A DETAILED GUIDE TO

HOME HEATING SYSTEMS

SUSTAINABLE ENERGY IRELAND

The energy for life…

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

So what is sustainable energy?

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

What are the benefits of sustainable energy?

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

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

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

Who is Sustainable Energy Ireland?

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

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

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

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

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

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Did you know…

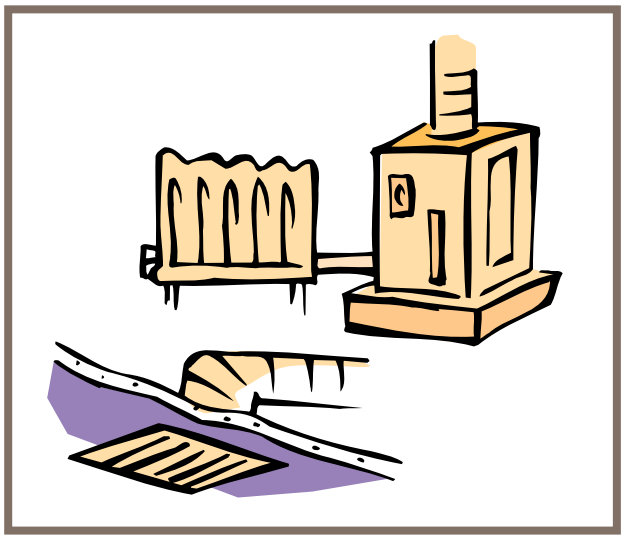
- **Energy use is responsible for two-thirds of Ireland's greenhouse gas emissions.**
- **Irish homes use around a quarter of all energy used in the country– that's even more than industry.**
- **The average home consumes almost 40% more electricity than it did in 1990.**
- **Renewable energy currently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

contents

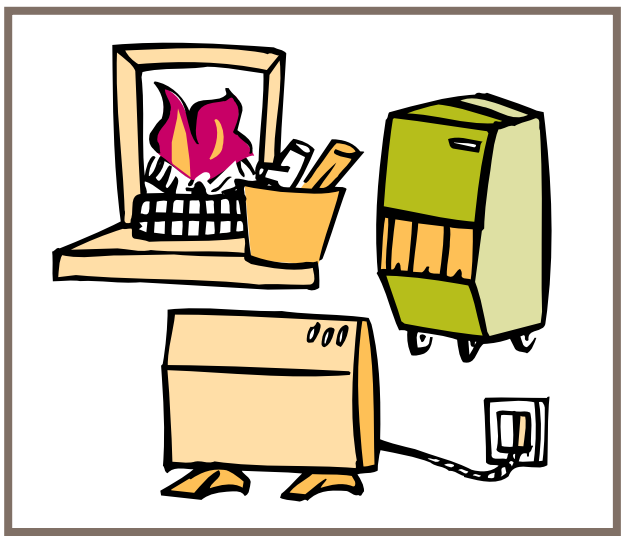
A major capital and on-going expense in your household budget is the provision of energy for heating your house and providing hot water for showers, baths, washing etc. The householder is faced with a bewildering choice of heating systems and this booklet will assist in examining options.

There are two broad categories of heating systems available:

- Heating systems that generate heat in central unit in your house (i.e. boiler) and distribute the heat using water (i.e. pipes to radiators) or air (i.e. ducting to grilles).



- Heating systems that generate heat in each room separately by means of a solid fuel, gas, oil or electricity.



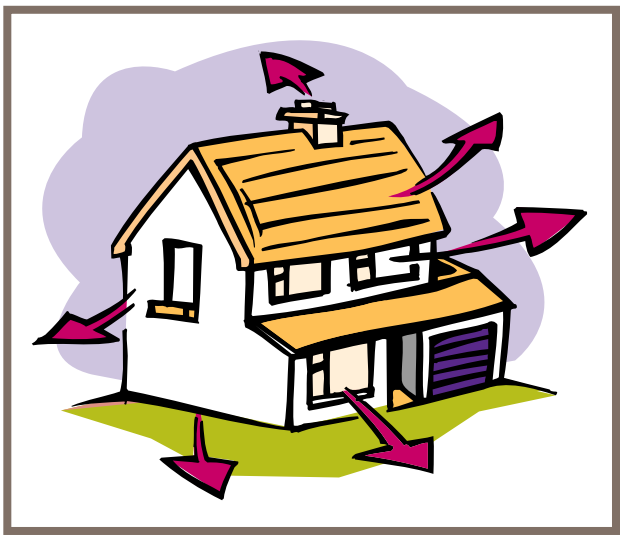
But before you consider a heating system you should first take a look at your house.

Is it poorly insulated?

House should be insulated to the current Building Regulation Standards insulated or better.*

Is it draughty?

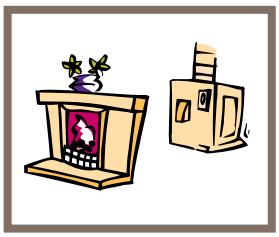
Windows and doors should be draught-proofed to allow the minimum ventilation rates to ensure good air quality and avoid condensation. However, be careful not to overseal the house as this can be unhealthy and unsafe. For new buildings, part F of the Building Regulations outlines exact ventilation requirements.



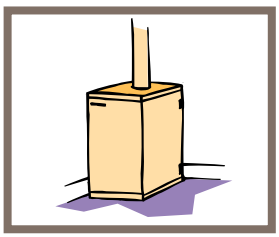
* *For advice on insulation and draught-proofing see SEI's A Detailed Guide to Insulating Your Home.*

Fuel types

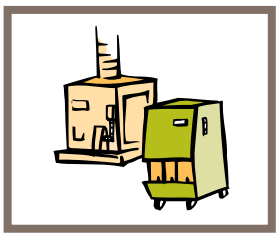
Solid fuel
Turf
Wood
Coal



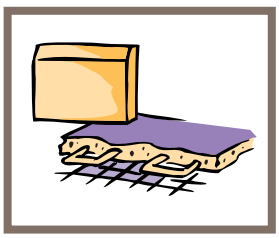
Oil
Kerosene
Gas oil



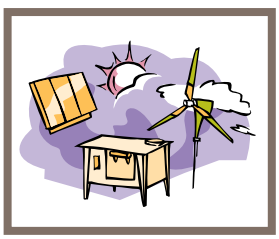
Gas
Natural gas
LPG



Electricity
Day rate electricity
Off-peak supply

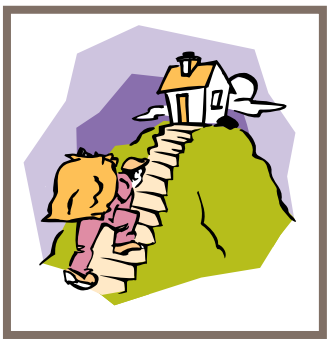


Sustainable fuels
Solar energy
Wood*
Wind energy



* *Wood fuel from managed forests*

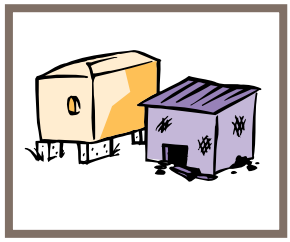
Considerations for the householder



Availability

Check with local fuel suppliers for convenience of supplying a particular fuel.

Storage



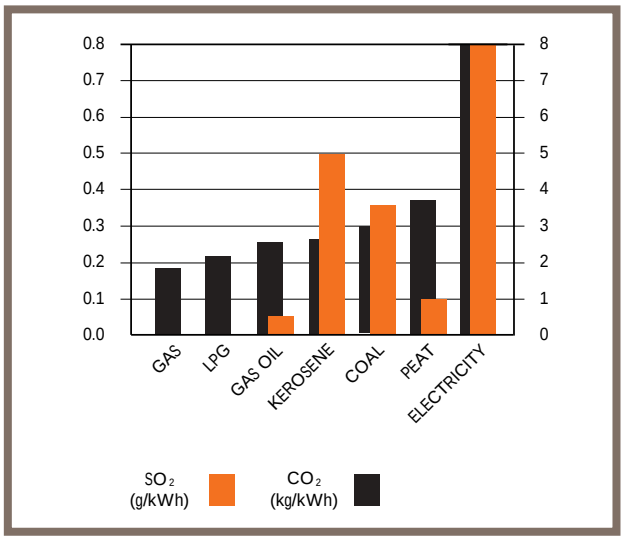
Some fuels, i.e. solid fuel, oil, LPG, etc will require you to provide space to store the fuel. This may be bulky or unsightly or may have safety or insurance implications.

Costs

In general the more convenient the form of heating and the more refined the fuel the higher will be the cost to the householder. The delivered cost of fuels alters from time to time due to a variety of factors. The annual running costs of a heating system depend largely on the cost of the useful energy of a fuel taking account of the efficiency of the heat generator employed. See ***SEI's Fuel Cost Comparison Sheets*** for a comparison of current energy costs and typical appliance efficiencies

Environmental issues

All fossil fuels when burnt will cause emissions to the atmosphere. All these fuels will emit CO_2, the main greenhouse gas which is contributing to global warming. In addition to carbon dioxide and water vapour, some fuels will also emit smoke particles, sulphur dioxide and oxides of nitrogen to the air which will reduce our air quality.



The most effective ways we can protect our environment are by insulating our homes sufficiently and by operating our heating systems efficiently. This way we will reduce the amount of fuel we use and hence our impact on the environment.

The required output of a heat generator to heat a home is determined by calculating the heat lost from the home for winter conditions and matching the heat output of the generator to this loss. The heat demand of the home will include three components:

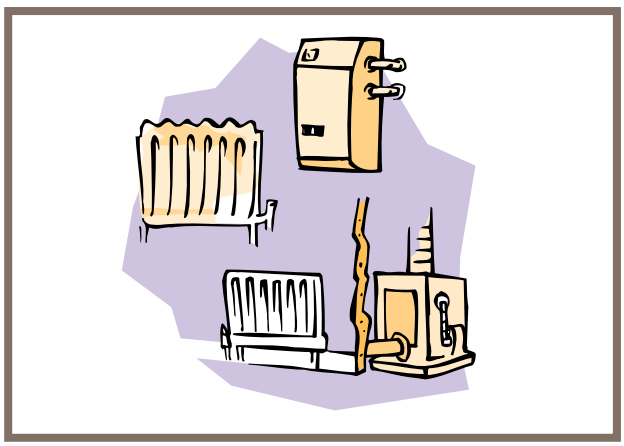
- Heat lost by conduction from inside to outside through the roof, windows, walls and floor
- Heat required to warm the cold air which will infiltrate through windows, doors and other openings in the house
- Heat required to provide an adequate supply of hot water for baths, showers, etc.

The total amount of heat for these three components will represent the required kilowatt output of the heat generator to be installed. An addition of approximately 25% is often added to the calculated heat losses when choosing a heat generator. This allows for faster heat-up of the house particularly if the house has been unheated for a long period.

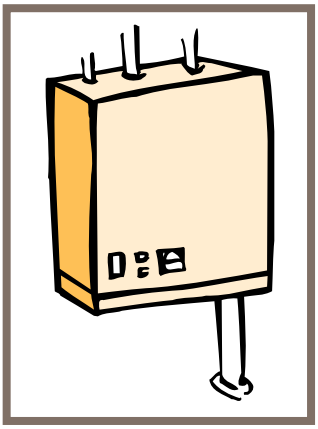
The types of central heat generators available are illustrated below. Heat generators that produce heat separately in each room are shown in the Heat Emitters section of this booklet.

Conventional boiler

Gas, oil or solid fuelled boilers, located inside or outside the house, will heat water which is distributed by pump or gravity circulation to heat emitters in each room. Maximum efficiency of approximately 84% will be achieved with new boilers when the burner air/fuel ratio are set properly and the heat transfer surfaces inside the boiler are clean. Boilers located outside the house and distribution pipes from them to the house should be well insulated and waterproofed to minimise wasteful heat loss. The heat losses from a boiler located inside a house actually contribute to the heating of the house.



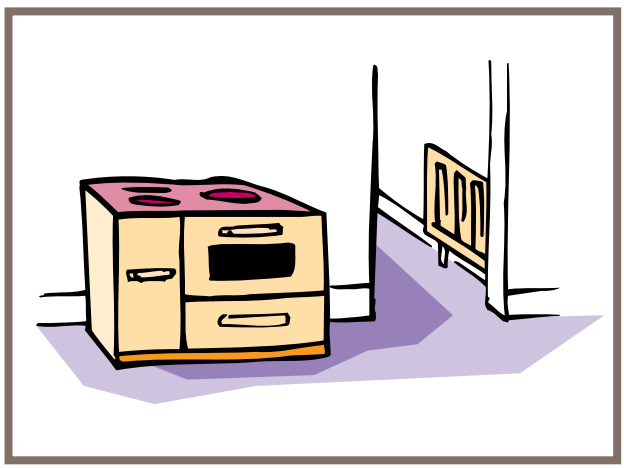
Condensing boiler



This type of boiler, burning gas or oil, condenses the flue gases and increases the efficiency of combustion to approximately 92% or higher. These boilers are more costly to buy than conventional boilers but the price difference will be recovered over 10–15 years due to reduced annual running costs. These boilers, which operate at maximum efficiency when running at lower temperatures are ideal for under floor heating systems. For radiator systems operated at lower temperatures the radiators may need to be oversized to provide the required heat output. A condensing boiler will emit a plume of water vapour to the atmosphere during operation, this is normal and harmless.

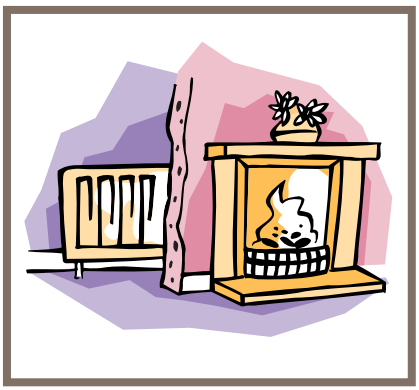
Cooker and boiler

Using solid fuel, oil or gas this type of appliance, located in the kitchen, will supply hot water for heating and also provide cooking ovens and hot plates. They are suitable for large kitchens with a frequent cooking requirement. When using solid fuel, the chimney should be cleaned twice annually and the appliance itself should be cleaned as often as twice weekly, particularly if bituminous coal is used.



Back boiler

A typical open fire has a poor efficiency, perhaps as low as 15–20%. The installation of a high output back boiler will provide domestic hot water and space heating while increasing the efficiency to approximately 40–50%. Open fires, whether solid fuel or gas fired, cause an increased ventilation rate in rooms. Air for combustion must be provided. If the location of the air supply can be located close to the fire, (i.e. from a floor void), then draughts will be avoided. Solid fuel back boilers must be cleaned frequently (as much as twice weekly).



Safety Watchpoint

It is important to note that the design of solid fuel systems must incorporate a 25 mm independent gravity circulation circuit to dissipate heat from the boiler or fire. This is particularly important if a pump is used to aid the circulation of heating water in the main heating circuit. In the event of an electricity failure the pump will not function and the gravity circuit will be the only means of dispersing heat from the boiler. If the water boils, a dangerous situation could arise.

Hot water supply system

Immersion heater

Electric heating elements are installed in the hot water storage cylinder. The typical hot water storage cylinder has two elements. A low rated element located towards the top supplies small quantities of hot water for sinks or showers. An element of higher rating, located lower down in the cylinder, heats sufficient water for larger demands such as baths.

Even when the domestic hot water storage cylinder is heated by another fuel, an electric immersion heater is usually installed in the storage cylinder. The electric immersion can be used in the summer months when the central heating is not required.

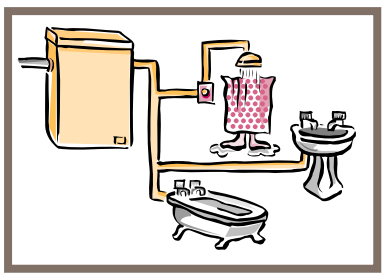
If the electricity supply to the immersion heater is controlled by a separate time switch then it may be possible to avail of a cheaper night rate tariff.

Local storage systems

A local hot water storage heater must have an adequate capacity to meet the anticipated demand for domestic hot water for the appliances supplied by the system. The heater must have sufficient rating to return the water stored to the correct temperature in a reasonable amount of time.

Gas fired and electrical local hot water storage heaters of the following types are available.

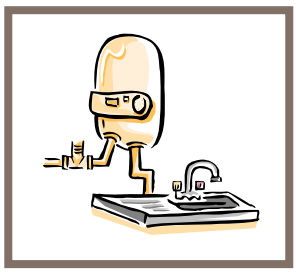
Larger storage type



For baths and multi-outlet applications a range of gas fired or electric wall or floor mounted domestic water storage heaters are available. With certain types of storage heaters, cold water supply must be from the mains; with others it may be from the attic cold water cistern.

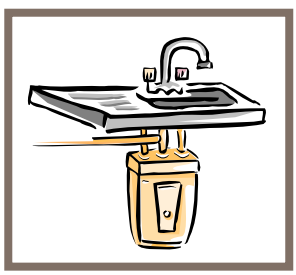
Over-sink type

Gas fired or electric hot water storage heaters of this type are available for single outlet sinks or basins. Oversink hot water heaters are suitable where the demand is less than 10 litres at any one time.



Undersink type

Electric under-sink hot water storage heaters are available for single outlet applications.

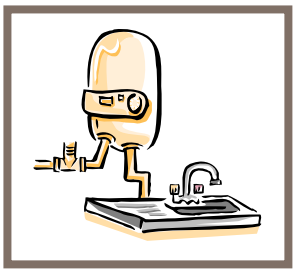


Local instantaneous systems

The necessity to store hot water to meet the household's demand may be avoided by installing water heaters that heat the water as it is required. This type of domestic hot water heater has no facility for storing hot water and is designed to match the required demand of the points of use. It operates with a low flow rate of water and is therefore most suited to be used in conjunction with low demand appliances such as showers or spray taps.

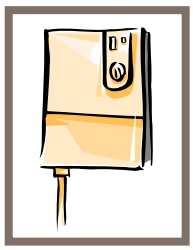
Gas fired instantaneous water heater

A suitable natural or liquid petroleum gas supply and a minimum water supply pressure of 1 bar or 10 metre head is required to operate this type of water heater.



Electric instantaneous water heater

An electricity supply of 30 amps and a minimum water supply pressure of 1 bar is required to operate this type of water heater.



Renewable Heating Sources

The rapid depletion of non-renewable energy sources along with the necessity to reduce our emissions of greenhouse gases when we burn fossil fuels has encouraged us to seek sustainable energy sources.

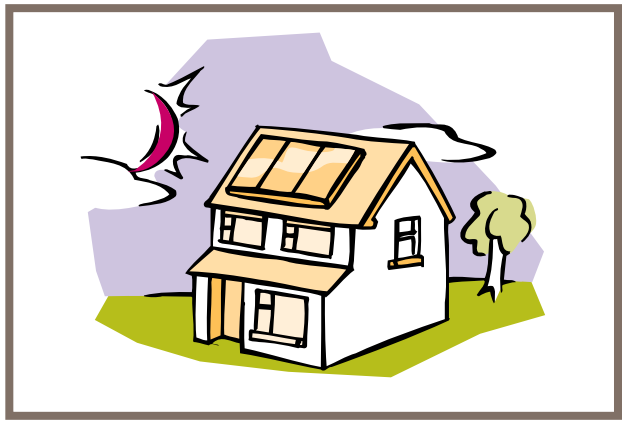
Practical renewable energy sources available to us for home heating are solar and geo-thermal energy.

Solar energy

In temperate climates, such as that of Ireland, solar energy can contribute to the heating requirements of a house. Heat may be gained in a passive or active way. Recent technology developments mean that solar heating can be exploited to provide a considerable proportion of a home's heating and hot water demand.

Passive solar heating

If the house is exposed to low-altitude winter sun, glazing should be concentrated on the south façade. Window area on the north façade should be minimised to limit heat loss. Thermal mass within south-facing rooms, e.g. masonry walls or concrete floors can absorb and store energy during the day and release it gradually during the evening.

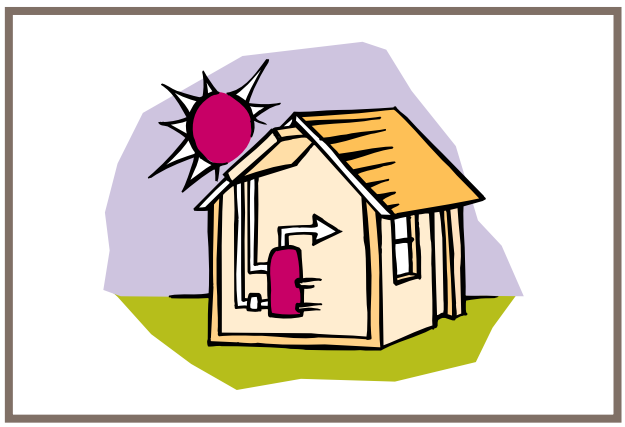


Whatever heating system is installed in the home, it should have a suitable response time and good controls to maximise the usefulness of solar gains. Overhanging eves, blinds, natural ventilation, thermal mass and other means can provide overheating protection in south facing rooms in summer

In general, it is not wise to increase south-facing glazed areas too dramatically. Otherwise additional measures will be required to avoid overheating in summer and excessive heat loss at night and on overcast days in winter.

Active solar heating

Active systems have collectors and heat on south-facing roofs and heat is distributed using air or water.

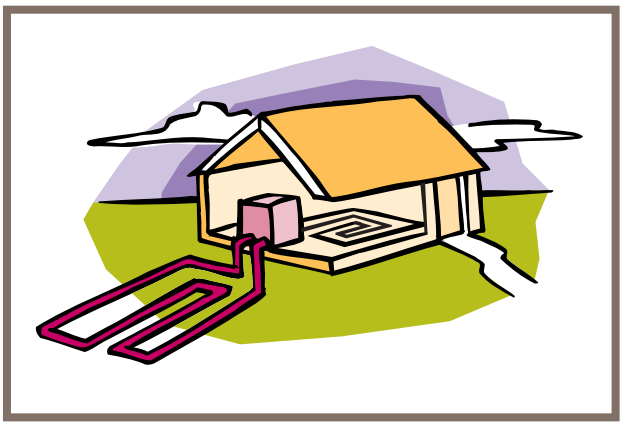


A cost analysis of solar heating systems must be completed to determine the possible payback period before embarking on an installation. The complexity of controls required to integrate the solar heating with other forms of heating employed should be carefully considered. The installation of a solar heating system is best contemplated when building a new house. The retrofitting of an installation to an existing house is more difficult and expensive.

Geo-thermal energy

Geo-thermal ground water energy

If sufficient ground water is available close to a house it may be used as a heat source. Open or closed systems are used to tap into this heat source. In open systems the ground water is pumped up, cooled and then reinjected into the ground. Open systems should be carefully designed to avoid problems such as freezing, corrosion and fouling. Closed systems can be direct expansion systems, with the working fluid evaporating in underground heat exchanger pipes, or water/antifreeze loop systems. This system is particularly appropriate when using under floor heating coils in a house. Geo–thermal heating systems have a higher installation cost than the conventional fossil fuel using heating systems.



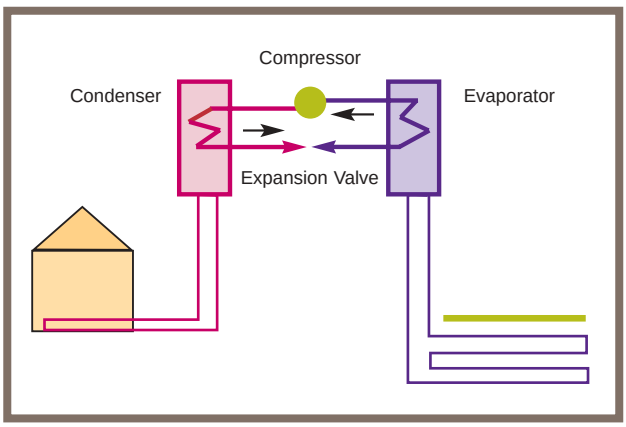
Geo-thermal ground energy

If the ground around your house is suitable and has sufficient area then a heat pump system may be considered. This system is also very appropriate when using under floor heating coils in a house. Heat is extracted from pipes laid horizontally or vertically in the soil and both direct expansion and water/antifreeze systems can be used. The thermal capacity of the soil varies with the moisture content and the climatic conditions.

Heat pumps

Heat pumps offer a most energy-efficient way of providing heating. Even at temperatures, which we consider to be cold, air, ground and water contain useful heat that's continuously replenished by the sun. By applying a little more energy a heat pump can raise the temperature of this heat energy to the level needed.

The great majority of heat pumps work on the principle of the vapour compression cycle. The main components in such a heat pump system are the *compressor*, the *expansion valve* and two heat exchangers referred to as *evaporator* and *condenser*. The components are connected to form a closed circuit. A volatile liquid, known as refrigerant, circulates through the four components. In the *evaporator* the temperature of the liquid refrigerant is kept lower than the temperature of the heat source, causing heat to flow from the heat source to refrigerant, and refrigerant evaporates. Vapour from the *evaporator* is compressed to a higher pressure and temperature. The hot vapour then enters the *condenser*, where it condenses and gives off useful heat. Finally, the high-pressure refrigerant is expanded to the *evaporator* pressure and temperature in the *expansion valve*. The refrigerant is returned to its original state and once again enters the evaporator. The *compressor* is driven by an electric motor.



Air to air

Ambient air is free and is a common source of energy for commercial heat pumps when summer cooling is also required. The economics of applying air-to-air heat pumps to home heating should be examined carefully to evaluate all considerations such as the energy required to defrost evaporators during low ambient air temperature periods.

The most common means of heat distribution are water or air.

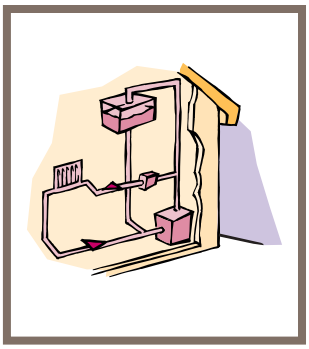
Water

Hot water from a boiler is pumped around a circuit of copper, steel or plastic pipes. Pumps to circulate the water around the house are sized on the basis of the resistance of the circuit components (i.e. pipes, valves, and radiators) and on the amount of water to be circulated at the desired flow velocity. A heating engineer calculates the sizes of the pipes that bring the water to the heat emitters and return it to the boiler. The larger the heat output required from the heat emitters in the house the larger the pipe sizes required to supply those emitters.

The water circuit may be open or closed to the atmosphere.

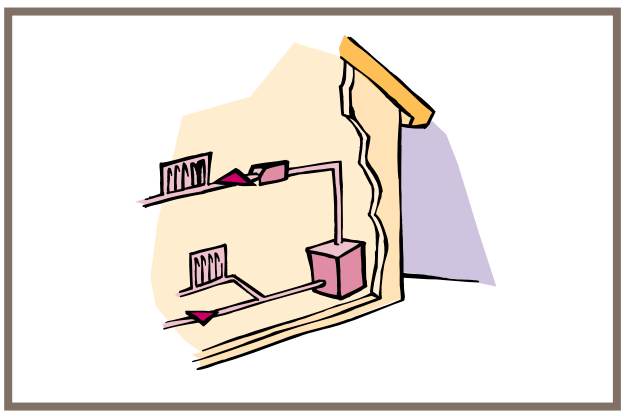
Open systems

Open systems use a small feed and expansion tank located in the attic to fill the system and to accommodate the expansion of water during the heating process. A vent pipe from the heat generator provides a safety outlet in the event of water boiling.



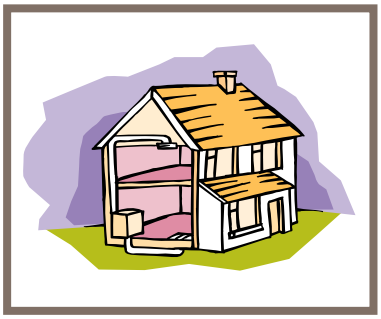
Closed systems

Systems which are closed to the atmosphere can operate at slightly higher temperatures than open systems. They use a small expansion vessel near the boiler and a valved filling systeminstead of an open feed and expansion tank. An extra safety valve must be installed close to the boiler in addition to the normal boiler controls to substitute for the open vent pipe of the open system.



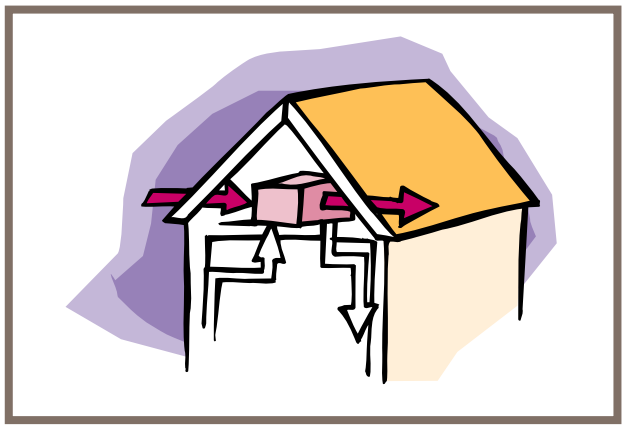
Air

Warm air generators supply heating via ducting installed in floor or ceiling voids. Warm air systems will have a faster response time than a water system and are suitable for thermally lightweight buildings and buildings which have a particularly intermittent occupancy. A thermally lightweight building is one in which the walls floors and ceilings of the rooms are constructed of plasterboard or timber (i.e. there are no concrete or brick surfaces which would otherwise store heat).



Warm air systems

Warm air systems may be designed to accommodate solar heat gains and heat recovery arrangements in the general layout of ducting from the heat generator to the rooms. This typically takes the form of a ventilation system incorporating an air-to-air heat exchanger located in the attic where temperatures are 2ºC to 3ºC higher than outside



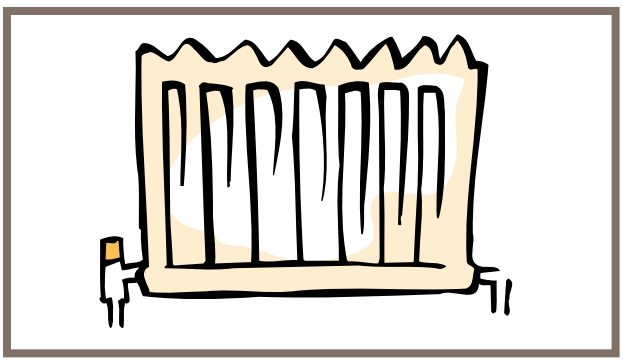
Modern houses are more tightly sealed than older ones and ducting systems can incorporate the provision of controlled ventilation rates to all parts of the house. Houses heated by warm air systems will normally be pressurised relative to outside, hence our ingress for fresh air must be provided by mechanical means.

Air ducting, will occupy more space than pipes in a house and is not as easily concealed.

Heat emitters may be divided between those supplied with heat from a central heat generator and those which generate their heat in the room.

The most common heat emitters using hot water from a boiler are radiators and underfloor coils.

The next section looks at the pros and cons of each form of heat emission



Radiator

Radiator – pros

- The response time (speed of heating up) is suitable for Irish temperate climate.
- Radiators can be situated to heat cold surfaces, i.e. near single glazed windows or on poorly insulated walls, thereby reducing down-draughts
- Flexibility – radiators can be relocated or replaced and additional radiators can be added to the system
- Convenient individual room temperature control is possible
- Lower installation costs
- Simpler retro-fit in older homes

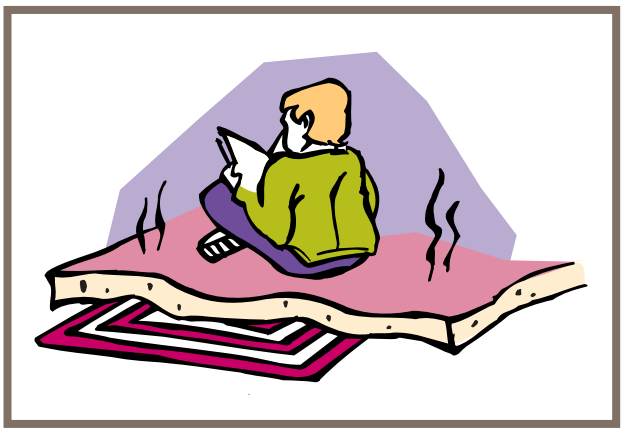
Radiators – cons

- Subject to possible leaks and requires some maintenance
- Larger radiators are required to operate effectively with a condensing boiler
- Radiators can be ugly and unsightly and will accumulate dirt and dust
- Radiators create uneven heating particularly in larger rooms with high ceilings
- Furnishing difficulties resulting from location of radiators

Underfloor heating

Underfloor heating – pros

- Absence of emitters (radiators) allows freedom for decoration and improves room appearance
- Lower temperature, radiant heat provides a stable comfortable environment.
- Potentially more efficient if properly installed and controlled due to lower temperature of circulating water
- Suitable for providing a background level of heating
- Additional heat emitters, such as radiators, may be added to ensure comfort in living spaces
- Ideal for use with heat pumps or condensing boilers (because lower temperature water circulation is required)
- More uniform heat distribution throughout the room
- Intelligent/self-learning controls can improve the response times



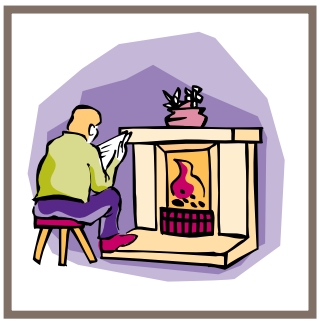
Underfloor Heating – cons

- High cost of installation (20–25% more expensive)
- Slow response time is less suited to the Irish temperate climate
- Controls and design must be of high standard to ensure satisfactory operation
- Limited flexibility – considerable building work is required to change the system
- Furniture in room may limit heat emitter surfaces available
- Low temperature surface of floor may be inadequate to satisfactorily heat poorly insulated spaces
- Generally only appropriate for new homes/new buildings

Heat emitters which generate their own heat locally are:

- Open fires
- Gas or oil fired room heaters
- Electric heaters – radiant, blow heaters, convectors, oil filled radiators and storage heaters

Open fires



Traditional open fires, whether solid fuel or gas decorative fuel effect, remain a visually attractive form of heating for Irish homes. They are, however, an extremely inefficient form of heating (typically 15% to 20% efficiency) and will also induce a high ventilation rate which can be wasteful of energy. Householders must understand the energy implications of the open fire.

Safety Watchpoint

When using non-smokeless fuels, the chimney must be cleaned at least annually, to reduce the risk of chimney fires.

Portable gas or oil fired room heaters

These appliances, which operate at 100% efficiency, burn liquid petroleum gas (LPG) or kerosene. They have a high efficiency but the products of combustion (mainly CO_2 and water vapour) will be emitted to the room. Adequate ventilation must be provided to ensure comfort and safety and may give rise to local condensation.

Safety Watchpoint

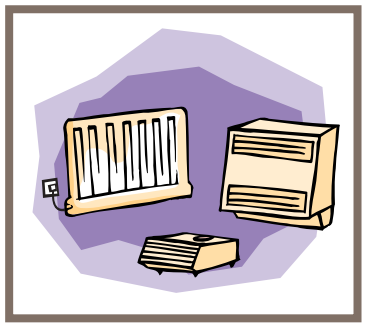
For safety reasons, gas or oil fired room heaters must be kept clean and in good operating condition and should not be used if the burner is in any way defective; never use a gas heater if the ceramic radiants are cracked or loose.

Gas heaters

Radiant and convector gas fires are about 65% efficient, so they are ideal for use on cool spring and summer evenings when the daytime temperatures are too high to justify turning on the main central heating system. Usually they make no pretence to imitate the appearance of an open fire, and they use the existing chimney to take away the gases formed by combustion. Some are designed to be fitted in front of special back-boilers, central heating boilers which sit in place of the old solid fuel grate.

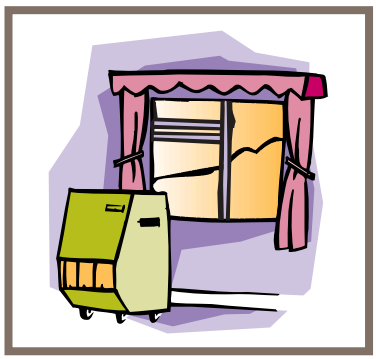
Convector heaters have similar efficiencies, and use a short connector pipe, or balanced flue, through an outside wall to take away the flue gases and to bring in the necessary combustion air.

Electric heaters



A variety of electric appliances using full price electricity are available. Radiant fires provide direct heating to occupants and oil filled radiators, blow heaters and convectors supply quick response heat to rooms. It is recommended that proper time and temperature controls be installed with this type of heating to ensure economical operation. These operate at 100% efficiency.

Off-peak electricity at a considerably cheaper rate is available to storage heaters and electric floor warming coils. The design of the heating installation and the level of control employed must ensure the matching of the heat output of the appliance with the heat demands of the room.



Providing space heating and domestic hot water for a household represents a sizeable expense each year.

There are a number of factors that will have a major effect on the size of the annual heating energy bill. Among the most important are the:

- insulation of the roof, walls, floors and windows of the house
- design and installation of a space heating and a hot water system to match the specific requirements of the house
- matching the output of the space heating and hot water systems to the demands of the household at all times

Following the construction of the house and the installation of the heating systems the householder will have the opportunity to manage the output of these heating systems each year. This section of the guide will illustrate the various forms of control that can be used on typical space heating and domestic hot water systems to ensure a balance between the requirements of the household and the output of the systems installed in the house.

It is necessary to emphasise the importance of controlling the outputs from all heat producing appliances so that they equate with the needs of the occupants. Heat energy must be used in the correct quantities and at the times required. Generating too little heat energy results in lack of comfort while employing too much energy will cause waste and fuel bills that are too high.

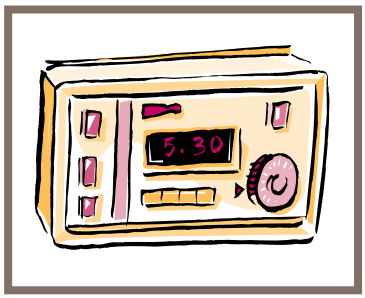
This section will cover the following topics:

- **Control of the heat generator**
- **Control of the heat distribution system**
- **Control of the space heating emission system**
- **Control of the domestic hot water supply system**

Control of the heat generator

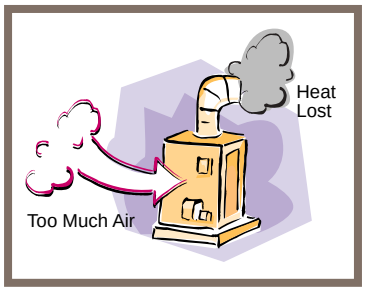
For the efficient and safe operation of a fuel burning heat generator, the following points should be considered:

Boiler/burner on-off

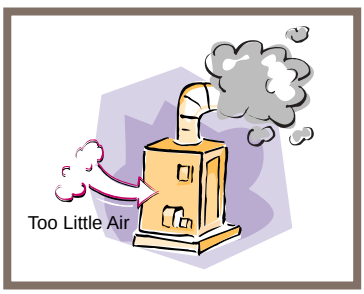


Ideally the space heating and domestic hot water supply circuits should be separate. A time clock or programmer will allow the householder ensure that the boiler will operate to provide heat only when required. The separate timer control of space heating and hot water supply will guarantee that domestic hot water can be provided in the summer period when heating is not required.

Air-fuel mixture



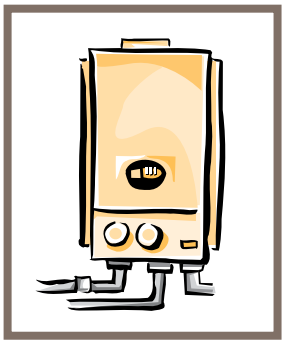
If too much air is used by the burner then an unnecessary amount of heat will be lost up the flue. Too much air can also lead to unstable combustion and ignition problems. Conversely if too little air is employed then there will be incomplete combustion and unburned fuel will be lost up the flue, causing air pollution, and rapid fouling of the boiler, hence lowering efficiency.



The optimum ratio of air to fuel is achieved by correctly adjusting the mixing arrangements of the burner. The adjustment of the burner air/fuel ratio is not automatic and must be performed during the regular servicing of the boiler and burner by a qualified heating engineer, following an analysis of the products of combustion.

Temperature of flow water

Each boiler is fitted with a control thermostat to regulate the flow water temperature. The householder should set this thermostat so that the temperature of the water flowing from the boiler is within the correct range of 70–80ºC.



Maximum temperature of water

For safety reasons it is important that the water temperature in the boiler should not rise to a level approaching 100ºC, the boiling point of water. To ensure that this does not occur the boiler will be fitted with a high limit thermostat which is factory set 5–7ºC above the control thermostat setting. It is not adjustable by the householder, who must manually re-set it in the event it is tripped. The cause of repeated activation of a high limit thermostat should be investigated by a heating engineer.

Safety protection device

In the unlikely event of both the control thermostat and the high limit thermostat malfunctioning at the same time, the boiler water temperature could rise dangerously to boiling point, resulting in steam formation and consequently a pressure build-up, above the normal working parameters. The boiler should be fitted with a safety valve which will relieve any such build-up of pressure. To cater for the unlikely operation, the valve outlet should be piped to a location where the discharge of boiling water and steam will not be harmful.

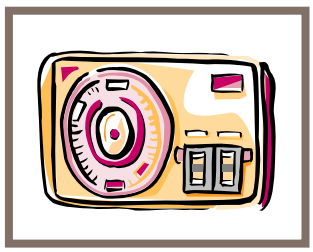
Protection against frost

If a house is left unoccupied during extremely cold weather then there is a possibility of water pipes freezing if the house remains unheated. A frost protection thermostat will automatically put the heating system into operation in the event of the outside temperature approaching 0ºC, supplying sufficient background heating to avoid burst pipes. While this type of thermostat is not common in domestic heating systems, it should be considered for a new installation or when modifying an existing system.

Control of the heat distribution system

In a typical heating system using water as the heating medium, the normal method of controlling the distribution of heat energy to the heat emitters is by means of a pump. In order to optimise the energy efficiency of the heating system it should be fitted with both time and temperature control so that the pump is activated and heat distributed when and where it is required.

Time clock/programmer control



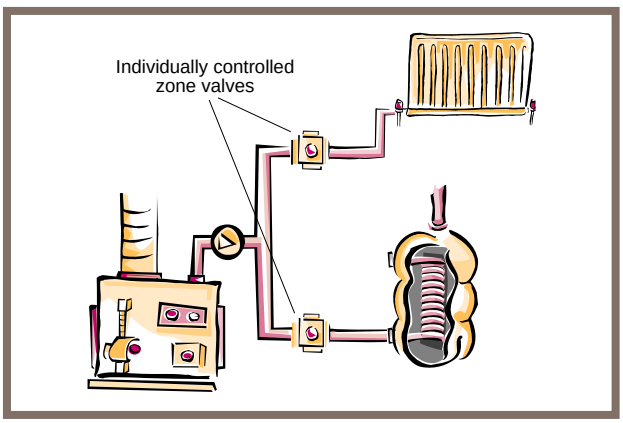
The operation of the heating system must match the occupancy pattern of the household. A suitable time clock/programmer will provide electric power to the boiler and pump when there is a requirement for heating. The householder may wish to turn off the heating system during the night when people are sleeping or during the day if the house is unoccupied, which can easily be achieved with suitable settings on the programmer. Time clock control is also important for occasional electric heating, i.e. fan heaters, convectors and oil filled radiators to avoid wasteful use of energy.

Pump on-off control

Heating water from the boiler will be distributed through pipes to the heat emitters around the house by means of a pump. The normal method of switching on the pump is by means of a *room thermostat*. The thermostat should be located in a position in the house which will be representative of the comfort conditions in the house. The hall or the living room are the typical locations employed by householders. The householder should set the lowest possible temperature that will provide comfortable conditions in the house, typically 18–20ºC. Turning down the room thermostat by 1ºC can reduce the fuel bill by 10%. For warm air systems a room thermostat should be used to switch on and off the heat generator in response to room conditions. When the heat generator is off, the fan circulating the air would continue to operate in order to utilise the residual heat from the heat generator and may revert to half speed when the heat generator cools.

Zone control

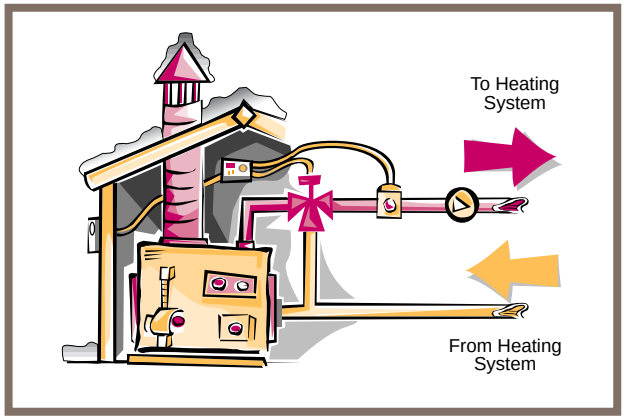
It is normally advisable to divide the heating system into separate zones. This will allow independent operation of the heating system in different parts of the house. Typical circuits would be the ground floor, the first floor and the domestic hot water storage cylinder. Autonomous operation of the zones will be achieved if individual motorised valves or pumps are fitted to each zone. Timer and thermostatic control will permit individual and economic functioning of the heating system in each part of the house. Each zone will be switched on only at the times required by the household and when there is a demand for heat indicated by the thermostat located in that area.



For all heating systems it is recommended that there be a separate hot water circuit to allow for the heating of hot water without needlessly heating the home. This is a requirement of all new buildings in accordance with the Building Regulations published in 1997. Additionally, these regulations suggest that for homes over 100 sq. m the heating system should be split into at least two zones in accordance with typical heat demand differences – namely the bedrooms and living areas, the former of which typically requires lower temperatures.

Weather compensator

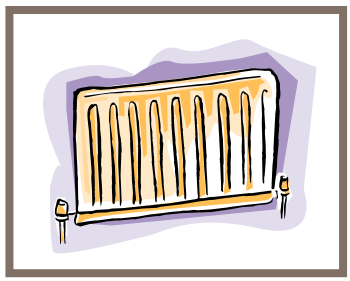
For larger installations consideration may be given to the provision of weather compensator control to help reduce fuel bills. This type of control system uses a thermostat located outside the house and a 3-port mixing valve positioned close to the boiler. The temperature of the flow water to the space heating circuits is adjusted according to the outside air temperature. A low outside air temperature will direct the control system to supply the highest possible flow water temperature to the heat emitters. When the outside temperature rises, the demand for space heating in the house will be reduced. The control system will cause the 3-port mixing valve to supply a lower temperature water to the space heating circuits and save on heating costs.



Optimiser control

A second type of control system, again for larger installations, is an optimiser control, which measures the outside and inside temperatures and switches on the boiler and pump in anticipation of the heat demands of the building. This form of control prevents the heating system operating unnecessarily when the outside temperature is relatively high and the building is already warm.

Control of the space heating



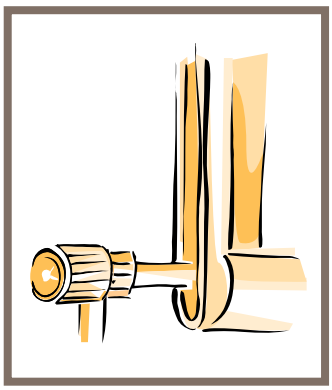
Water is the most common distribution medium in a heating system and heat is generally emitted to the rooms in the house via radiators or convectors (fan assisted radiators). There will be occasions when heating is not required in particular parts of the building. The householder may isolate the heat emitters in these areas either manually or automatically.

Manual control

Radiators and convectors will most often be fitted with a ***hand wheel valve***. This valve allows the heat emitter to be isolated from the heating circuit from which it derives its supply. It has a very limited capacity to regulate the water flow, so it is used fundamentally as an on-off control.

A ***lock shield valve*** will also be installed on each emitter. This valve is used by the installer to balance the flow of water to each heat emitter. The valve must be operated using a screwdriver or special tool and is therefore not intended to be adjusted by the householder.

Automatic control

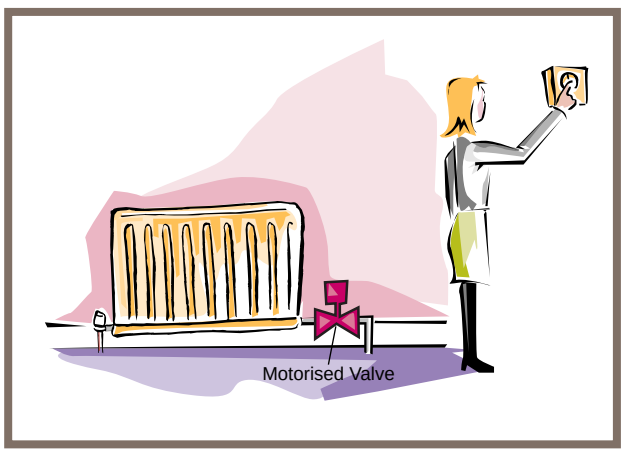


A ***thermostatic radiator valve*** (TRV) may be installed instead of the hand wheel valve. The TRV contains a bellows which will close the valve on a rise in air temperature in the room, stopping the flow of heating water to the heat emitter. The TRV has a number of settings, which the householder may use to set the desired air temperature for each room. In locations where a high level of heating is required, the TRV will be set at the top setting. Conversely, if only background heating is desired then the valve will be fixed at its lowest setting.

A ***motorised valve*** can also be placed in series with the hand wheel valve. The motorised valve will be activated by a room thermostat located in a suitable position in the room. The room thermostat will be set by the householder to maintain a specific level of heating in the room. Where it is anticipated that a room may be unoccupied for a period then the room thermostat may be set to ensure only minimum background heating.

The air temperature will be measured by the room thermostat at a suitable location in the room rather than at a low level close to the heat emitter, as is the situation with the TRV.

This ensures improved response to changes in room temperature. This type of automatic control for a heat emitter is more effective than conventional TRVs, but more expensive t121.663 mm



Control of the domestic hot water supply system

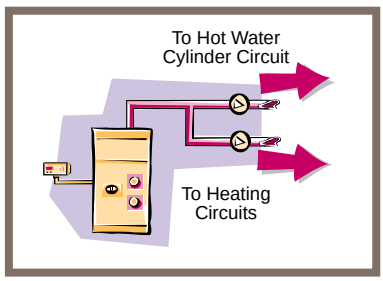
Domestic hot water supply may be provided from a central storage cylinder, from local storage or from an instantaneous source. There is scope for energy saving in the way hot water is produced and used.

Control of central storage cylinder

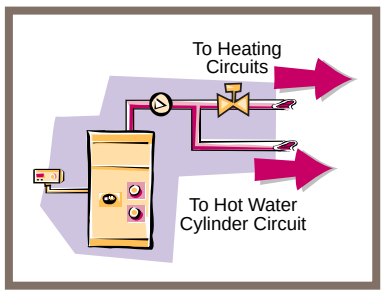
The hot water cylinder should be supplied with heating water from the boiler via a separate circuit from the space heating circuits. Two aspects of a hot water cylinder that should be controlled are the times that heating water is circulated from the boiler to the coil heat exchanger and the temperature at which the hot water in the cylinder is stored.

Motorised valve/separate pump

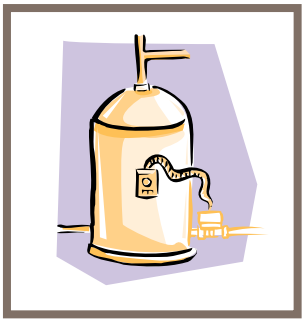
The most common method of ensuring that the hot water cylinder can be heated at times when space heating is not required is to install a motorised valve on the space heating circuit so that it can be isolated from the cylinder heating circuit.



An alternative could be to provide individual pumps for the hot water cylinder and heating circuits.



A time clock/programmer will provide electric power to the motorised valve or the hot water heating pump at the times the household requires the hot water cylinder to be heated. A cylinder thermostat located on the domestic hot water cylinder will control the supply of heating water to the coil heat exchanger in the cylinder. Its operation will maintain the domestic hot water at the temperature selected by the householder. If the water is stored at too high a temperature then energy will be wasted. However, if water stored in the cylinder is kept at too low a temperature, then there is a danger that harmful bacteria may flourish. The cylinder thermostat



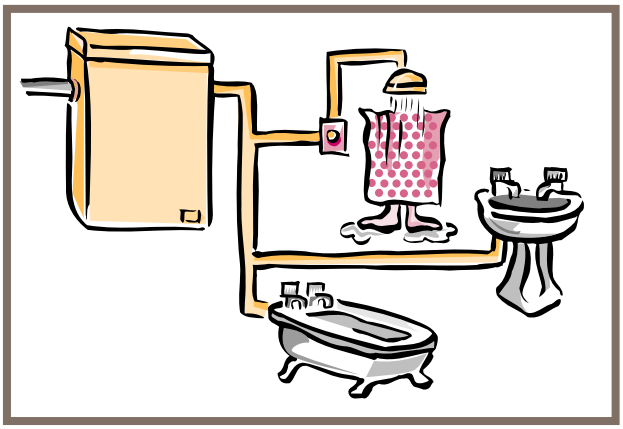
should be set to ensure that the domestic hot water is stored at a temperature of 60ºC. Note too, that, where an electric immersion heater is fitted on a cylinder, that this should not be on while the heating system is on, as this is wasteful of energy.

Control of local systems

In large houses where points of use are far apart, heat energy and water are wasted during distribution from a central storage cylinder. The installation of a local hot water system eliminates this wastage.

Local systems may be of the storage or instantaneous type and natural gas, liquid petroleum gas or electricity are the fuels used. The manufacturers of storage or instantaneous hot water heaters provide a control thermostat on the appliance with which the householder may set the temperature at which the water is stored or produced. Manufacturers will also fit a high limit thermostat to prevent the water boiling in the event of the ***control thermostat*** malfunctioning. The ***high limit thermostat*** is not adjustable by the householder and must be reset manually if it has been activated. Repeated activation of the high limit thermostat must be investigated by a heating engineer.

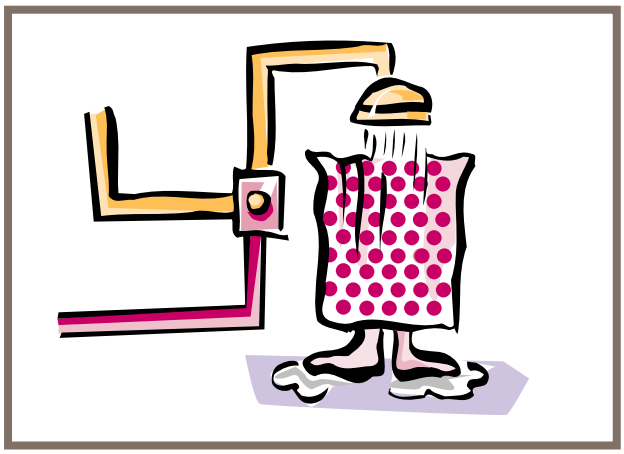
Timers may be used to automatically switch on and off the water heaters at the times required by the household.



Point of use control

Domestic hot water should be stored at 60ºC. However, water at this temperature is too hot for showers. Manual mixing valves are used to mix water from the storage cylinder with cold water from the cold water cistern to provide water at the correct temperature.

The mixing process can be automated by installing a Thermostatic Mixing Valve. This valve may be adjusted by the householder to provide water at the desired temperature. Once the setting is maintained the shower water temperature will always be the same provided the water in the storage cylinder is at or above the desired temperature. This will minimise energy and water wastage.



Summary

Effective control of the space heating and domestic hot water supply systems in a house will ensure that comfort conditions are achieved at the minimum cost. Heat energy should be used only when and where it is required. Additional automatic control measures that would improve the energy efficiency in the house may be identified and installed where appropriate. Where a new installation is proposed, as many as possible of the applicable energy saving control measures shown in this guide should be included.

In this section on energy conservation, we are going to examine typical domestic heating systems to illustrate where energy may be wasted. This will assist householders with existing heating systems to identify problem areas where heat may be lost, and it will also help householders planning to install a new system to select devices that offer maximum efficiency. This section is comprehensive and therefore sometimes covers areas which should only be addressed by a qualified heating engineer.

Heat generator

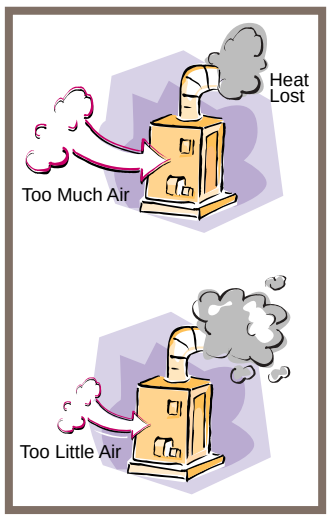
The most common types of heat generator are boilers using solid, liquid or gas fuel.

Burner not operating properly

The function of the burner is to ignite the correct mixture of air and fuel to achieve the most efficient combustion possible.

Problem – Air/fuel mixture not correct.

- If too much air is used by the burner then an unnecessary amount of heat will be lost up the flue.
- If too little air is used by the burner, then there will be incomplete combustion and un-burned fuel will be lost up the flue, causing air pollution. The boiler will become dirty and inefficient very quickly.



Solution – An analysis of the flue gases should be performed when the boiler is being serviced by a qualified technician at least once a year. The analysis will assist in ensuring that the correct mixture of air and fuel is being burnt.

Householders intending to purchase a new boiler should consider choosing a condensing boiler. This type of system can operate with an efficiency of 92% compared with a typical efficiency of approximately 84% for a conventional boiler.

Boiler surfaces not clean

The heat from the burner flame must transfer across the boiler surfaces to the water.

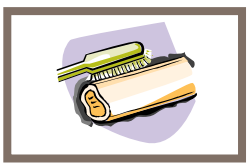
Problem – Ash and soot scale on boiler surfaces.

If deposits of ash and soot scale form on the boiler heat transfer surfaces, then a barrier to the flow of heat between the flame and the water will be created. This will lead to a reduction in the amount of heat being transferred to the water and an increase in the loss of heat to the outside via the flue.

Solution – The ash and soot deposits on the fire side of the boiler transfer surfaces should be removed with a wire brush when the boiler is being serviced.

Flue in poor condition

The products of the combustion process must be removed safely and efficiently from the boiler.



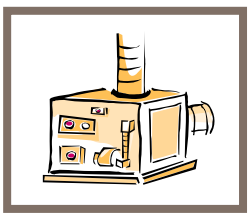
Problem – Excessive noise and fumes from boiler flue.

Obstructed or leaking flues will cause poor combustion in the boiler and will result in noise and fume problems and possible danger to occupants of the building.

Solution – Ensure that all flue joints are sealed, the flue is clean and the flue gases can exit safely and efficiently to the outside.

Boiler insulation in poor condition

The function of the insulation around the boiler is to minimise the 'heat radiation loss' from boilers.



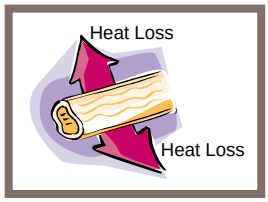
Problem – Poor insulation around boiler jacket.

If the boiler is in a location not requiring heat, i.e. an outside boiler-house, then heat lost from the boiler jacket through its insulation will contribute to a reduction in the efficiency of the boiler in transferring heat from the fuel to the water.

Solution – Ensure that the insulation and metal cladding of the boiler are in a sound condition.

Heat distribution system

The most common type of heat distribution system is hot water circulated by a pump through either copper or steel pipes.

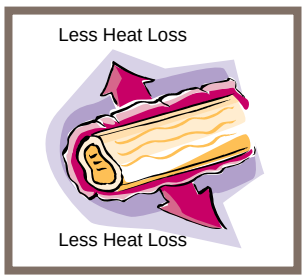


Uninsulated pipes

The function of the pipes is to convey the hot water from the boiler to the heat emitters.

Problem – Uninsulated pipes in unheated locations.

The water in heating pipes will be typically 65ºC higher in temperature than the surrounding air when they pass through unheated areas of the house, i.e. underfloor. Heat will be lost from uninsulated pipes.



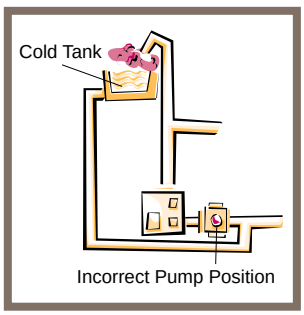
Solution – Insulate all exposed pipes in unheated locations with a minimum thickness of 15 mm of suitable insulation.

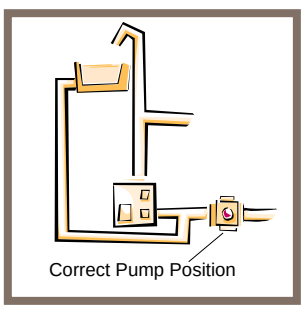
Pump located in wrong position

Problem - Hot water being pumped into feed and expansion tank.

If the pump in an open system (i.e. with a feed and expansion tank in the attic) is located between the feed and expansion connections, then 'pitching' may occur.

'Pitching' is the pumping of hot water into the feed and expansion tank. This phenomenon results in the loss of heat from the system and increases corrosion of steel pipes and radiators.



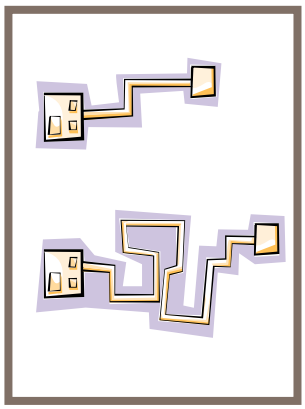


Solution - The pump should be located outside the feed and expansion connections in the return or the flow pipes.

Unnecessary pipe runs

Problem - Heat being lost from unnecessary pipe runs.

Pipes that do not take the most direct practical route from boiler to heat emitter will lose heat unnecessarily. Further energy will also be wasted in pumping through the excess pipe lengths.

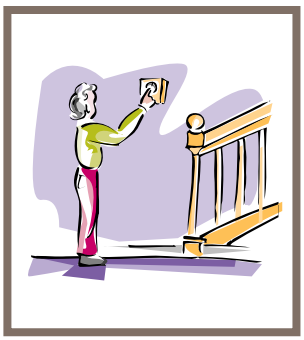


Solution – Pipes should take the shortest practical route from boiler to heat emitter.

Pump running unnecessarily

Problem – Pump running when heat is not required.

A typical arrangement would be that a room thermostat would control the operation of the pump. The overall control of the boiler and the pump would be by means of a time-switch.

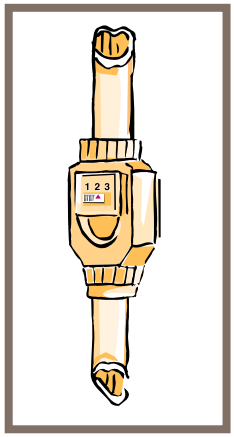


Solution – Ensure that the Room Thermostat controlling the operation of the pump is mounted in a suitable location and set at an appropriate temperature for that location.

The room thermostat should be set at the lowest practical temperature that will ensure acceptable comfort conditions in the house.

Pump speed incorrectly set

Problem – The pump has been installed in the correct location, but the speed setting is wrong.



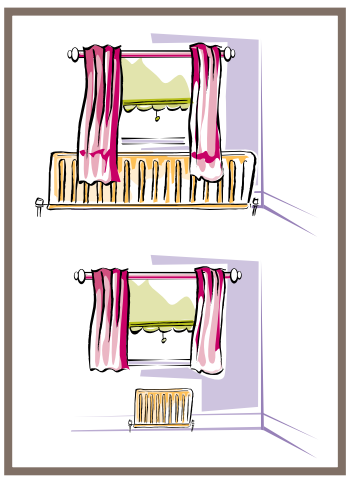
Typical pumps installed in domestic installations will have a number of speed settings available. The pump should be set to run at the optimum speed by the installing heating engineer to ensure that the output of energy matches the pressure requirements of the home heating system.

Solution – Ensure that the output of the pump installed matches the pressure and flow rate requirements of the heating system.

Heat emitters

The function of the heat emitters is to transfer heat from the circulated hot water to the heated space.

Restricted air flow around the heat emitter



Problem – Air unable to circulate freely over the heat emitter.

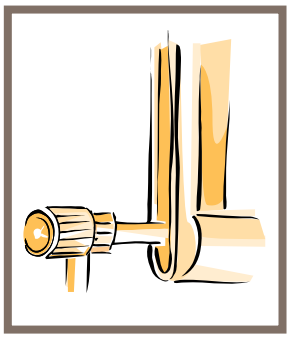
Radiators and convectors (fan assisted radiators) require an unrestricted air flow over the front and rear panels. Any obstruction to the upward flow of air will result in a reduction in the heat output from the emitter.

Solution – Allow a gap of 150 mm from the floor to the bottom of the heat emitter and approximately 50 mm between the wall and heat emitter. Any shelf above the heat emitter should be located at least 150 mm above the top surface. Avoid placing full length curtains in front of heat emitter.

Heat emitter incorrectly sized

Problem – Heat emitter not matching the requirements of the room.

If a heat emitter is too small for a room, comfort may be sacrificed during cold periods.



If a heat emitter is too large either fit a TRV to reduce the flow and prevent overheating and waste of energy or reduce the flow via the lock shield valve.

Solution – The correct 'heat loss' should be calculated for each room by a heating engineer and the matching heat emitter size selected.

Heat emitters operating unnecessarily

Problem - Heat emitter providing heat in excess of immediate requirements.

There will be occasions when heating is not required in particular parts of the house. Heat emitters may be isolated manually by turning the handwheel valve.

Automatic control of radiators may be achieved by installing thermostatic radiator valves. These will ensure convenient and effective reduction of heat emission in locations where a reduced heat input is required.

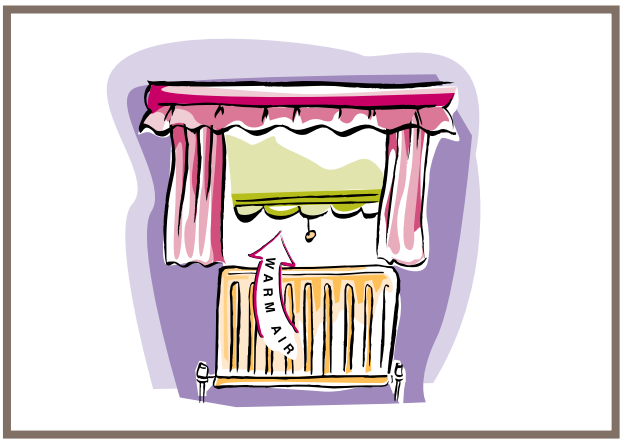
Solution – Install thermostatic radiator valves on all heat emitters.

Heat emitter location

Problem – An incorrectly located heat emitter may result in poorer system performance.

Windows and outside walls will be the coldest surfaces in the house. Cold windows cause downdraughts and uncomfortable conditions for the occupants. Higher air temperatures must be maintained to achieve comfort conditions.

Solution – Locate heat emitters under windows to raise the glass temperature and to eliminate cold downdraughts.



Heat control

Achieving control of the heating system is the most important aspect of energy conservation in a house.

See pages 14–18 of this guide for details of the types of controls, their applications and proper operations.

Summary

The information contained in this section will allow householders to examine their heating system, identify possible sources of energy wastage and initiate remedial action to conserve heat and reduce fuel bills.

Useful contacts for further information

SEI, Glasnevin, Dublin 9.
Energy Hotline: 1850 376666

Irish Agrément Board, Glasnevin, Dublin 9.
Telephone: (01) 8073800

National Standards Authority of Ireland, Glasnevin, Dublin 9.
Telephone: (01) 8073800

Construction Industry Federation, Federation House, Canal Road, Dublin 6.
Telephone: (01) 4977487

Relevant Standards

Irish Standards

IS 240:1994, Efficiency Requirements for Hot Water Boilers

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

Irish Building Regulations 2002

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

Irish Agrément Board Certified Products

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

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Don Byrne

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