Before we begin to look at the environmental technologies, it is important to understand the role that environmental technology systems have in helping to address climate change and improve sustainability. Before considering the installation of environmental technology systems it is essential that approaches to reduce demand and to improve efficiency are taken first.

Solar Thermal

Although there are a number of system types, variations and configurations, solar thermal hot water systems fall into two basic system categories:

Solar Thermal Hot Water Systems – Direct Active Systems

This type of system can be added to existing hot water systems, but it is essential that all system components are compatible with the system design. For example, as the domestic hot water is circulated through the solar collector it is not possible to add anti-freeze protection to the system water – therefore some components such as the solar collector need to be freeze tolerant.

Solar Thermal Hot Water Systems – Regulatory Requirements

Note: The requirements stated relate to England and Wales only. The requirements for Scotland and Northern Ireland may differ.

The Building Regulations (England and Wales) comprise of 14 parts.

Seven of these parts may have relevance to solar hot water systems installation.

Part	Topic	Relevance or possible relevance
A	Structure	Where solar collectors and other components put load on the structure, in particular wind uplift loads.
B	Fire Safety	Where holes for pipes etc. may reduce the fire resistant integrity of the building structure
C	Site preparation and resistance to moisture	Where holes for pipes etc. may reduce the moisture resistant integrity of the building structure

Part	Topic	Relevance or possible relevance
E	Resistance to the passage of sound	Where holes for pipes etc. may reduce sound proof integrity of the building structure
G	Sanitation, hot water safety and water efficiency	Hot water safety and water efficiency
L	Conservation of fuel and power	Energy efficiency of the system and the building
P	Electrical safety in dwellings	Safe installation of electrical controls and components

Town and Country Planning Regulations – Building Mounted Collectors

The installation of a solar hot water system collector array is typically classed as permitted development for houses and bungalows providing :

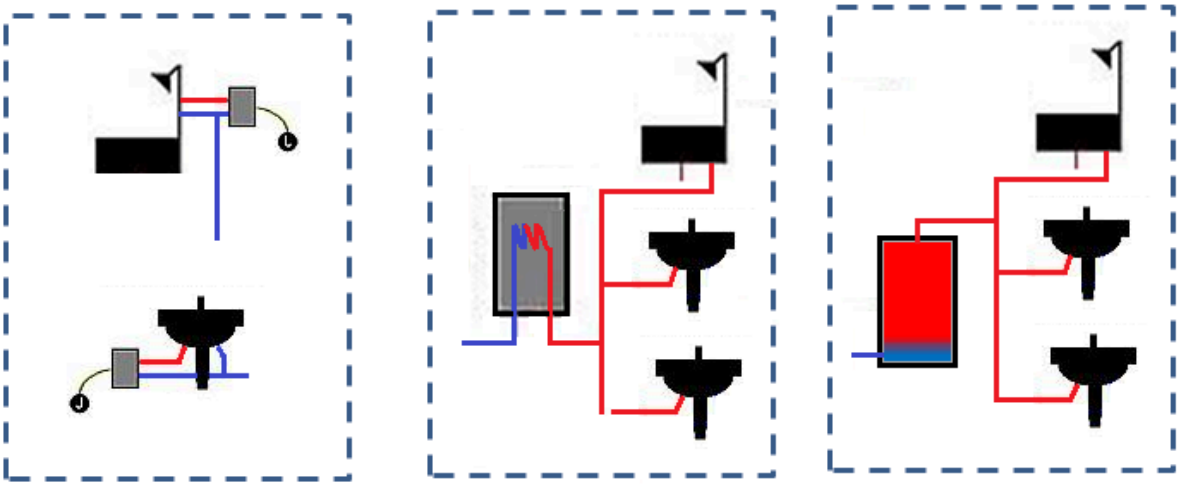
the solar collectors are not installed above the ridgeline and do not project more than 200mm from the roof or wall surface.
the solar collectors are sited, so far as is practicable, to minimise the effect on the appearance of the building
the solar collectors are sited, so far as is practicable, to minimise the effect on the amenity of the area.
the property is not a listed building*
the property is not in a conservation area or in a World Heritage Site
The local authority should always be consulted.

Listed building consent may be required even if planning permission is not required.

In the UK, we tend to relate a south facing garden in our homes to the availability of the most sunshine throughout the day. Well the same applies in relation to solar hot water systems.

As well as orientation, the 'tilt' of the solar collector is also key factor that determines the amount of solar energy that is transferred from the sun to the solar hot water system.

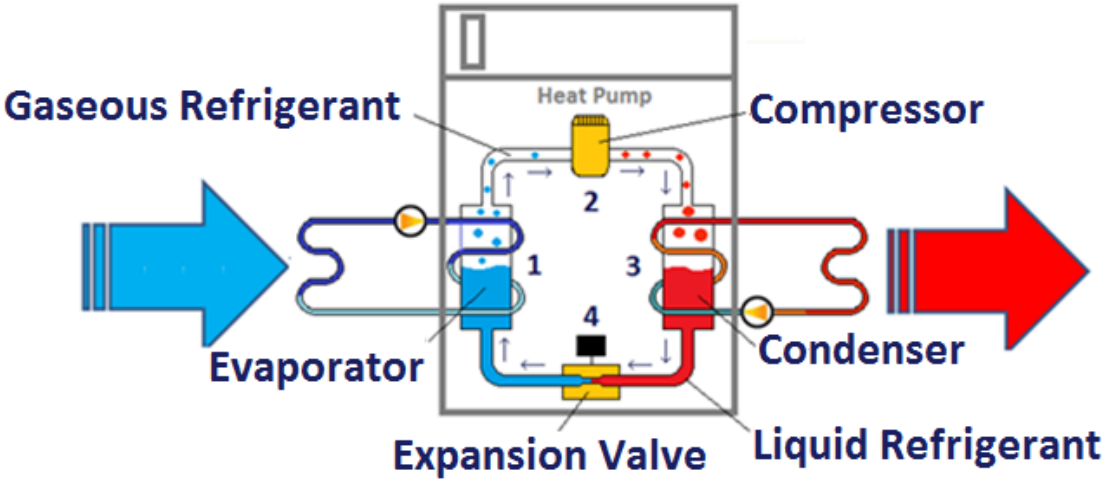
Overshading	% of sky blocked by obstacles	Impact of overshading (% reduction in potential system performance)
Heavy	> 80%	50%
Significant	> 60 - 80%	35%
Modest	20% - 60%	20%
None or very little	< 20%	none

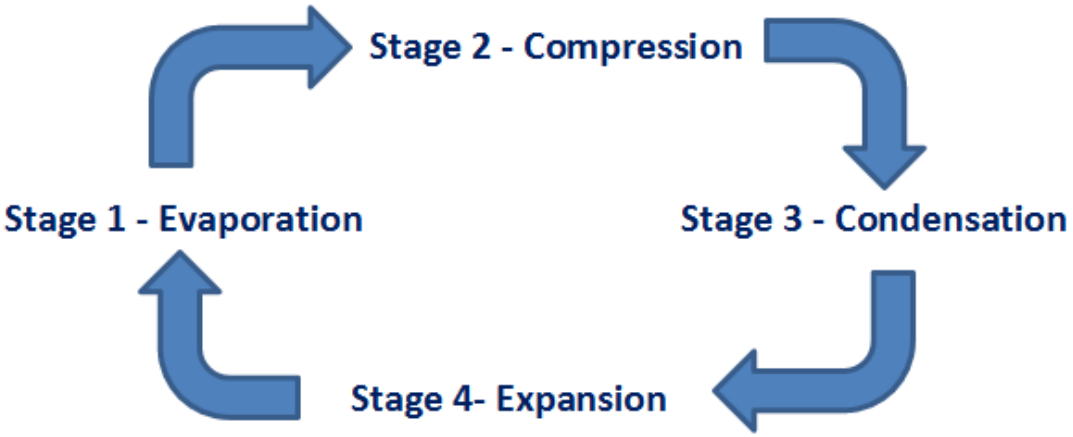


Existing hot water systems come in various types and configurations. Three types of systems are shown

Point of use systems and instantaneous centralised systems are not normally suitable for use with solar hot water systems. However, some combination boilers are compatible with solar pre-heated water. Product manufacturer's instructions should always be consulted for advice.

Heat pumps





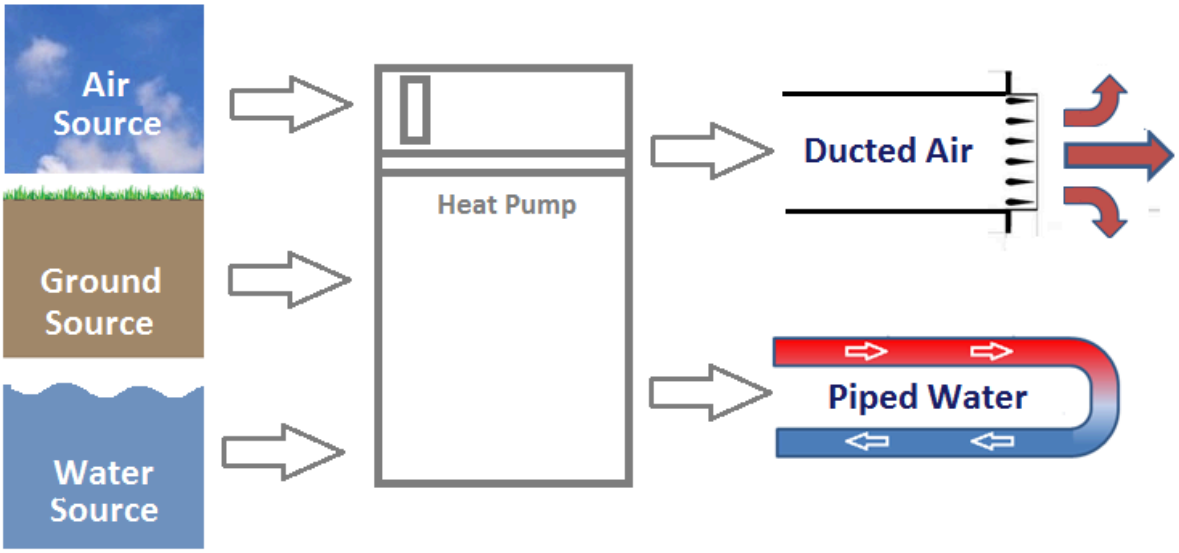
1. The low temperature heat (heat source) enters the Evaporator which is a heat exchanger . A refrigerant on the other side of the evaporator is at a cooler temperature than the heat source and heat is transferred from the source into the refrigerant causing the refrigerant to boil and evaporate

2. The now gaseous refrigerant enters the compressor, resulting in a rise in the temperature and pressure of the refrigerant.

3. The refrigerant continues its course through the Condenser (which is also a heat exchanger) transferring the higher temperature heat to either an air or water distribution circuit (often referred to as the 'heat sink' or emitter circuit).

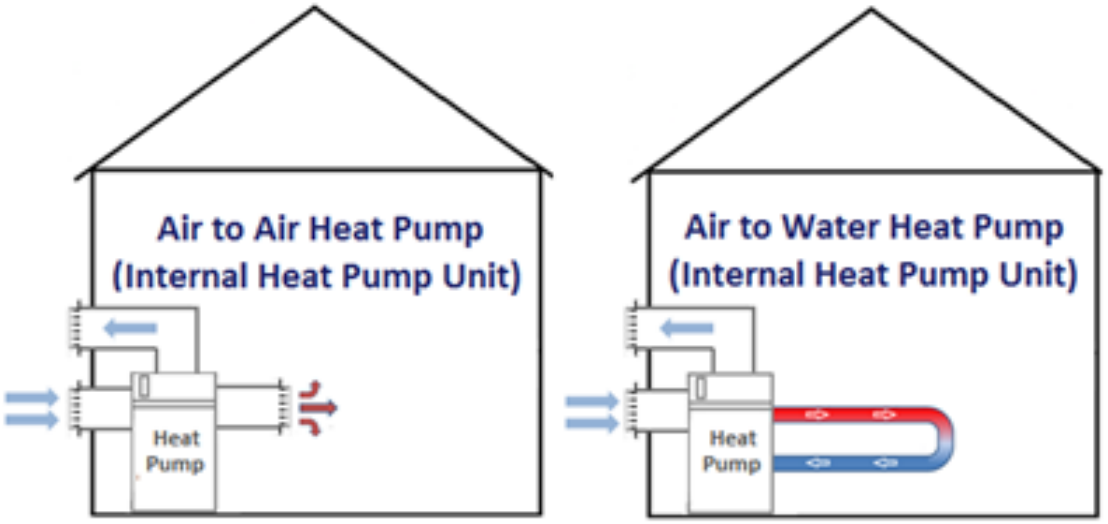
4. The refrigerant, now at a cooler temperature, enters the expansion valve, which reduces its pressure and temperature to its initial state at the evaporator. The cycle then repeats itself.

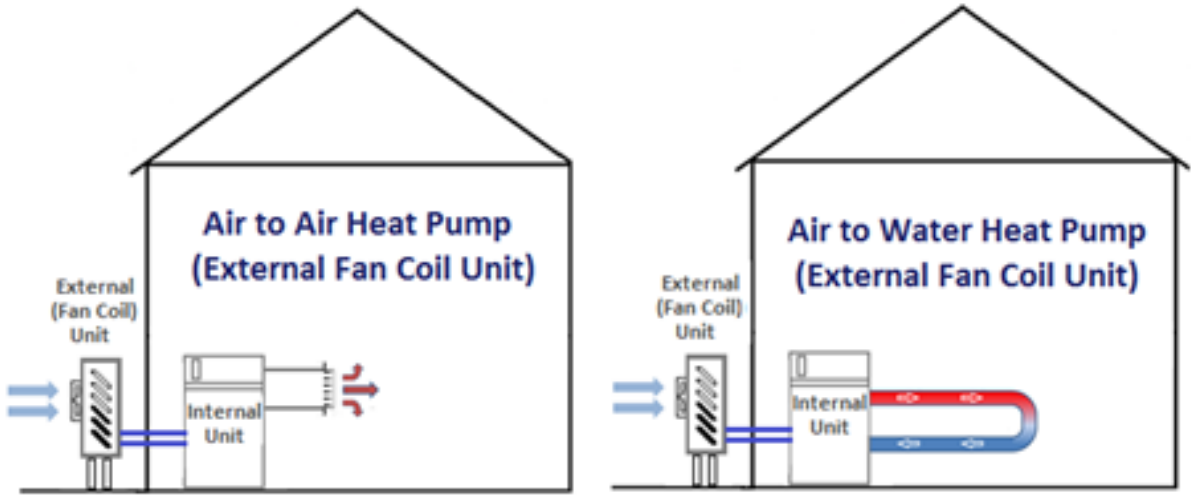
Heat pumps are classified as a 'low' carbon technology because they need some electrical energy to operate.



Heat Pump Input and Output Options

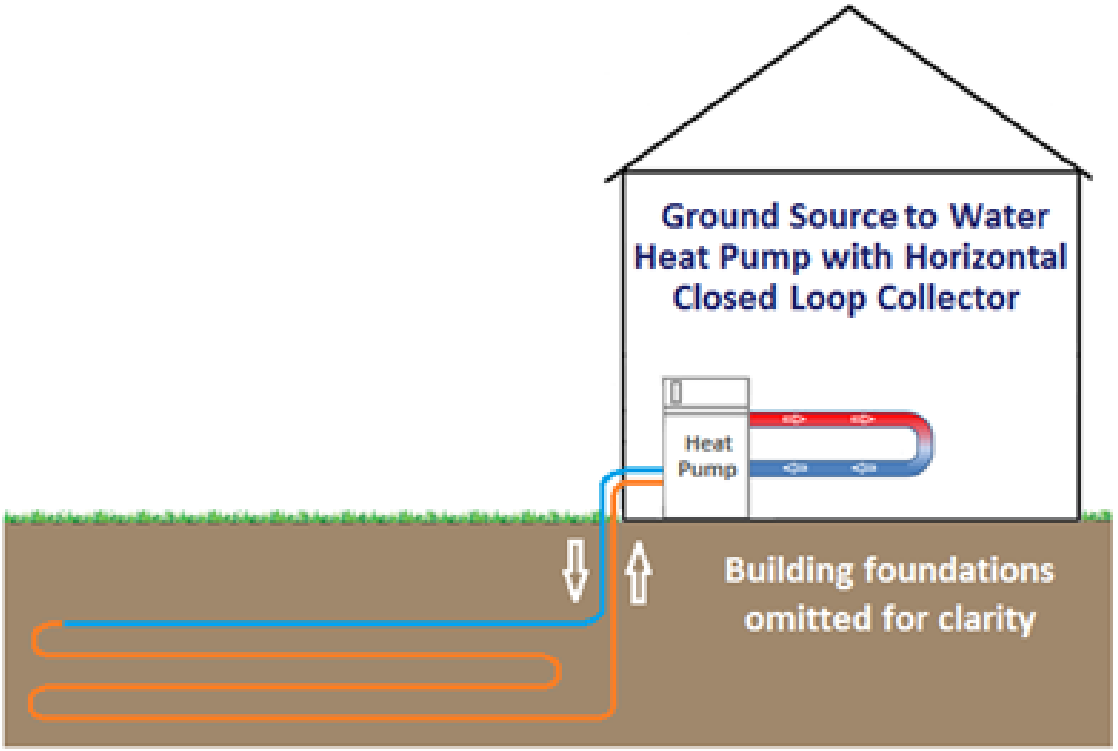
Heat pump technology can convert low temperature heat from an air, ground or water source to higher temperature heat for use in ducted air or piped water 'heat sink' systems. The type of heat pump unit must be selected in relation to the intended 'heat source' and 'heat sink' arrangement'





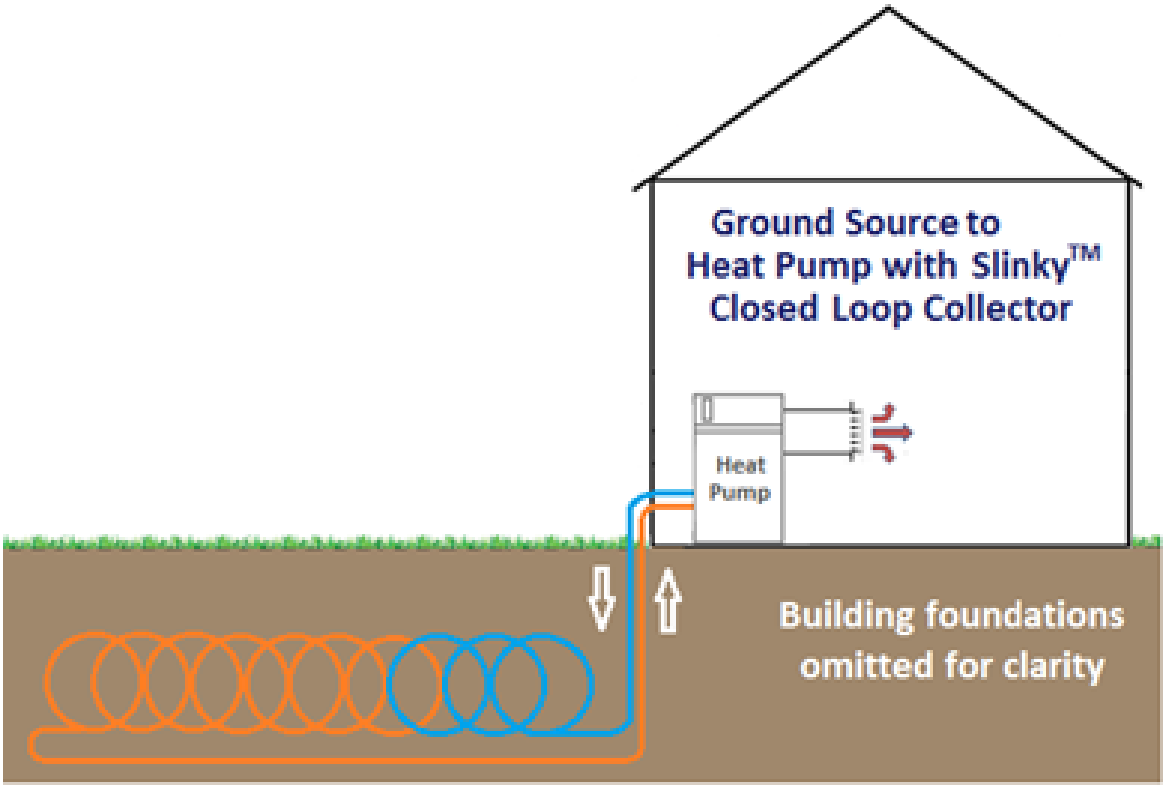
A variety of heat pump system arrangements are possible using the external air as the heat source.

Air source heat pumps will typically operate at temperatures up to -20 ^{o}C. Air source heat pumps can be single internal units that receive the incoming air through an inlet duct that passes through the external wall of the building . An popular alternative is the use of an external fan coil (evaporator) unit that is linked to an internal unit. Fan coil units can be noisy and this need to be considered at the design stage.

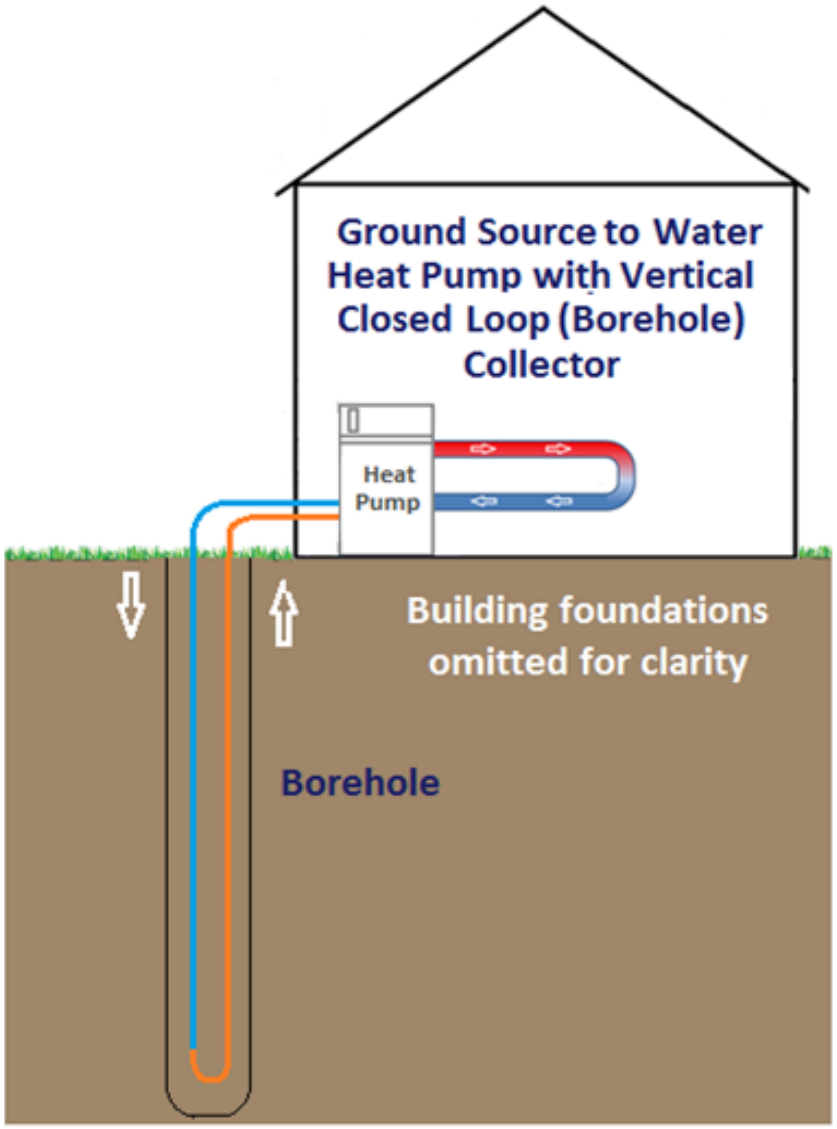


A variety of heat pump system arrangements are possible using geothermal ground heat as the heat source. A variety of closed (sealed circuit) collector loop arrangements can be used.

External ground source heat pump units (not illustrated) are also available.



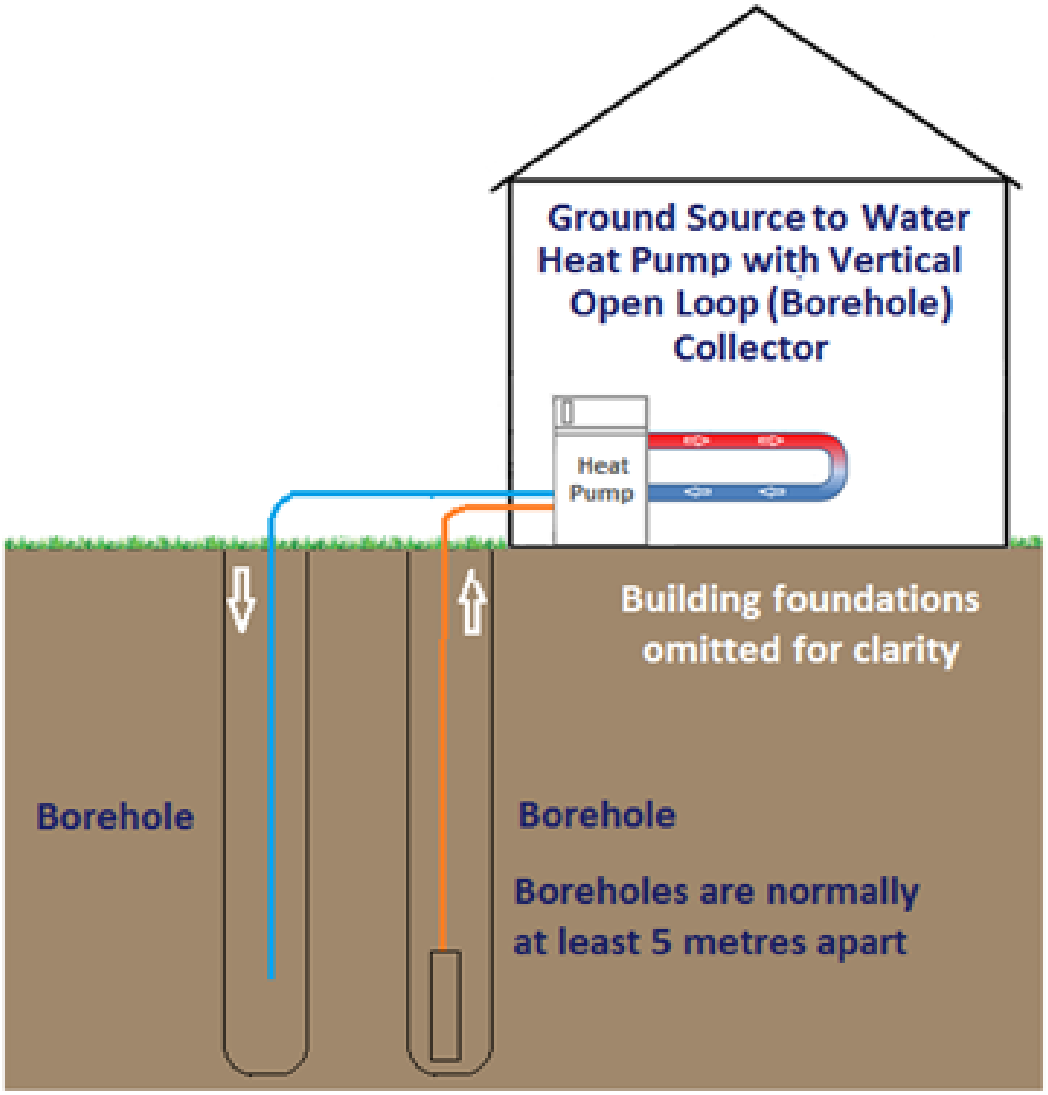
Slinky™ type collectors (illustrated) are sometimes used where available ground area (m^2) is limited.



An alternative to horizontal ground collector loops is a vertical collector loop installed in a borehole.

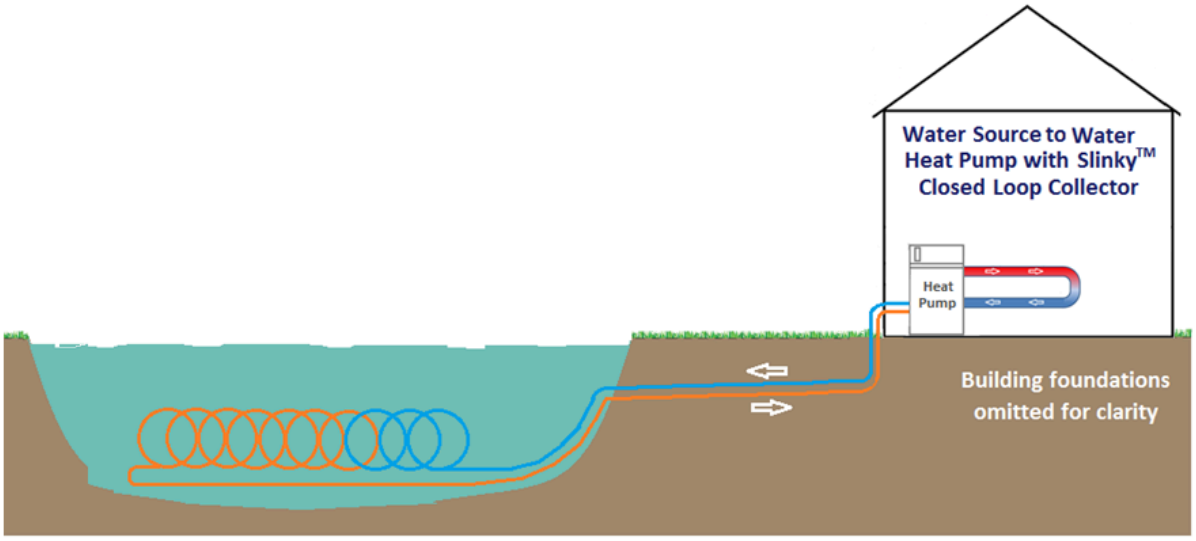
This type of installation requires a specialist drilling rig to be used to create the borehole. A specialist contractor is normally used to undertake the drilling operation.

Vertical borehole collector loops are often used where the geothermal conditions support the use of a ground source heat pump but where the available ground area (m^2) is limited.

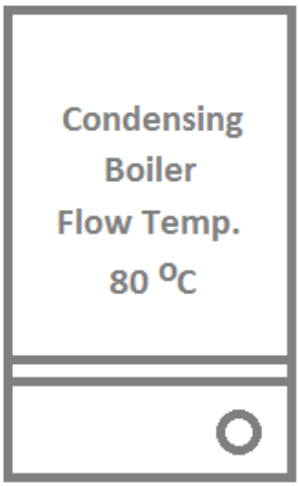


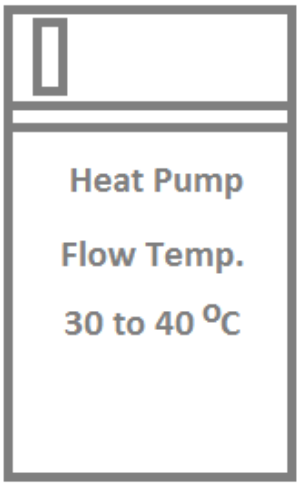
An ‘open’ vertical borehole ground collector loop is an alternative to a ‘closed’ vertical borehole ground collector loop.

With this arrangement , two boreholes are used and the collector circuit is open and the collector circuit fluid flows naturally from the open ended return pipe to the open ended flow pipe. . This type of arrangement requires the availability of a suitable geothermal water source.



Where a suitable water source exists such as a lake or a pond, this can be a very effective alternative to a ground source collector circuit. For illustration purposes the Slinky™ type collector is shown in a vertical position, but water source collectors are simply laid on the bottom of the lake or a pond and weighted as necessary to keep them in place. 'Open' water source collector circuits (not illustrated) are also an option.

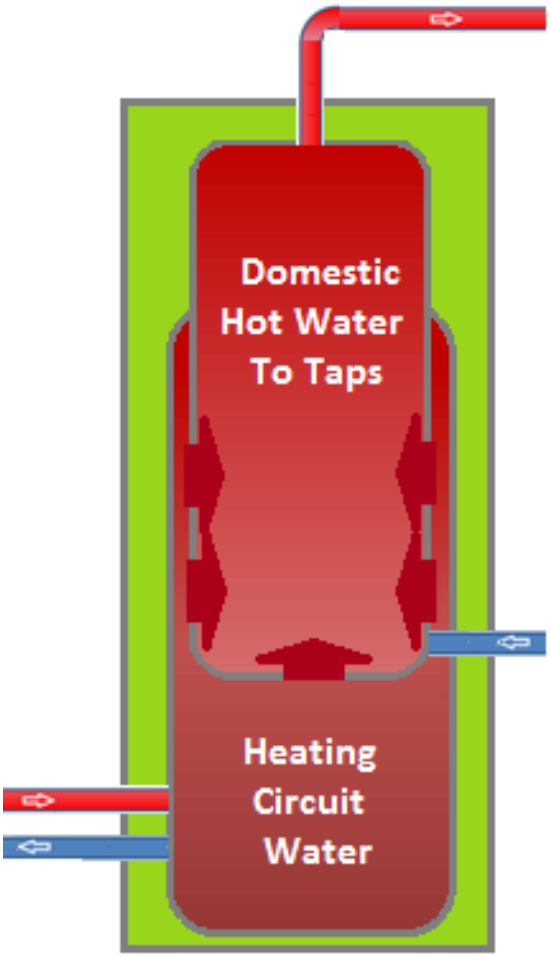




One of the factors that affects heat pump system efficiency is the

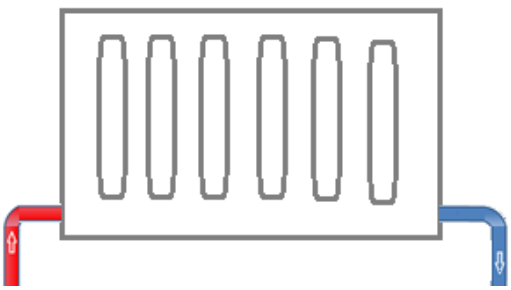
temperature difference between the heat source and the heat sink.

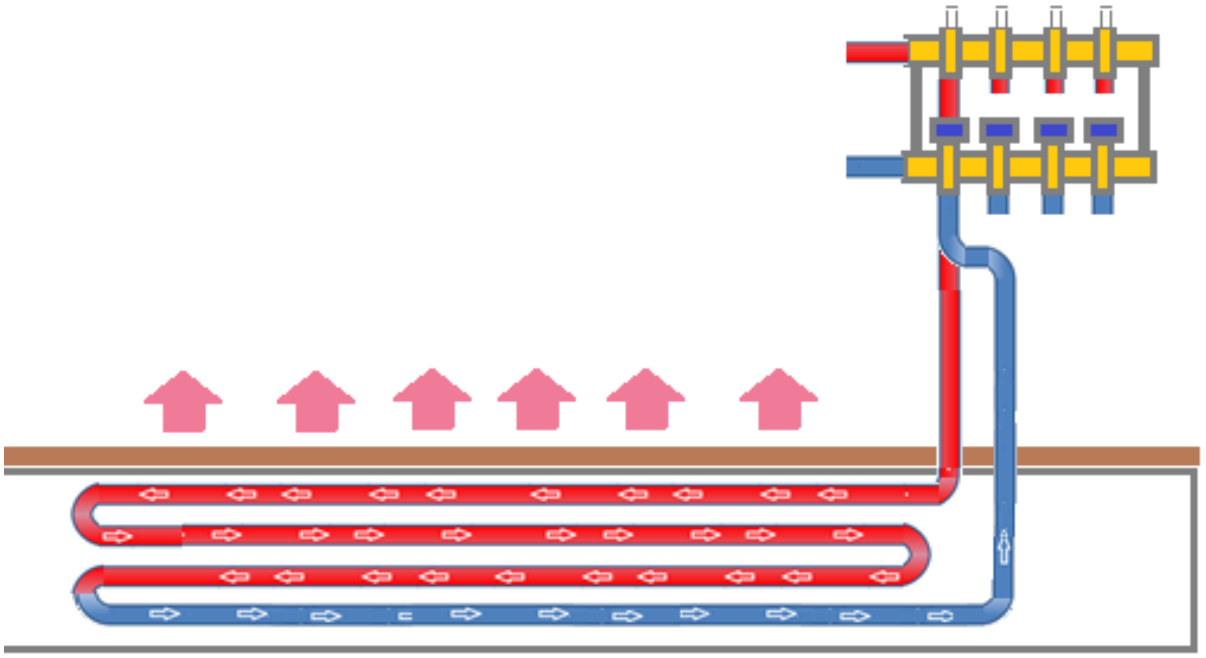
The closer the temperature between the heat source and the heat sink circuit, the better the Coefficient of Performance



Heat pumps can be used to heat a domestic hot water storage cylinder. Standard type indirect hot water storage cylinders are not suitable for heat pump system due to the size of the heat transfer coil. A 'tank-in-tank' hot water cylinder is the most appropriate for use with heat pumps. Some heat pump units have an integrated 'tank-in-tank' cylinder.

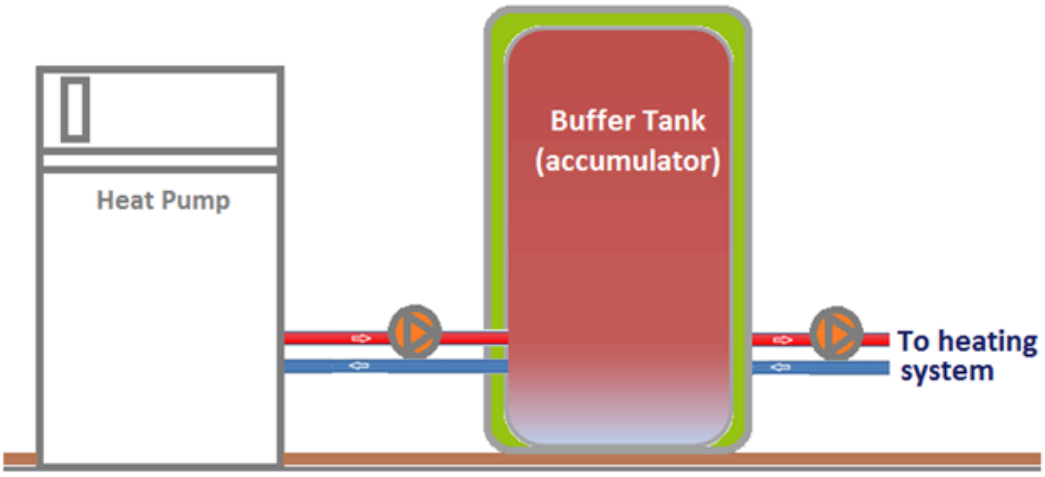
A 'boost' or auxillary heater is required to boost the stored water temperature to standard 60°C domestic hot water storage temperature





To be effectively and efficiently used with a heat pump system, standard type panel radiators would need to be significantly over-sized to enable the required heat output to be achieved using a lower mean water temperature . This factor means that heat pump units are typically less suitable for use with existing standard type panel radiator circuits that have been sized for a mean water temperature of 70 ^{o}C.

Low temperature, high efficiency panel radiators are available and these are more suitable for use in a heat pump heat sink circuit. Where low temperature, high efficiency panel radiators are used, the Coefficient of Performance will typically be lower than if underfloor heating is used.



Heat pumps are not designed or sized to meet short-term heat loads. For efficient operation a heat pump heeds to be able to start-up and run for a period of time. Stop-start operation can also shorten the life of the heat pump compressor.

Buffer tanks are also useful where an auxillary heat source such as a boiler is being used with a heat pump. This type of system is known as a bivalent system.

Most air source heat pumps, particularly those with an external fan coil unit need to defrost regularly. Buffer tanks are also useful to provide heat for the defrost cycle.

Part	Topic	Relevance or possible relevance
A	Structure	Where heat pumps and other components put load on the structure
B	Fire Safety	Where holes for pipes etc. may reduce the fire resistant integrity of the building structure

C	Site preparation and resistance to moisture	Where holes for pipes etc. may reduce the moisture resistant integrity of the building structure

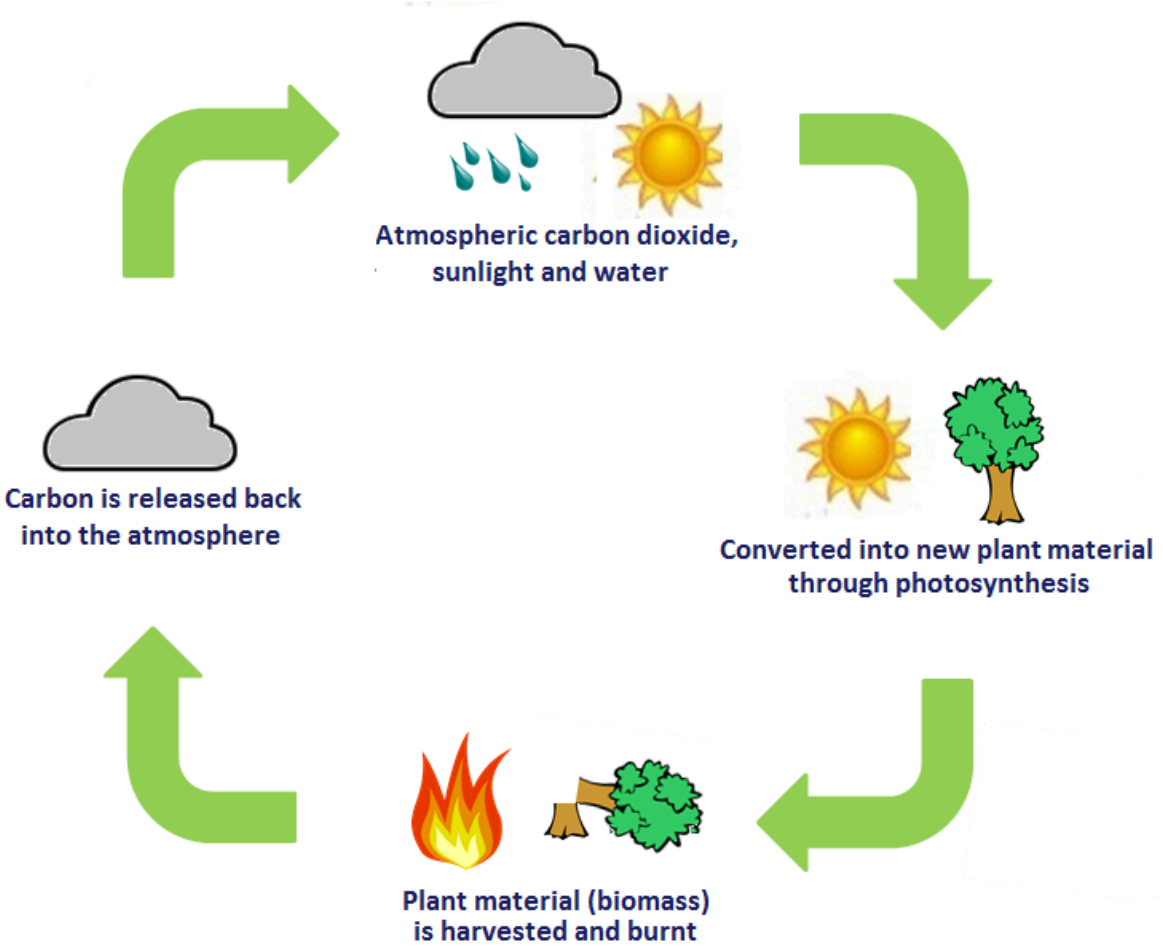
The Building Regulations (England and Wales) comprise of 14 parts.

Seven of these parts may have relevance to heat pump systems installation.

E	**Resistance to the passage of sound**	**Where holes for pipes etc. may reduce sound proof integrity of the building structure**
G	Sanitation, hot water safety and water efficiency	Hot water safety and water efficiency
L	Conservation of fuel and power	Energy efficiency of the system and the building
P	Electrical safety in dwellings	Safe installation of electrical controls and components

The Local Planning Authority should be consulted for clarification, particularly for installations in conservation areas and installations to non-dwelling building types.

Listed Building Consent may be required even if planning permission is not required.



Biomass fuelled systems are generally considered to be carbon neutral. This is because the carbon dioxide released when combustion takes place is equal to the carbon dioxide that was used during tree growing process.

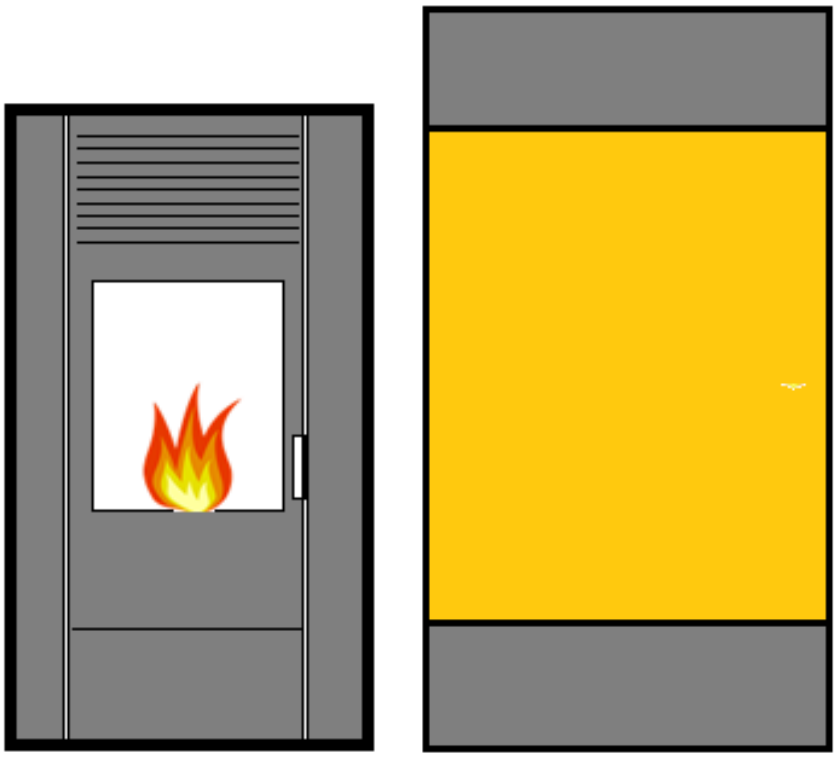
Even when the carbon dioxide produced through the growing, harvesting and transportation processes is taken into account, biomass fuelled systems are extremely carbon friendly when compared to fossil fuelled appliances

Logs		Logs have been used to provide heating for hundreds of years and is the original biomass fuel. Logs for biomass appliances need to be of maximum length and diameter

Wood Chip		Wood Chip is typically produced from the ‘small round-wood’ that is left over when trees are felled and logs are harvested but can also be produced from reclaimed timber
Pellets		Wood pellets are pellets made from fine wood particles such as sawdust. They are cylindrical in shape, typically 6 or 8mm wide (diameter), and 15-30mm long.

Woody Biomass fuels come in three main types

Note: woody biomass fuels must be stored in a dry environment to minimise the fuel moisture content level. Logs and wood chip also require a ventilated storage area

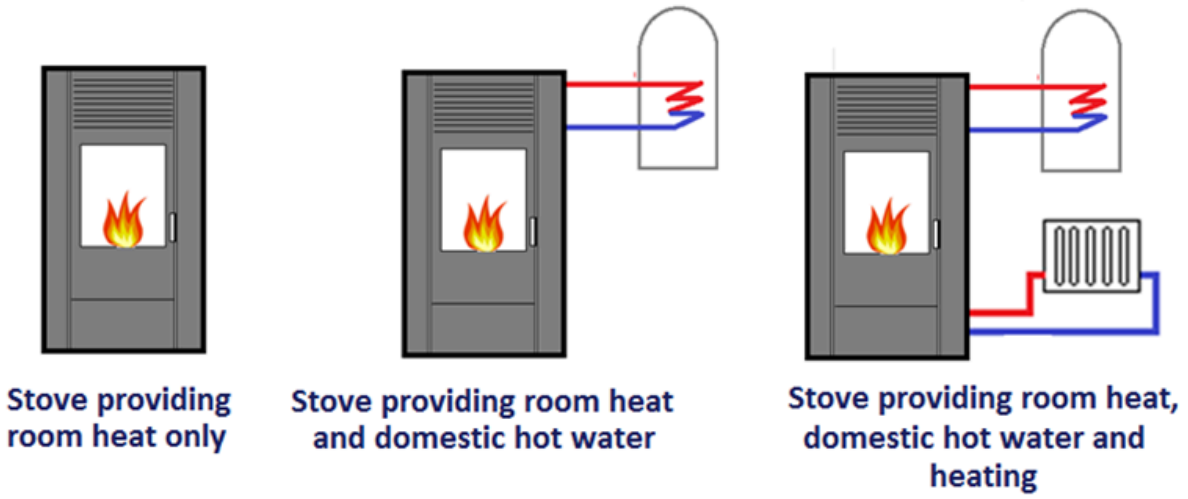


There are two main categories of biomass appliance:

- Biomass stove
- Biomass boiler

Each type of appliance has a range of fuel type and output options

The typical heat capacity range for biomass stoves is 5- 15kW but some stoves can be regulated to outputs as low as 2kW

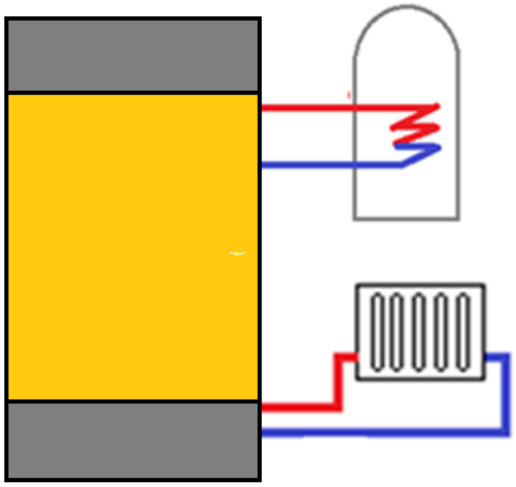


Stove providing room heat only

Stove providing room heat and domestic hot water

Stove providing room heat, domestic hot water and heating

Most biomass boilers also include an automated arrangement to clean the heat exchanger surfaces



For smaller domestic properties, a biomass stove that can provide heat for domestic hot water and space heating purposes is often used.

It is normally cheaper to have large loads of fuel delivered providing suitable storage is available.

The Building Regulations (England and Wales) comprise of 14 parts. Eight of these parts may have relevance to biomass systems installation.

Part	Topic	Relevance or possible relevance
A	Structure	Where the biomass appliance and other components put load on the structure
B	Fire Safety	Where holes for pipes etc. may reduce the fire resistant integrity of the building structure
C	Site preparation and resistance to moisture	Where holes for pipes etc. may reduce the moisture resistant integrity of the building structure
E	Resistance to the passage of sound	Where holes for pipes etc. may reduce sound proof integrity of the building structure

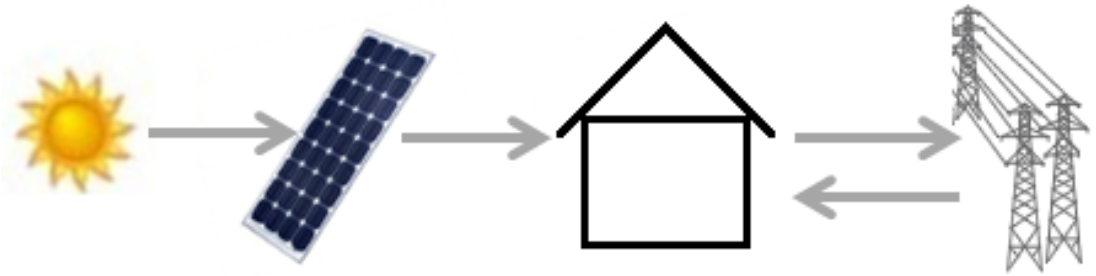
Part	Topic	Relevance or possible relevance
G	Sanitation, hot water safety and water efficiency	Hot water safety and water efficiency
J	Combustion appliances and Fuel Storage system	Biomass appliances are a heat-producing combustion appliances and must be installed safely

L	Conservation of fuel and power	Energy efficiency of the system and the building
P	Electrical safety in dwellings	Safe installation of electrical controls and components

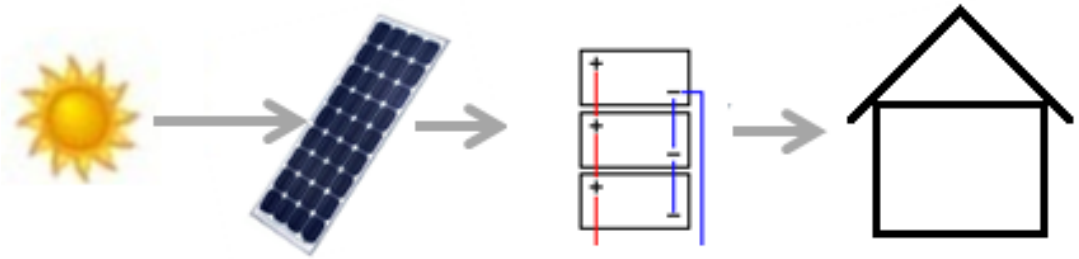
The Secretary of State for Environment, Food and Rural Affairs has powers under the Clean Air Act to authorise smokeless fuels or exempt appliances for use in smoke control areas in England.

Further information is available at http://smokecontrol.defra.gov.uk/

Solar photovoltaic - On Grid



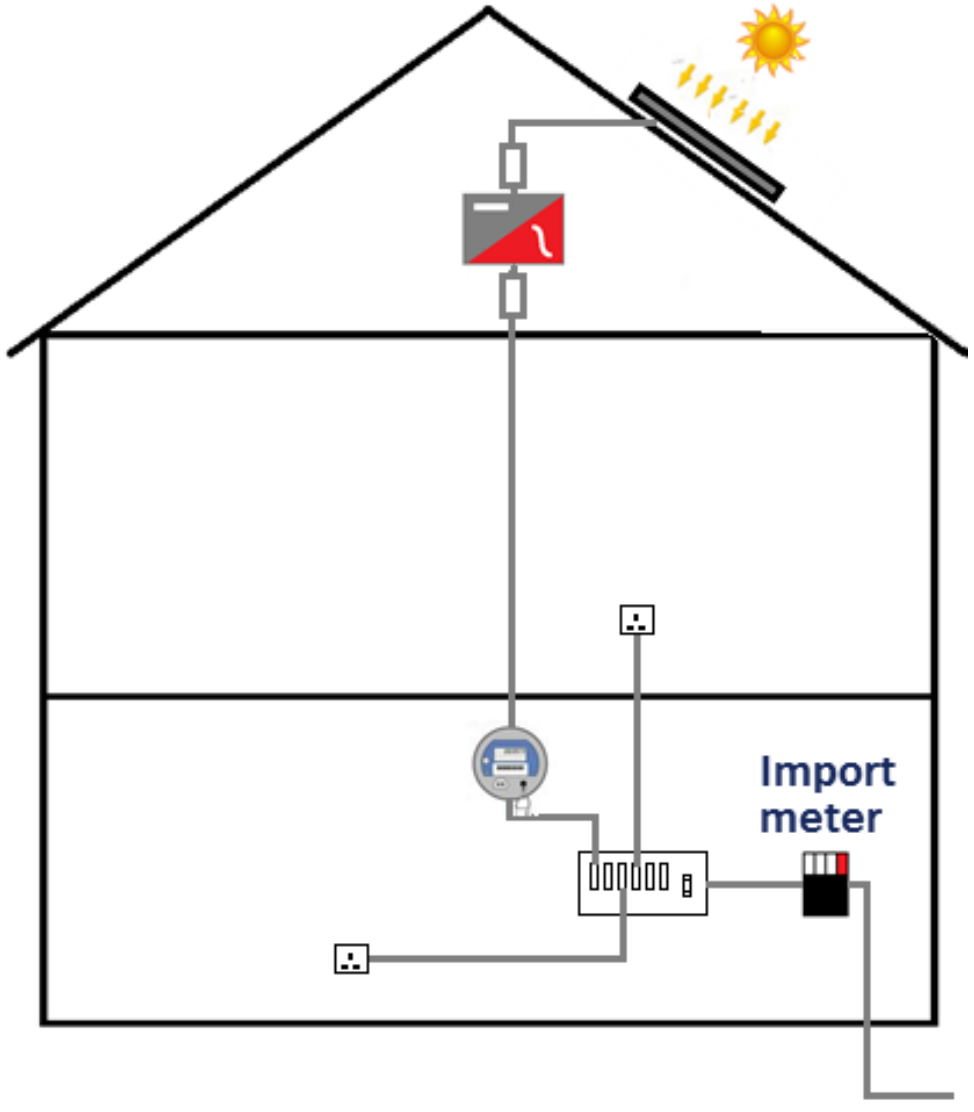
is a zero carbon technology. - Off Grid



'On-grid' systems allow any surplus electricity that is generated to be exported to the electricity distribution grid. This type of system is very popular since the introduction of the Feed-in Tariff scheme

'Off-grid' systems use a battery bank arrangement to store the electrical power generated for use when needed.

Some systems combine 'on' and 'off' grid arrangements.



Example

‘on-grid’ system layout
Roof mounted solar photovoltaic modules can be mounted on the surface of the roof using a rail system or integrated into the roof surface. Some manufacturers also make solar photovoltaic roof tiles.

Part	Topic	Relevance or possible relevance
A	Structure	Where solar photovoltaic modules and other components put load on the structure, in particular wind uplift loads

B	Fire Safety	Where holes for cables etc. may reduce the fire resistant integrity of the building structure
C	Site preparation and resistance to moisture	Where holes for cables etc. may reduce the moisture resistant integrity of the building structure

Part	Topic	Relevance or possible relevance
E	Resistance to the passage of sound	Where holes for cables etc. may reduce sound proof integrity of the building structure
P	Electrical safety in dwellings	Safe installation of electrical controls and components

The Building Regulations (England and Wales) comprise of 14 parts.

Five of these parts have relevance to solar photovoltaic systems installation.

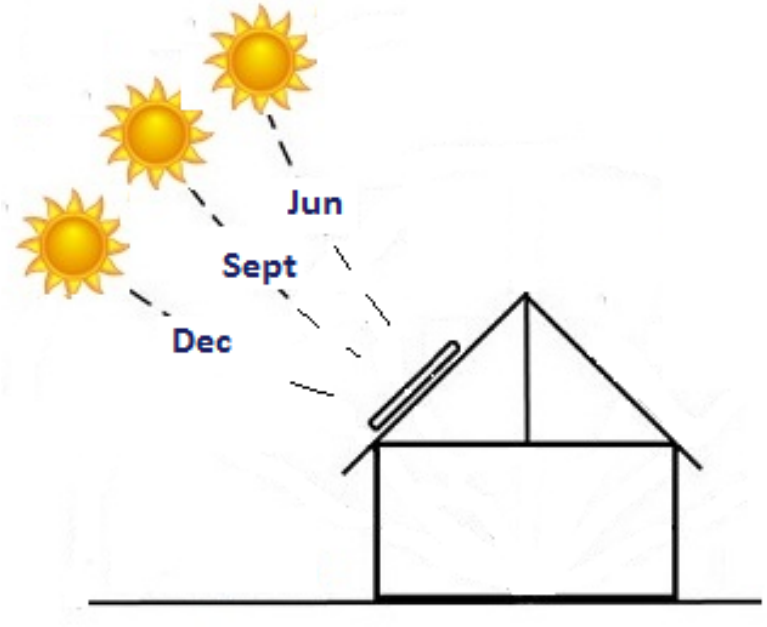
The Local Planning Authority should be consulted for clarification, particularly for installations to flats and non-dwelling building types.

Listed Building Consent may be required even if planning permission is not required.

The installation of building mounted solar photovoltaic arrays is typically classed as permitted development providing :

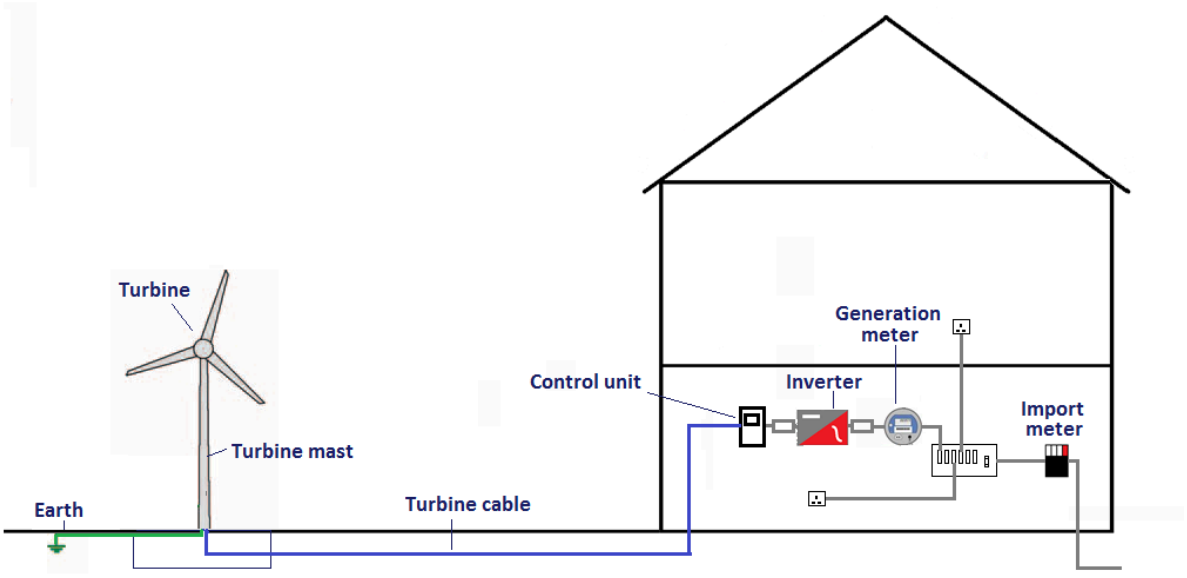
the solar modules are not installed above the ridgeline and do not project more than 200mm from the roof or wall surface.
the solar modules are sited, so far as is practicable, to minimise the effect on the appearance of the building
the solar modules are sited, so far as is practicable, to minimise the effect on the amenity of the area.

the property is not a listed building
the property is not in a conservation area or in a World Heritage Site



Where a pitched roof already exists, the tilt is typically determined by the roof pitch.

Where there is no pitched roof available, it is possible to mount solar photovoltaic arrays on vertical and horizontal surfaces. Solar photovoltaic array may also be mounted on purpose built support frames to provide the required tilt.
Snow loading will need to be considered in some areas



It is also possible to mount micro-wind turbines directly onto the building, although this is not recommended for small buildings or for premises where noise and flicker may be an issue

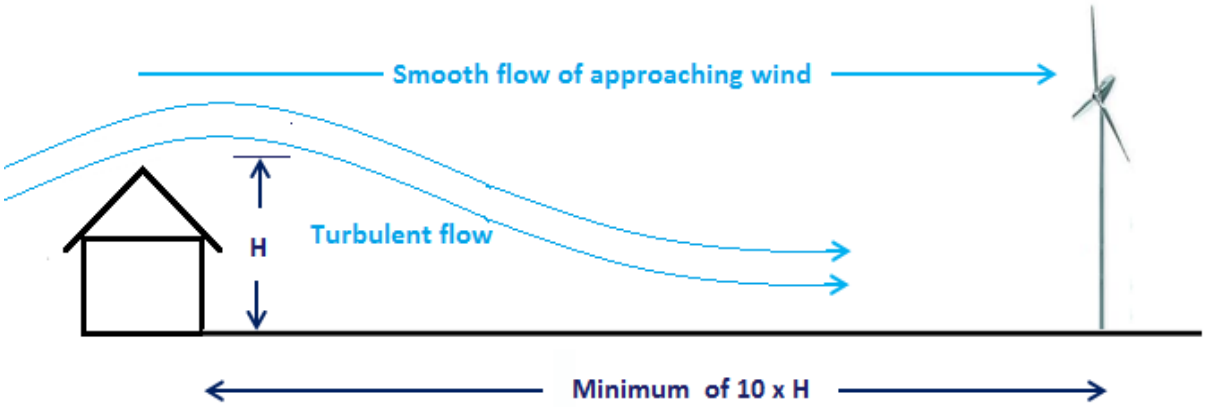
Part	Topic	Relevance or possible relevance

A	Structure	Where micro-wind turbines are mounted on buildings and put load on the structure
B	Fire Safety	Where holes for cables etc. may reduce the fire resistant integrity of the building structure
C	Site preparation and resistance to moisture	Where holes for cables etc. may reduce the moisture resistant integrity of the building structure
E	Resistance to the passage of sound	Where holes for cables etc. may reduce sound proof integrity of the building structure
P	Electrical safety in dwellings	Safe installation of electrical controls and components

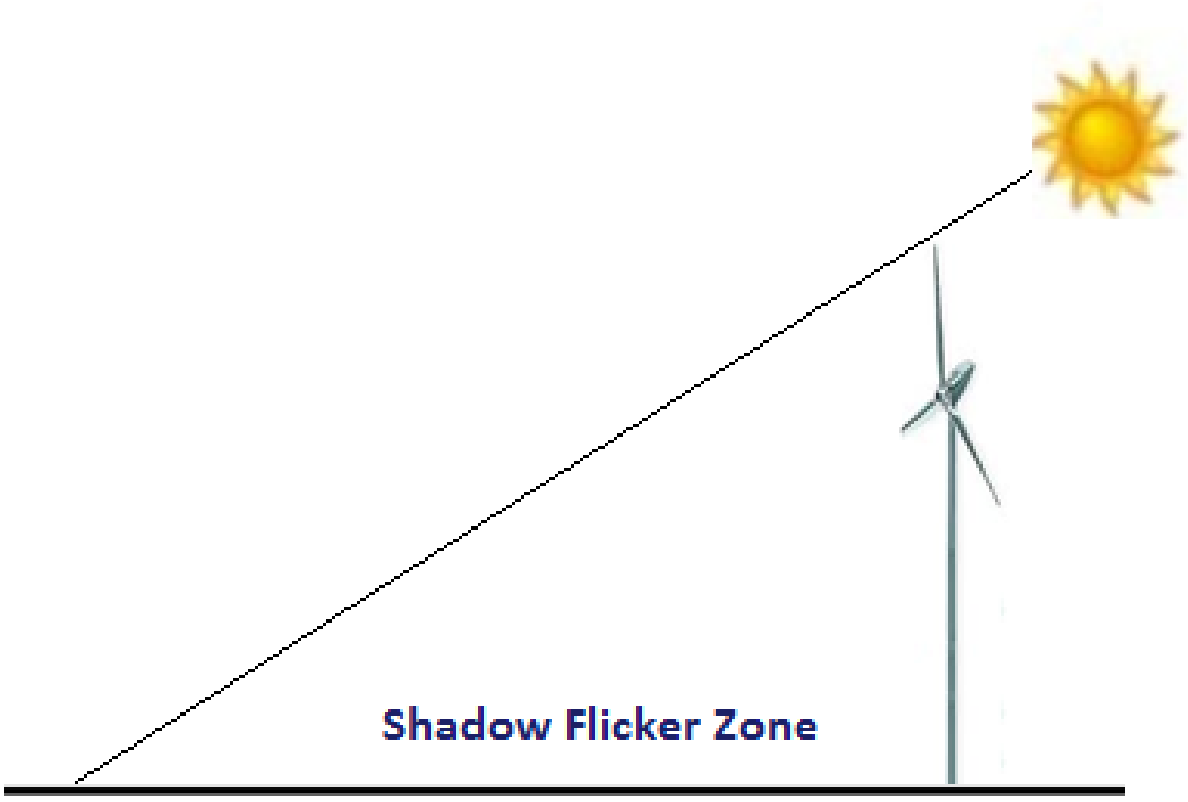
The Building Regulations (England and Wales) comprise of 14 parts.
Five of these parts may have relevance to micro-wind turbine systems installation.
The installation of micro-wind turbines is not classed as permitted development.

At present planning permission is nearly always required to install a micro-wind turbine to a building, or grounds surrounding a building.
Factors that may affect whether permission is granted or not include:

visual impact
noise
vibration
electrical interference (with TV aerials)
safety
The Government is currently reviewing the planning requirements for micro-wind turbines and it is possible that some permitted development will be included in the future.

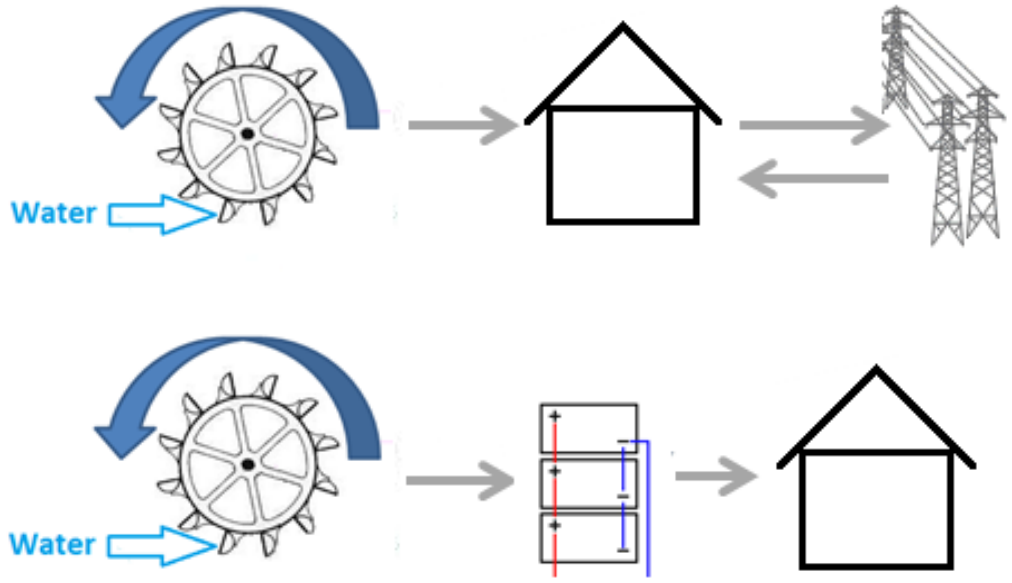


As wind speed typically increases with height, the basic principle is the higher the mounting location the better.



All wind turbines will generate some degree of noise, vibration and shadow flicker which caused by the sun passing across the turbine rotor blades as it spins.

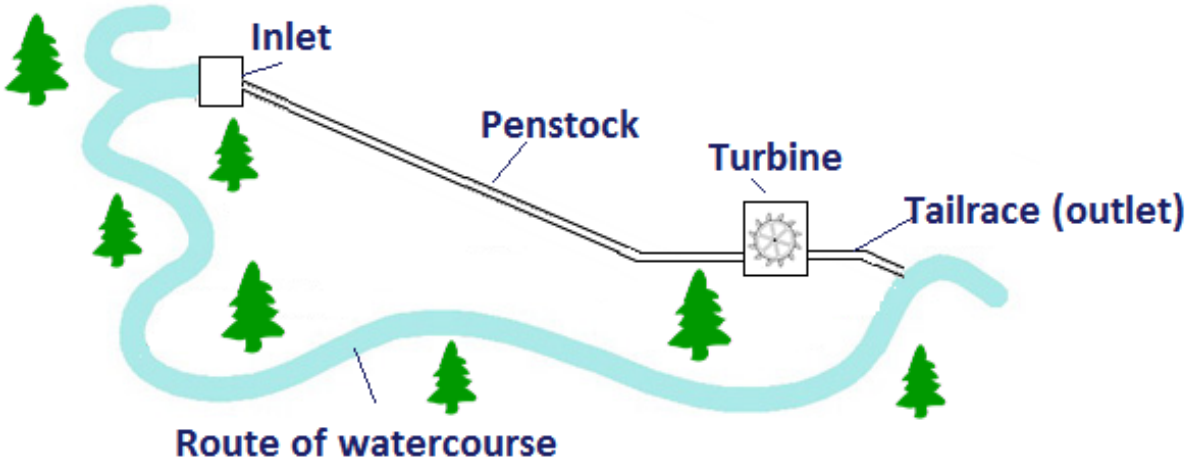
Micro-Hydropower Systems – Basic System Categories



Top on grid, bottom off grid

On-grid' systems allow any surplus electricity that is generated to be exported to the electricity distribution grid. This type of system is included in the Feed-in Tariff scheme

'Off-grid' systems use a battery bank arrangement to store the electrical power generated for use when needed.



The water passes through a pipe known as a 'penstock' to reach the turbine unit.

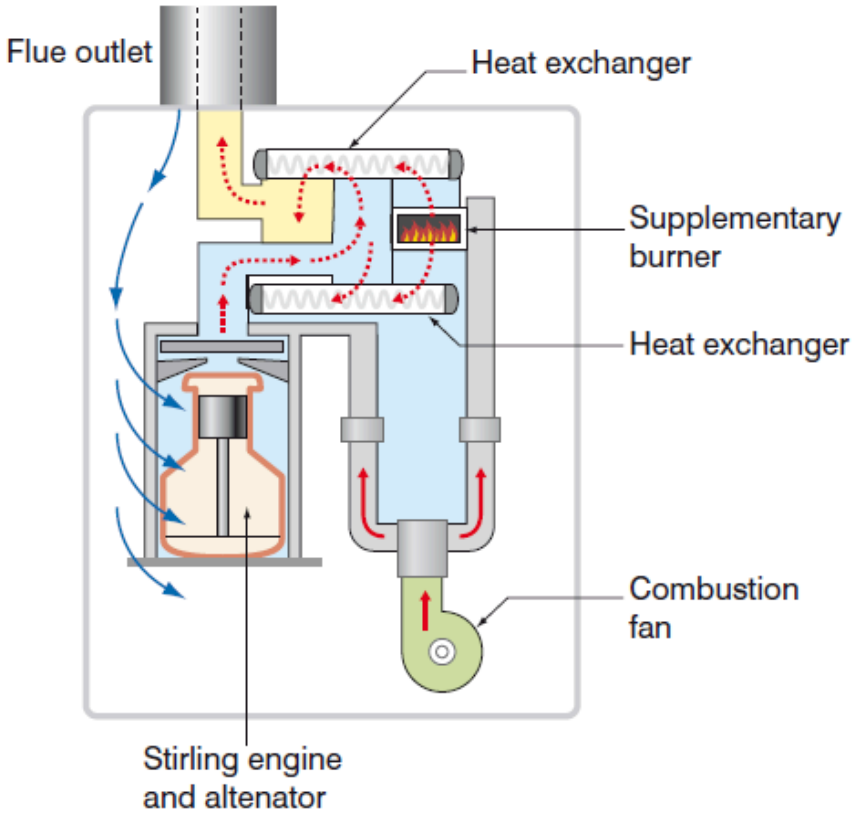
As water passes through the turbine the hydropower is harnessed and electricity is generated.

As water leaves the turbine unit it is returned to the watercourse or another discharge to a suitable location via a outlet known as a tailrace.
The Building Regulations (England and Wales) comprise of 14 parts. Five of these parts may have relevance to micro-hydropower systems installation, depending upon the actual installation details and arrangements. Where a micro-hydropower systems is partly installed in or connected to a habitable building some or all of these parts may apply.

Part	Topic	Relevance or possible relevance
A	Structure	Where any part of the micro-hydropower system puts load on the structure
B	Fire Safety	Where holes for cables etc. may reduce the fire resistant integrity of the building structure

C	Site preparation and resistance to moisture	Where holes for cables etc. may reduce the moisture resistant integrity of the building structure
E	Resistance to the passage of sound	Where holes for cables etc. may reduce sound proof integrity of the building structure
P	Electrical safety in dwellings	Safe installation of electrical controls and components in dwellings

MCHP

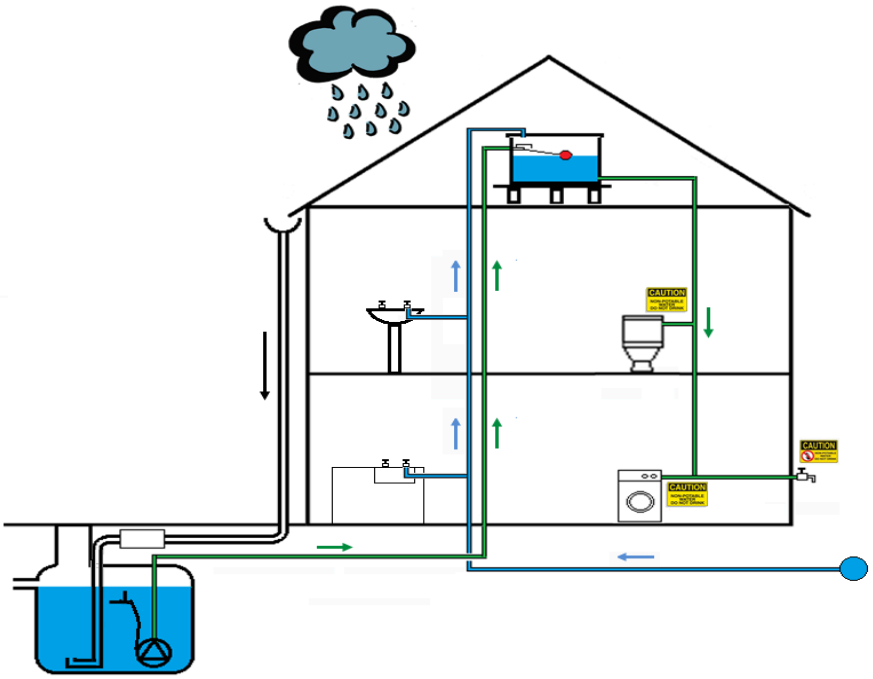


Part	Topic	Relevance or possible relevance
A	Structure	Where the mCHP unit and other components put load on the

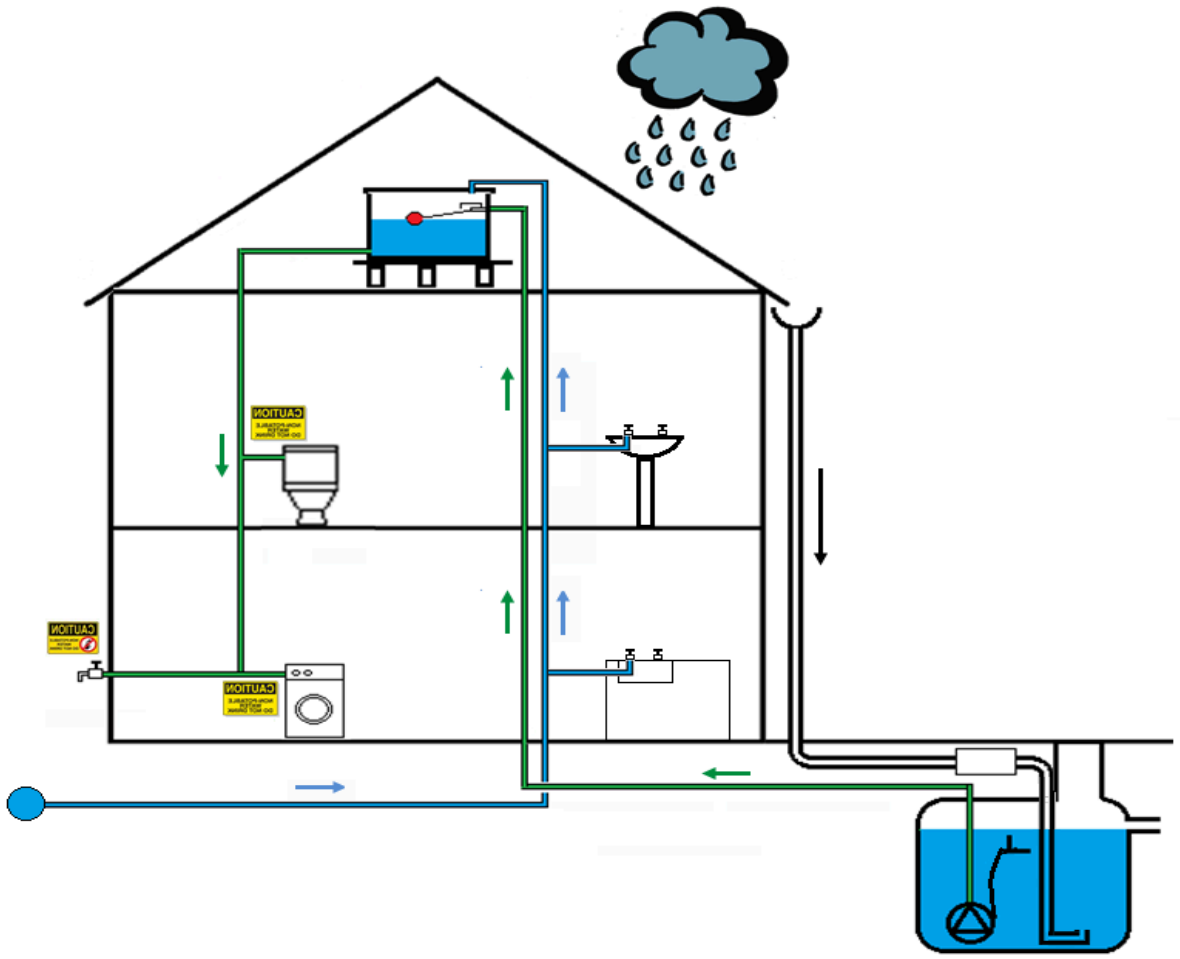
		structure
B	Fire Safety	Where holes for pipes etc. may reduce the fire resistant integrity of the building structure
C	Site preparation and resistance to moisture	Where holes for pipes etc. may reduce the moisture resistant integrity of the building structure
E	Resistance to the passage of sound	Where holes for pipes etc. may reduce sound proof integrity of the building structure

Part	Topic	Relevance or possible relevance
G	Sanitation, hot water safety and water efficiency	Hot water safety and water efficiency
J	Combustion appliances and Fuel Storage system	mCHP units are a heat-producing combustion appliance and must be installed safely
L	Conservation of fuel and power	Energy efficiency of the system and the building
P	Electrical safety in dwellings	Safe installation of electrical controls and components

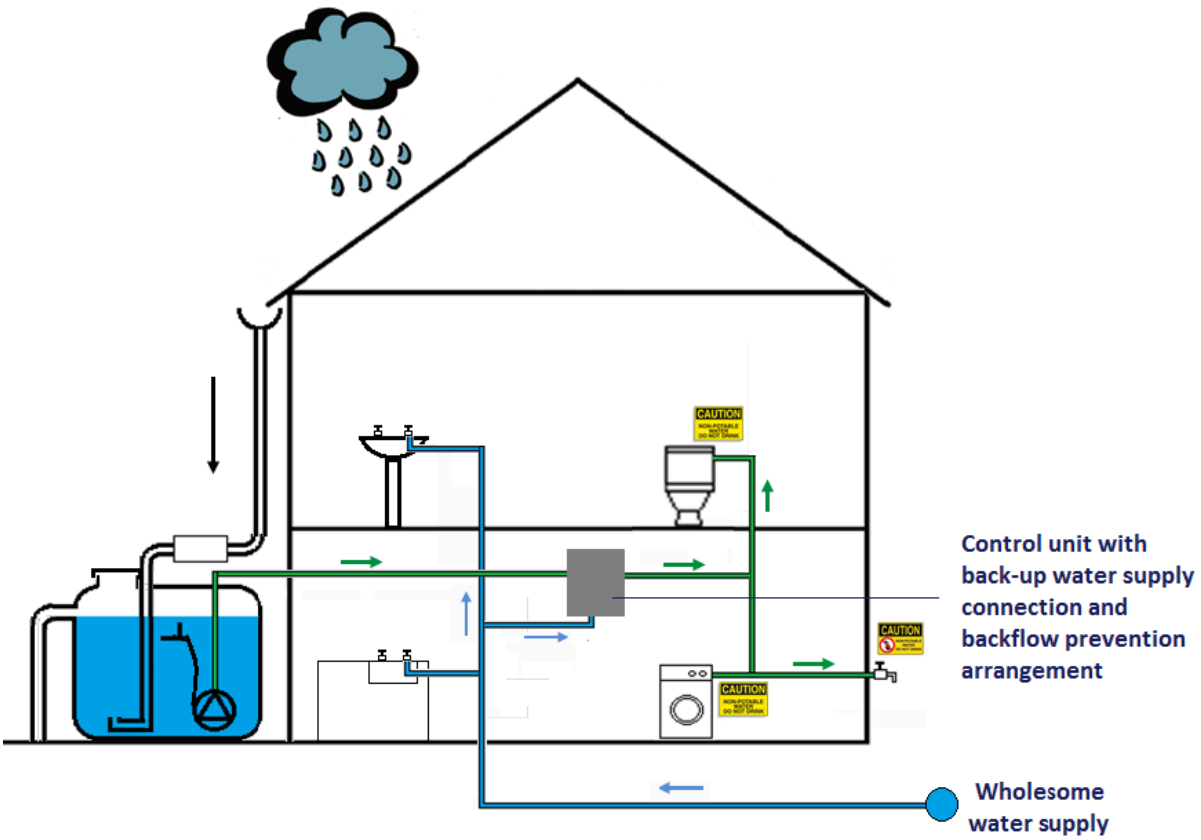
Rainwater



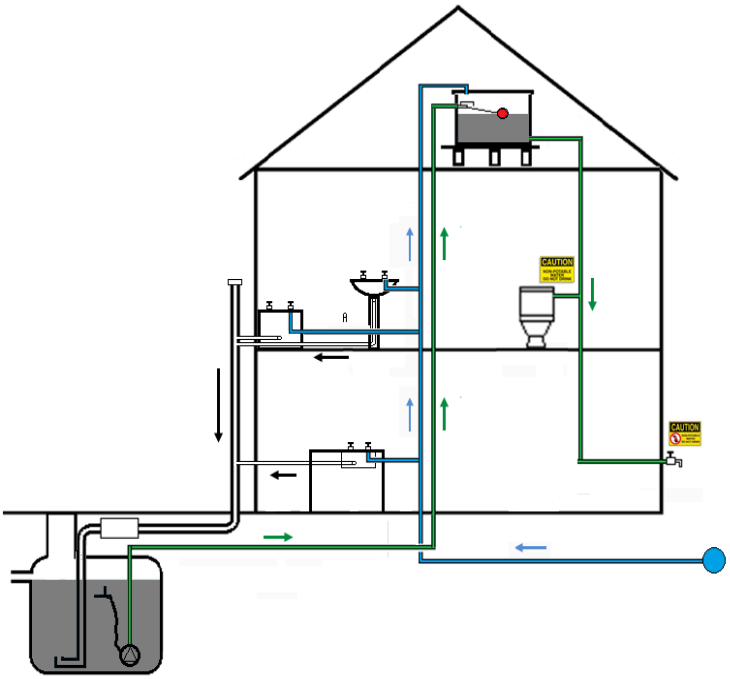
Indirect



Direct



Greywater



As with rainwater harvesting systems, greywater re-use systems are not typically associated

with being a low carbon technology, greywater re-use systems do reduce wholesome (mains) water consumption. Any reduction in usage of wholesome water will also lead to energy savings and a carbon emission reduction through a reduction in treated water consumption.