matter. It is similar to sunlight, which is ultra-violet light radiation that we feel as heat. It should be noted that dark and cold objects can radiate heat as well as those that we see glowing.

**Radiant heat**
Heat which travels in straight lines directly from the heat source, warming up any objects in its path without appreciably heating up the air it passes through. In heating terms this radiation is usually infra-red.

**Renewable energy**
Energy derived from sources which are inexhaustible. These include the sun, the wind, flowing water, the heat of the earth and replenishable fuels such as plants and waste products.

**Room thermostat**
A device which controls the overall temperature of a dwelling by regulating the source of heat, based on the air temperature around the room thermostat.

**S**

**SAP rating**
A Standard Assessment Procedure (SAP) rating measures the energy efficiency of a dwelling on a scale from 1 to 100. A reduced SAP process is used to calculate the energy performance certificate of a dwelling.

**Secondary glazing**
The addition of a second pane to an existing single-glazed window.

**Smart meter**
This is a gas or electricity meter that can send meter readings to the supplier via a data communications company, thus avoiding estimated bills. An in-home display is provided that can show the householder information about fuel consumption and cost in near real time. They can act as a credit meter or a pre-payment meter.

**Solar electricity**
Electricity derived from the Sun through the use of photovoltaic (PV) cells, laid out in panels.

**Solar water heating**
Heat derived from the sun to provide domestic hot water through solar thermal panels.

**Solid fuel**
Solid fuel by definition is not a gas or a liquid and it includes: coal, smokeless fuel or wood etc.

**Solid wall**
A wall constructed without a cavity, usually made of brick, stone, cob or concrete.

**Standing charge**
A charge levied by the fuel companies in return for providing a fuel supply, whether or not any fuel is used. It is charged in pence per day.

# Glossary of Terms

**Storage heater**
An electric heater which stores heat at night, to take advantage of the cheaper off-peak electricity that is available then. The heat is released throughout the following day.

**System boiler**
This boiler will be part of a central heating system with a hot water cylinder. So it will provide hot water for radiators and a hot water cylinder.

**T**

**Tariff**
The rate at which fuel, such as gas or electricity is charged.

**Thermostat**
A device which senses temperature and turns a heating appliance off and on accordingly, to maintain a set temperature.

**Thermostatic Radiator Valve (TRV)**
A device which controls the temperature of an individual radiator and therefore of the room in which the radiator is sited.

**Timer**
A device which controls the times at which an appliance is turned on or off.

**U**

**Unit (electricity)**
A measure of electricity. One unit is equal to one KILOWATT HOUR of electricity.

**Unit (gas)**
A volume of gas measured by the meter. Old meter units measure 100ft$^3$, new meters measure m$^3$.

**U-value**
A measure of the rate at which heat passes through the building fabric, measured in W/m$^2$K (Watts per square meter per degree Centigrade). Where the degree is temperature difference between the warm side and the cool side of the fabric. The higher the U-value, the greater the rate of heat loss.

**V**

**Vent**
A fixed opening in building fabric to ensure an air supply to a fuel burning appliance.

**Ventilation**
The process by which air enters and leaves a building.

**W**

**Warm air heating**
This is a form of central heating, which blows warmed air round the home through ducts and vents. The heat source can be a gas boiler or a large central off-peak storage heater.

**Water vapour**
Water vapour results from absorption of moisture into the air caused by common household activities such as cooking, washing, drying clothes and the breathing of occupants. True water vapour is an invisible gas and will remain in this form until the air reaches saturation level, at which point it will condense on any surface colder than the air temperature.

**Watt (W)**
A rate of flow of energy, equivalent to one joule per second. (SEE KILOWATT).

**Wet central heating**
A central heating system which uses hot water to distribute heat through the home.

**Wind power**
The use of energy contained in masses of moving air which is then converted into electrical power in a turbine.

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# Notes

# Notes

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