**Advisors Toolkit**
**Factsheet No 6.a**
Revised 16 Jan 2020

## Renewable Technologies and Planning

Broadly the term ‘microgeneration’ has the meaning given in section 82(6) of the Energy Act 2004 which identifies energy generating equipment with an output of up to 50 kilowatts of electricity or 45 kilowatts of thermal (heat) energy.

There are a number of microgeneration renewable energy technologies that can be incorporated into both new developments and existing homes. These can reduce greenhouse gas emissions (which contribute to climate change) and save money by providing cheap energy and reducing the impact of gas and electricity price rises. Anyone intending to install domestic renewable technologies should be advised to first install ‘traditional’ energy efficiency measures such as cavity wall or loft insulation where possible.

The Town and Country Planning (General Permitted Development) (Domestic Microgeneration) (Scotland) Amendment Order 2011 grants rights to carry out certain limited forms of development on the home, without the need to apply for planning permission. Full details of General Permitted Development Rights for householders can be found here: http://www.gov.scot/Resource/0038/00388268.pdf

The scope of the TCP (GPD) Order in Scotland extends to the following microgeneration technologies:

**Solar PV and solar thermal (roof mounted) is permitted unless:**

- panels protrude more than 200mm when installed
- installed on any part of the external walls of the building if the building contains a flat
- panels, when installed on a flat roof, are situated within 1 metre from the edge of the roof or protrude more than 1 metre above the plane of the roof
- panels, when installed, project higher than the highest point of the roof (excluding the chimney)
- the building is within a conservation area and the solar PV or solar thermal equipment is installed on a roof which forms the front of the building and is visible from the road.

The solar PV or solar thermal equipment must, as far as is reasonably practical, minimise its effect on the amenity of the area and be removed when it is no longer needed or used for domestic microgeneration.

**Solar PV and solar thermal (standalone) is permitted unless it is:**

- more than 4 metres in height
- above a maximum area of array of $9m^2$
- installed a distance from the boundary of the curtilage of the dwelling house which is less than the height of the array
- within the curtilage of a listed building
- within a conservation area and is visible from the road.

The solar PV or solar thermal equipment must, as far as is reasonably practical, minimise its effect on the amenity of the area and be removed when it is no longer needed or used for domestic microgeneration.

**Wood burning boilers and stoves, and micro-CHP is permitted unless:**

- the flue exceeds 1m above roof height (excluding the chimney)
- installed on the principal elevation and visible from a road in buildings in Conservation Areas
- the flue is situated within an Air Quality Management Area (for biomass fuelled systems).

**Ground source heat pumps:**

Permitted

**Water source heat pumps:**

Permitted

**Micro wind turbines and air source heat pumps (ASHP)**

GPD rights extend to the installation, alteration or replacement of a free-standing micro wind turbines and air source heat pumps (ASHP) within the curtilage of a dwelling, which means a dwellinghouse, a building containing one or more flats or a flat contained within such a building. Written approval re the size and design of a wind turbine must be obtained from the planning authority.

The limitations are that:

- the installation must be not less than over 100 metres from the curtilage of a neighbouring dwelling
- development is not permitted if it would result in the presence within the curtilage of a dwelling of more than one installation of each type of technology.

That still provides potential opportunities for one wind turbine and one ASHP within the same curtilage but not more than one of each using permitted development rights. This allows for a wind turbine to provide the electricity to power a heat pump.

*Most renewable technologies must be installed by an appropriately qualified/ registered/approved installer.*

*If planning permission is not required, there are sometimes other approvals that may be required. It is for the individual to ensure that their development complies with relevant legislation. Planning permission is usually required for listed buildings or properties within a conservation area.*

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## Solar Photovoltaic (PV)

Solar Photovoltaic (PV) is a technology in which daylight is converted into electrical power. The most common systems comprise a number of cells (the cells comprise one or two layers of a semi conducting material, usually silicon, which converts solar energy into electrical energy) interconnected to form a solar panel or module. A number of modules are usually connected together in an array. Solar PV systems are sized by their optimum output energy measured as Kilowatt Peak (kWp).

Solar PV can either be roof mounted or free-standing in modular form, or integrated into the roof or façades of buildings as solar shingles, solar slates or solar glass laminates. Solar PV can be connected to the national grid or used as a stand-alone system.

Solar PV:

- Does not produce greenhouse gases or cause pollution when in use. Each kilowatt-peak (kWp) of electricity produced can save approximately 455 kilograms of carbon dioxide emissions compared with electricity generated from fossil fuels
- Has no moving parts, and is low maintenance
- Can be integrated into the building fabric
- Does not require direct sunlight.

The cost of a solar system varies depending on the type of system used and the size of the array installed. A typical array on a family home would produce 1.5 to 3kW peak output (providing approximately half of the household’s electricity needs every year). In grid-connected solar PV systems any surplus electricity can be sold back to the local distribution network with the agreement of the network operator and an electricity supplier.

- See Factsheet 4.l Feed-in Tariffs and Factsheet 4.o Smart Export Guarantee

The optimum location for PV panels is facing south and at a tilt of 35 - 40˚. Direct sunlight is not needed but care must be taken to avoid overshadowing from buildings, trees and other structures. If the roof surface is in shadow for parts of the day, the output of the system decreases.

Solar PV installations should always be carried out by a trained and experienced installer. Solar PV is low maintenance, however wiring and components should be checked regularly by a qualified technician.

Stand-alone systems, i.e. those not connected to the grid, need maintenance on other system components, such as batteries.

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## Solar Thermal / Solar Water Heating

Solar thermal systems use the heat of the sun to preheat domestic hot water. Solar thermal systems comprise a solar collector (usually referred to as a panel), a water distribution system including a pump and controller and a thermal store/hot water cylinder.

Panels come in two main forms: flat plate (the collectors are in a box which is usually glazed and insulated behind); and evacuated tubes (where vacuum glass tubes enclose each pipe and its associated absorber plate acts as the insulation). Flat plate systems tends to be cheaper to buy but evacuated tubes are more efficient.

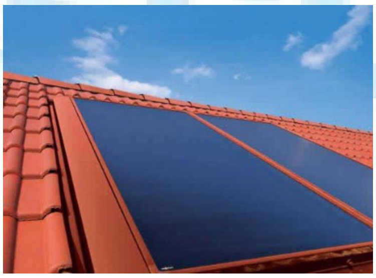
Solar thermal systems:

- can meet almost all domestic hot water requirements during the summer months (approximately half all total annual requirements) for an average household (when sized and sited appropriately)
- have no moving parts (excluding plumbing system parts) and are low maintenance
- produce energy even with diffused sunlight.

The cost of a solar system varies depending on the type of system used and the amount of hot water required. A collector area of 3-5m² is typically installed for a family of four.

For solar thermal panels the optimum location is facing south and at a tilt angle of 30 - 40˚. If the roof surface is in shadow for parts of the day, the output of the system decreases. Solar thermal panels are heavy and the roof must be strong enough to take their weight.

Solar thermal installations may be eligible for the domestic Renewable Heat Incentive (RHI) – see Factsheet 4.e



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## Wind Turbines

Wind turbines convert the power of the wind into electricity, using rotating blades to drive a generator. The electricity produced can be used directly, used to charge batteries or linked directly into the national grid.

The power of a wind turbine increases exponentially in relation to the speed of the wind, and the diameter of the blades. This makes larger turbines with higher wind speeds more cost effective - the energy payback for larger turbines in windy places is multiplied.

There are two types of domestic-sized micro wind turbine:

- mast mounted: these are free standing and are erected in a suitably exposed position
- roof mounted: these are smaller than mast mounted systems and can be installed on the roof of a home

Micro wind turbines may be eligible for Smart Export Guarantee – see Factsheet 4.o

If they are connected to the grid in a location with high wind speeds, consumers can sell excess or surplus generated electricity to an electricity supply company, and earn an added export tariff. If a wind turbine is not connected to the grid, surplus electricity can be stored in a battery. Wind turbines need to be appropriately sited. The issue of intermittency has to be taken into consideration, as well as amenity issues in terms of noise and visual amenity.

NB - Wind turbines need to be sited in appropriately windy and usually exposed locations to operate optimally. Approved installers can advise on the best locations and should be able to provide fairly accurate predictions on energy outputs. Energy outputs for wind are very site-specific, so at least a three month period of advance wind speed testing is recommended, as well as certified products and installation.

The presence and location of a house will have a significant effect on the performance of a micro wind or roof-mounted turbine. The possibility of vibration effects from a roof-mounted turbine should also be investigated.

Wind turbines are not permitted within conservation areas, World Heritage Sites, sites of special scientific or archaeological interest, or within the curtilage of a listed building.  Written approval re size and design must be obtained from the planning authority.

Advice on siting and design is available at
www.scotland.gov.uk/resource/doc/150324/0040009.pdf

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**Ground Source Heat Pumps (GSHP)**

Ground source heat pumps (GSHPs) use pipes which are buried in the garden to extract heat from the ground. This heat can then be used to heat radiators, underfloor or warm air heating systems and hot water in the home.

Heat from the ground is absorbed at low temperatures into a fluid inside a loop of pipe (a ground loop) buried underground. Heat is extracted from the water in a similar way to how a refrigerator works. The fluid passes through a compressor that raises it to a higher temperature, which can then heat water for the heating and hot water circuits of the house. The cooled ground-loop fluid passes back into the ground where it absorbs further heat from the ground in a continuous process as long as heating is required.

Normally the loop is laid flat or coiled in trenches about two metres deep, but if there is not enough space a vertical loop can be installed down into the ground via a borehole to a depth of up to 100 metres for a typical domestic home. Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the ground, the air, or water is constantly renewed naturally, largely by the movement of ground water.

The ground, at 2m deep and lower, stays at a fairly constant 8°C temperature, so the heat pump can be used throughout the year.

Unlike gas and oil boilers, heat pumps deliver heat at lower temperatures over much longer periods. During the winter they may need to be on constantly to heat your home efficiently. Radiators won't feel as hot to the touch as they might do when using a gas or oil boiler. Those installing GSHP need to consider whether a back-up system will also be required.

GSHPs differ in size and complexity, so cost and payback are difficult to specify. Payback is also influenced by: efficiency of the system; the type of system being replaced; energy efficiency of the home; and whether the GSHP is also being used for heating domestic hot water as well as space heating.

The efficiency of a GSHP system is measured by the Coefficient of Performance (CoP). This is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Typically, for every unit of electricity used to pump the heat, 3 to 4 units of heat are produced.

In addition to planning requirements (domestic GSHP are usually a permitted development), consideration needs to be given to the area and type of land and access for machinery.

The Energy Saving Trust has completed field trials of ground and air source heat pumps, in order to get a better idea of how they perform and the savings they achieve in real life environments. Read the final report 'Getting warmer: a field trial of heat pumps' on their website at www.energysavingtrust.org.uk

Some GSHPs (ground-to-water) are eligible for the domestic Renewable Heat Incentive (RHI) – see Factsheet 4.e

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**Air Source Heat Pumps (ASHP)**

Air source heat pumps (ASHP) absorb heat from the outside to heat buildings. There are two types of air source heating systems. Air-to-air systems provide warm air, which is circulated to heat a home. Air-to-water systems heat water to provide heating to a home through radiators or an underfloor system. ASHP can extract some useful heat from air at temperatures as low as minus 15°C.

ASHPs need electricity to run, but they should use less electrical energy than the heat they produce. Typically, for every unit of electricity used to power the pump, 3 to 4 units of heat are produced.

ASHPs extract heat from the outside air, and use it to heat your home and hot water. An air source heat pump has three main parts: an evaporator coil which absorbs heat from the outside air; a compressor which drives the refrigerant through the heat pump, compressing it to increase its temperature and; a heat exchanger which transfers the resulting heat to air (for warm air convection systems) or water (for radiators, underfloor heating or pre-heating water in a storage tank).

ASHPs differ in size and complexity, so cost and payback are difficult to specify. Payback is also influenced by: efficiency of the system; the type of heat distribution system being installed (underfloor heating tends to be more effective); the type of system being replaced by ASHP; energy efficiency of the home; whether ASHP is also being used for heating the domestic hot water supply.

In addition to planning requirements, consideration needs to be given to the installation site (space and air flow).

The Energy Saving Trust has completed field trials of ground and air source heat pumps, in order to get a better idea of how they perform and the savings they achieve in real life environments. Read the final report 'Getting warmer: a field trial of heat pumps' on their website at www.energysavingtrust.org.uk

ASHPs are not permitted within a World Heritage Site or within the curtilage of a listed building. They are not permitted within Conservation Areas unless situated at ground floor level and on the rear elevation of a building.

ASHP are permitted development for a single installation as long as no other building or area designation is in effect.

Some ASHPs qualify for the domestic Renewable Heat Incentive (RHI) – see Factsheet 4.e

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**Water Source Heat Pumps**

Water source heat pumps (WSHP) absorb heat from a source of groundwater to heat buildings. There are two types of WSHP, water-to-air systems provide warm air, which is circulated to heat a home and water-to-water systems heat water to provide heating to a home through radiators or an underfloor system.

A water source heat pump system extracts heat from a local water source and usually operates exactly like ground source heat pumps within a 'closed loop' system. In a closed loop system, the pipe work will simply be sunk to the bottom of a water course. However in some instances a water source heat pump can operate using an 'open loop' system. This involves water being abstracted from a borehole and discharged via a heat exchanger to a river or sewer. These systems can be very efficient because of consistent water temperatures.

The Coefficient of Performance (the units of heat generated for each unit of electricity used) – CoP - of water-to-air heat pumps will depend on the temperature of the source water, but typically lies between 2.8 and 3.7. The CoP of water-to-water heat pumps will depend on the source water temperature and the temperature to which it is being raised, but is typically in the range of 3 and 5.

Possible water heat sources are:

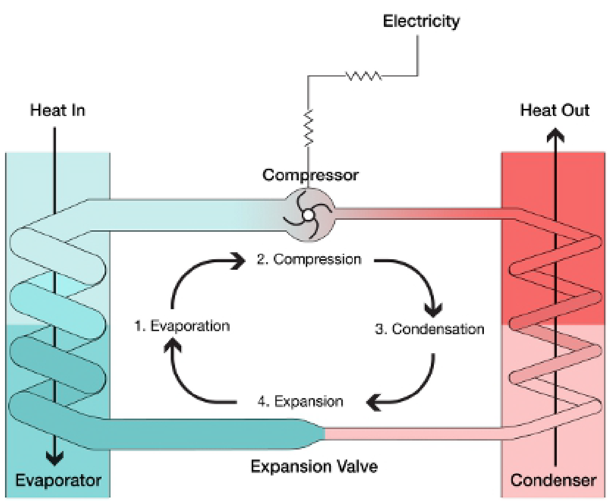
- **Ground water** is available with stable temperatures (4-10°C) in many regions. Open or closed systems are used to tap into this heat source. In open systems the ground water is pumped up, cooled and then re-injected in a separate well or returned to surface water. Open systems should be carefully designed to avoid problems such as freezing, corrosion and fouling. Closed systems can either be direct expansion systems, with the working fluid evaporating in underground heat exchanger pipes, or brine loop systems. Due to the extra internal temperature difference, heat pump brine systems generally have a lower performance, but are easier to maintain. A major disadvantage of ground water heat pumps is the cost of installing the heat source. Additionally, local regulations may impose severe constraints regarding interference with the water table and the possibility of soil pollution.

- **River and loch water** is in principle a very good heat source, but has the disadvantage of low temperatures in winter (close to 0°C). Great care has to be taken in system design to avoid freezing of the evaporator.

- **Waste water and effluent** are characterised by a relatively high and constant temperature throughout the year. Examples of possible heat sources in this category are effluent from sewers (treated and untreated sewage water), industrial effluent, cooling water from industrial processes or electricity generation, condenser heat from refrigeration plants. The major constraints for use in residential and commercial buildings are, in general, the distance to the user, and the variable availability of the waste heat flow. The heat is then delivered to either radiators or fan-coil units within the indoor space.

- WSHP needs electricity to run, but it should use less electrical energy than the heat it produces.
- Water source heat pumps are ideal for new builds, highly insulated renovated houses and houses with underfloor heating.
- Installation costs can be slightly higher than other types of heat pumps. The pipes require space and good depth and some flow of water to refresh the heat collection. Lake source heat pumps have lower running costs and can capture better temperatures from "refreshed" water.
- A heat pump consists of three main elements; the evaporator, the compressor and the condenser. A heat pump uses its ‘evaporator’ to pump energy from outside to inside, raising the internal temperature through releasing heat via an internal ‘condenser’. The diagram below shows how this works.

In essence heat pumps work on the same principle as a refrigerator or freezer. A freezer will extract heat from a food item, even when it is cold, and disperse it through the panels at the back. A heat pump does the same thing.



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## Micro Combined Heat and Power (CHP)

Micro-CHP is a specific form of CHP designed for individual households. It replaces a standard domestic gas boiler, generating heat and electricity simultaneously, from the same energy source. A typical domestic system is expected to have the potential to generate up to 1kW of electricity per hour, which would be enough to power the lighting and appliances in an average home. The amount of electricity generated ultimately depends on how long the system is running.

Most domestic micro-CHP systems use mains gas or Liquid Petroleum Gas (LPG) as a heating fuel, although they can also be powered by oil or biofuels. While gas and oil are not renewable energy sources, the technology is still considered to be a 'low carbon technology' because it is more efficient than just burning the fossil fuel for heat and getting electricity from the national grid.

Micro-CHP systems should always be installed and run to meet the heating needs of the building, rather than to generate more heat than is needed just to meet electricity demand. The electricity generated should be treated as a useful by-product of heat generation. For this reason, electricity will only be generated when there is a heat demand.

Because they only generate electricity when there is a heat demand, micro-CHP systems are more cost effective in houses with large heat demands that cannot be reduced by other means such as upgrading insulation, draught proofing and other low carbon heat technologies such as wood stoves.

Any electricity generated and not used in the home can be exported back to the grid.

Micro-CHP installations may be eligible for Smart Export Guarantee) – see Factsheet 4.o

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**Wood Fueled Heating (Biomass)**

Wood-fueled heating systems, also called biomass systems, burn wood pellets, chips or logs to provide warmth in a single room or to power central heating and hot water boiler. Biomass is produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. It is considered to be a carbon neutral fuel, as trees absorb carbon from the atmosphere when growing, which is then emitted when burnt. Wood fuel includes forest products, untreated wood products, energy crops and short rotation coppice (SRC), e.g. willow.

Homes can either use stand-alone stoves providing space heating for a single room, or boilers connected to central heating and hot water systems. Stoves (which can often be fitted with a back boiler to provide water heating) can be fuelled by logs or pellets but only pellets are suitable for automatic feed. Boiler systems are suitable for pellets, logs or chips. Many boilers will dual-fire both wood chips and pellets, although the wood chip boilers need larger hoppers to provide the same time interval between refuelling. Boilers can be designed with an integral hot water energy storage or accumulator tank that stores water up to 90º C.

As part of the installation a flue which meets the regulations for wood-burning appliances needs to be used. This could be a new insulated stainless steel flue pipe or an existing chimney, though chimneys normally need lining to make them safe and legal. Under the Clean Air Act (1993), in Smoke Control Areas (usually in the main cities) wood can only be burnt on exempted appliances. Installations must comply with the appropriate safety, planning and building regulations i.e. Part J of the Building Regulations.

The cost for boilers varies depending on the fuel choice and payback depends both on the fuel being used and the fuel being replaced.

Consideration must be given to storage space for the fuel, appropriate access to the boiler for loading and availability of local fuel supplies. It is both more cost-effective and sustainable when a local fuel source is used.

Wood-fueled heating (not log stoves or pellet-fueled stoves without a back boiler) may qualify for RHI – see Factsheet 4.e

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## Micro Hydro

Hydro-power systems convert potential energy from water to kinetic energy (the energy used in movement) to turn a turbine to produce electricity. Micro hydro refers to generation capacity below 100kW.

Hydro power requires the water source to be relatively close to where the power will be used, or to a suitable grid connection. Hydro systems can be connected to the main electricity grid or as a part of a stand-alone (off-grid) power system. In a grid-connected system, any electricity generated but not used can be sold to electricity companies. In an off-grid system, electricity can be supplied directly to the devices powered or through a battery bank and inverter set up. A back-up power system may be needed to compensate for seasonal variations in water flow.

Energy available in a body of water depends on the water's flow rate (per second) and the height that the water falls from. The actual output will depend on conversion efficiency (the power of the water into electrical power).

Total system costs can be high but may be less than the cost of a grid connection and with no electricity bills to follow. It should be noted that in off-grid applications the power is used for lighting and electrical appliances. However, space and water heating can be supplied when available power exceeds demand.

Relevant planning authorities, including SEPA, should be consulted to ensure that site and design are acceptable and to identify any other permissions required.

Micro-hydro installations may qualify for Smart Export Guarantee - see Factsheet 4.o