Section Four

MICRO RENEWABLES

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Introduction

Renewable energy can be used to provide hot water, heating and electricity. A number of options are available to householders and communities. They include biomass, solar, heat pumps, wind, hydro, geothermal and combined heat and power. A thermal store can be used to store heat generated and can be particularly useful if several sources are used. To decide which is the most suitable it is necessary to assess the site, storage and other requirements, consider what you want from it and how efficiently it is likely to work in your particular situation. If electricity is produced and sold to the grid you will be paid the feed in tariff (FIT: see handout section 6). The renewable heat incentive (RHI) is planned to pay for hot water generated from 2011.

Microrenewables are most effective in a well insulated home. So good insulation is the first step.

Domestic microrenwables do not normally need planning permission; but homes in conservation areas or listed buildings will need discussion with your planning authority, and sometimes building regulations departments.

Solar thermal water heating. Solar panels of two types can be used; flat panels or evacuated tubes. They supply hot water into a large, very well insulated tank. They need clear sunshine to work best.

Solar Photovoltaic panels produce electricity. Both types of solar heating need an unshaded south facing roof. Clear sunshine works best but there is some production on bright days.

Wood fuel is carbon neutral. Stoves need adequate ventilation and dry wood to work properly. With a back boiler a wood stove can provide hot water and heat radiators. Wood stoves and boilers can run on logs, wood pellets or chips.

Heat pumps run on electricity, extracting heat from the air, ground or water.
They produce more energy than they use and are effective in well insulated homes.

Wind turbines need suitable conditions to be effective.

Hydro systems need consistent flow and drop.

Combined heat and power (CHP). These installations simultaneously generate usable heat and power (electricity) in a single process. It is a technology still in development

All the figures in the tables come from the EST website.

Biomass (wood) stoves and boilers

Biomass is produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. It is often called 'bioenergy' or 'biofuels'. For small-scale domestic use the fuel usually takes the form of wood pellets, wood chips or wood logs.

Producing energy from biomass has both environmental and economic advantages. It is a carbon neutral process as the CO_2 released when energy is generated from biomass is balanced by that absorbed during the fuel's production, if the plants burnt for fuel are replaced.

Biomass can also contribute to waste management by harnessing energy from products that are often disposed of at landfill sites.

Applications

There are two main ways of using biomass to heat a domestic property:

- stand-alone stoves providing space heating for a room or part of a house, burning logs or pellets (shop around for pellets and make sure the system you are having installed will work with this type of fuel). Generally stoves are of 6-12 kW in output, and some models have a back boiler which will provide domestic hot water for radiators. A big wood stove can provide all your hot water and heating if you want to keep it on all the time.
- boilers connected to central heating and hot water systems. These are suitable for pellets, logs or chips, and are generally larger than 15 kW.

For buildings with a higher space heating requirement, larger wood chip boilers and log batch burners become viable. Wood (usually in the form of chip) can also be used in district heating systems whereby a central boiler provides heat for several properties.

Most log burning stoves and boilers have to be filled with wood by hand. Some pellet and chip burners use automatic fuel feeders which refill them at regular intervals from fuel storage units called hoppers. It's important that dry wood is used for maximum efficiency (and less air pollution).

Costs and savings

Costs for a standalone stove will depend on the size of the stove and other factors, but could be in the range £1,500 to around £3,000 including installation. DIY is cheaper, but requires a significant level of knowledge and skill. A typical automatically fed boiler for an average home costs around £9,000 including installation and fitting a suitable flue. Manually fed log systems are slightly cheaper. The automatic feed boilers may be eligible for an income from the renewable heat incentive, but a wood stove is cheaper and as effective. Savings in CO2 emissions are dependent on usage but can be significant - up to 9.6 tonnes per year when a wood boiler replaces a solid (coal) fired system.

Fuel savings are less significant, and if you replace a gas heating system with a wood burning system you may end up paying more for your fuel. But if you replace solid fuel or electricity you could save between £170 and £410 per year. The cost of wood heating varies a lot, and logs can be very cheap if you have access to free wood and enough space to store it until it is dry. For a list of wood fuel suppliers in your area, see the classified ads in your local paper or visit the log pile website (*www.nef.org.uk/**logpile***)

Types of wood fuel

Wood fuel	Comments
Logs	Cheapest form of wood fuel Most labour intensive
Chip	Typically 30kW boilers and over Suitable for larger buildings due to space requirements and boiler size
Pellets	Most expensive Most convenient Requires least storage space Needs to be dry

Is a wood fuelled heating system suitable for your home?

To tell if wood-fuelled heating is right for you, there are a few key questions to consider:

- **do you have appropriate space for a wood fuel boiler?**
- **do you have enough storage space?**
- **do you have a suitable flue?** You need a vent which is specifically designed for wood fuel appliances, with sufficient air movement for proper operation of the stove. Your existing chimney can be fitted with a lined flue, which is relatively inexpensive
- **do you live in a smokeless zone?**

You might need planning permission if an outside flue will be required, or if it will extend 1m or more above the height of your roof. There may be conditions that apply to you if you live in a conservation area.

Building Regulations apply to biomass appliances. You should take into account factors such as ventilation, noise and general safety as well as other aspects such as electrical installation and plumbing work.

Solar thermal and solar photovoltaic systems

1. Solar thermal

Solar water heating uses energy from the sun to work alongside your conventional water heater. Panels or vacuum tubes can be used to produce hot water for domestic use, not for heating.

Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles.

Solar water heating can be used in the home or for larger applications, such as swimming pools. You will need 3-4 square metres of southeast to southwest facing roof receiving direct sunlight for the main part of the day for a typical domestic system. You may also need space to locate an additional water cylinder.

It is possible to install solar panels as a DIY job, if you have the necessary skills. But for most people they will need to be installed by a trained and experienced installer. A NAPIT accredited installer is required to be eligible for the feed in tariff.

Benefits of solar hot water

- Hot water throughout the year: the system works all year round, though you'll need to heat the water further with a boiler or immersion heater during the winter months.
- Cut your bills: sunlight is free, so once you've paid for the initial installation your hot water costs will be reduced
- Cut your carbon footprint: solar hot water is a green, renewable heating system and doesn't release any harmful carbon dioxide or other pollutants

To tell if solar water heating is right for you, there are a few key questions to consider:

- **do you have a sunny place to put solar panels?** You'll need around 5 square metres of roof space (less for vacuum tubes) which faces east to west through south and receives direct sunlight for the main part of the day. Alternatively, if you do not have a south facing roof and if you have space, you could install two panels, one facing east and one facing west - but this will make installation more costly. The panels don't always have to be mounted on a roof; they can be fixed to a frame on flat roofs or on the ground.
- **do you have space for a larger, or an extra, hot water cylinder?** If a dedicated solar cylinder is not already installed then you will need to replace the existing cylinder, or add a dedicated cylinder with a solar heating coil.
- **is your current boiler compatible with solar water heating?** Most conventional boiler and hot water cylinder systems are compatible with solar water heating. If your boiler is a combination boiler (combi) and you don't currently have a hot water tank then a solar hot water system may not be compatible.
- **do you need planning permission?** *(see section 2)*

Costs and savings

Costs for a typical solar water heating system range from £3,000 to £5,000. Vacuum tubes cost a bit more. Savings are moderate. A solar water heating system can provide about a third of your hot water needs, reducing your water heating bill by between £50 and £85 per year. It will also save up to 580kg of CO2 emissions, depending on what fuel you will be replacing. Maintenance costs are very low. Most solar water heating systems come with a 5-10 year warranty and require little maintenance. You should take a look at your panels every year and have them checked more thoroughly by an accredited installer every 3-5 years, or as specified by your installer.

Fuel displaced	£ saving per year	CO2 saving per year
Gas	£50.00	200kg

Electricity	£85.00	580
Wood	£50.00	320
Solid	£65.00	530

2. Solar photovoltaic (PV)

Solar photovoltaic uses energy from the sun to create electricity to run appliances and lighting. It requires only daylight - not direct sunlight - to generate electricity. PV cells are panels you can attach to your roof or walls. Each cell is made from one or two layers of semiconducting material, usually silicon. When light shines on the cell it creates an electric field across the layers. The stronger the sunshine, the more electricity is produced. PV cells come in a variety of shapes and colours, from grey "solar tiles" that look like roof tiles to panels and transparent cells that you can use on conservatories and glass. The strength of a PV cell is measured in kilowatt peak (kWp) - that's the amount of energy the cell generates in full sunlight. Solar panels are not light and the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles *(see* Building Regulations in section 2). They should always be carried out by a trained and experienced installer.

Benefits of solar electricity

- It cuts your carbon footprint: solar electricity is green, renewable energy and doesn't release any harmful carbon dioxide or other pollutants. A typical home PV system could save around 1200 kg of carbon dioxide per year - that's around 30 tonnes over its lifetime.
- It cuts your electricity bills: sunlight is free, so once you've paid for the initial installation your electricity costs will be greatly reduced. A typical home PV system can produce around 40% of the electricity a household uses in a year.
- You can sell electricity back to the grid: if your system is producing more electricity than you need, or when you can't use it, someone else can use it - and you could make a bit of money (see Feed in Tariffs section 6)
- You can store electricity for a cloudy day: if your home isn't connected to the national grid you can store excess electricity in batteries to use when you need it.

To tell if solar PV is right for you

- you will need enough roof space to take the large panels (you will need 8-10 for an average installation).
- do you have a sunny roof? (See solar water heating).
- do you have a grid connection? If not, you will need to store the electricity in batteries, or a thermal store.

Costs and savings

Costs for installing a solar electricity system vary a lot - an average system costs between £8,000 and £14,000, depending on its size and type. A 2kWp system can provide around 40% of your yearly needs. You can save almost a tonne of CO2 a year and around £200 off electricity bills, and have electricity to sell to the grid – to a total value of about £1000 per year. Panels built into a roof are more expensive than those that sit on top but if you need major roof repairs PV tiles can offset the cost of roof tiles.

Heat pumps

Heat pumps can produce heat from a number of sources, principally the air and the ground. There are also water source heat pumps, which are very much less common and about which there is little technical information. Heat pumps run on electricity but produce more power than they use. This section deals with the first two types of heat pumps.

1. Air source heat pumps

Air source heat pumps absorb heat from the outside air. This heat can then be used to warm water for radiators or underfloor heating systems, or to warm the air in your home directly. The heat pumps extract heat from the outside air in the same way that a fridge extracts heat from its inside. They can extract heat from the air even when the outside temperature is as low as minus 15° C, although at this temperature the efficiency of the system will be greatly affected.

There are two main types:

- **an air-to-water system** uses the heat to warm water. Heat pumps heat water to a lower temperature than a standard boiler system would, so they are more suitable for underfloor heating systems than radiator systems.
- **an air-to-air system** produces warm air which is circulated by fans to heat your home.

The efficiency of air source heat pump systems is measured by a coefficient of performance (CoP), which is the amount of heat they produce compared to the amount of electricity needed to run them. A typical CoP for an air source heat pump is around 2.5. Ideally you need a low temperature demand.

Benefits of air source heat pumps

- **reduce your fuel bills:** air source heat pumps run on electricity, so there's no need to pay for gas, oil or solid fuels to heat your home.
- **cut down on wasted electricity:** heating your home with an air source heat pump is much more efficient than using electric radiators.
- **save space:** an air source heat pump system is compact, and requires no storage space for fuel.

To tell if an air source heat pump is right for you, there are a few key questions to consider:

- **do you have somewhere to put it?** You'll need a place outside your house where a unit can be fitted to a wall or placed on the ground. It will need plenty of space around it to get a good flow of air.
- **is your home well insulated?** Since air source heat pumps produce less heat than traditional boilers, it's essential that your home is well insulated and draught-proofed for the heating system to be effective.
- **what fuel will you be replacing?** The system will pay for itself much more quickly if it's replacing an electricity, Liquid Petroleum Gas (LPG) or coal heating system than a gas or oil one.
- **what type of heating system do you want?** Air source heat pumps are much better at powering underfloor heating systems or warm air heating than radiator-based systems.
- **is the system intended for a new development?** Combining the installation with other building work can reduce the cost of installing the system.

Costs and savings

Costs for installing a typical air to water system suitable for a detached home range from about £5,000 to £9,000 including installation. Air to air systems cost about £2000.

Running costs for space heating and hot water for washing are likely to be around £790 per year. This will vary depending on a number of factors - including the size of your home and how well insulated it is. Savings can be considerable - up to 5 tonnes of CO2 and £700 per year for a system that replaces an electric heating system.

Fuel displaced	£ saving per year	CO2 saving per year
Gas	£50.00	No saving
Electricity	£700.00	5 tonnes
Oil	£20.00	No saving
Solid	£460.00	4.6 tonnes

2. Ground source heat pumps

A ground source heat pump circulates a mixture of water and antifreeze around a loop of pipe - called a ground loop - which is buried in the garden. When the liquid travels around the loop it absorbs heat from the ground which is used to heat radiators, underfloor heating systems and even hot water. It can also be used to pre-heat water before it goes into a more conventional boiler. Beneath the surface, the ground stays at a constant temperature, so a ground source heat pump can be used throughout the year - even in the middle of winter.

The length of the ground loop depends on the size of your home and the amount of heat you need - longer loops can draw more heat from the ground. Normally the loop is laid flat, or coiled in trenches about two metres deep, but if there is not enough space in your garden you may be able to install a vertical loop to a depth of up to 100 metres.

The efficiency of a ground source heat pump is measured by a coefficient of performance (CoP) - the amount of heat it produces compared to the amount of electricity needed to run it. A typical CoP for a ground source heat pump is around 3.2 without any reductions for the type of distribution system. A higher CoP gives greater costs and CO2 savings.

Benefits of ground source heat pumps

- **eliminate your fuel bills:** ground source heat pumps run on electricity, so there's no need to pay for gas, oil or solid fuels to heat your home.
- **cut down on wasted electricity:** heating your home with a ground source heat pump is much more efficient than using electric radiators.
- **reduce your CO_2 emissions**: on average a ground source heat pump could save around 540kg of carbon dioxide every year when replacing an oil boiler.

To tell if a ground source heat pump is right for you, there are a few key questions to consider:

- **is your garden suitable for a ground loop?** It doesn't have to be particularly large, but the ground needs to be suitable for digging a trench or a borehole and accessible to digging machinery.
- **is your home well insulated?** Since ground source heat pumps only run efficiently at a lower temperature heat than traditional boilers, it's essential that your home is well insulated and draught proofed for the heating system to be effective. It could also make the system cheaper and smaller.
- **what fuel will you be replacing?** If you're replacing an electric, oil, Liquid Petroleum Gas (LPG) or coal heating system, a ground source heating system will pay for itself quite quickly (probably over 10 years). If you're replacing a gas heating system, your savings will be much smaller.
- **what type of heating system do you want?** Underfloor heating systems or warm air heating will work much better than radiator-based systems.
- **is the system intended for a new development?** Combining the installation with other building work can reduce the cost of installing the system.

Costs and savings

Fuel Displaced	£ Saving per year	CO2 saving per year
Gas	£190	No saving
Electricity	£840	6 tonnes
Oil	£160	540kg
Solid fuel	£600	5.6 tonnes

Costs of installing a typical system range from about £7,000 to £13,000. Running costs for a year, where all hot water and space heating can be provided by the system are likely to be around £650 per year, but will depend on a number of factors, including the size of your home and how well insulated it is. Savings can be considerable - up to 540kg of CO2 and £160 if you're replacing an oil-fired central heating system. To save more money on running costs, and to reduce your home's CO2 emissions further, consider installing solar electricity or some other form of renewable electricity generating system to power the compressor and pump.

Micro combined heat and power

Micro CHP systems simultaneously generate usable heat and power (electricity) in a single process and it is a technology still in development. Currently micro CHP systems are mainly used in new large housing developments. However, systems are available which are suited to use in single dwellings, and range in size from around 4kW heat output (suited to small, well insulated dwellings) up to 36kW (these units will incorporate a supplementary boiler for additional heat output in larger or hard to heat dwellings). Electrical power output is typically 1kW to 3kW and is grid-connected.

Costs and savings

Costs for an installation start at around £2500 for smaller (1kWe) units to around £3500, plus any work required to the heat distribution network .The maximum total fuel cost and carbon savings are around £150 per annum, compared with a conventional gas-fired boiler. This is more widely used in other countries but could also be developed here.

MCHP is suitable in any dwelling where conventional gas boilers can be used. Maintenance is comparable to gas boilers (up to £150 per annum). An annual service is recommended. The lifetime of an installation is around 15 years.

More information can be obtained from the Energy Saving Trust.

Micro or small wind turbines

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

There are two types of domestic-sized wind turbine:

- **mast-mounted:** these are free standing and are erected in a suitably exposed position, often around 2.5kW to 6kW
- **roof-mounted:** these are smaller than mast mounted systems and can be installed on the roof of a home where there is a suitable wind resource. Often these are around 1kW to 2kW in size.

If your small wind system is connected to the National Grid then you can make money by selling any generated electricity to an electricity supply company. The Feed in Tariff will pay for each unit of electricity you generate using this technology for 25 years. If the turbine is not connected to the electricity grid then unused electricity can be stored in a battery for use when there is no wind.

NOTE: many experts do not believe that roof mounted turbines work efficiently in most situations

Costs and savings

Costs for a roof mounted micro-wind system start at about £1,500. Larger mast mounted systems could cost between £11,000 and £19,000, including installation (the suitability of the site affects costs). These provide enough electricity for lighting and appliances in a typical home. There are a number of types of wind turbine, and it is recommended that you research which would be the most appropriate for you. The Microgeneration Certification Scheme gives information on available products.

Savings can be significant. Recent monitoring of a range of small domestic wind systems has shown that a well sited 2.5kW turbine could save around £380 a year on electricity bills when some electricity generated is sold to the grid, and a saving of around 2.6 tonnes of carbon dioxide per year.

Maintenance checks are necessary every few years, and a well-maintained turbine should last over 20 years. Battery storage life is typically between 6 and 10 years.

To tell if a small scale domestic wind turbine is right for you, there are a few key questions to consider:

- **are there any large obstacles like buildings, trees or hills near your home?** Small domestic wind turbines work best in exposed locations, without turbulence caused by these type of obstacles
- **is your home is a windy area?** To be effective you need an average windspeed of no less than 5m/second.
- **is your home located away from the National Grid?** Small domestic wind systems are particularly suitable for use in remote locations where mains electricity is unavailable.
- **do you need planning permission?** *(See separate sheet)* Permission is specific to a site and the proposed turbine, and it helps to be well informed when applying.
- **What are your energy needs?** As electricity is not good for heat generation it is worth considering other renewable energy sources as well if you mainly want to generate heat.

Small hydro schemes

Small hydro-electricity systems generate electricity from running water - usually a small stream. Small systems can produce enough electricity for lighting and electrical appliances in an average home.

Hydro power systems use running water to turn a small turbine which generates electricity. The faster the water flows and the more water there is, the more electricity can be generated. The amount of electricity a system actually generates depends on how efficiently it converts the power of the moving water into electrical power.

To tell if a hydro system is right for you, there are a few key questions to consider:

- **is there a river or steam close to your home?** You'll need access to a fairly fast flowing water course, and the right to build around it
- **does the water flow vary significantly during the year?** If so, the hydro system may not be able to supply you with all the electricity you need during dry months. If you're not connected to the electricity grid, you'll need a backup power system.
- **do you want to sell excess energy?** Hydro systems can be connected to the National Grid if a suitable connection point is available. Any electricity you generate but don't use can then be sold to electricity companies.

Costs and savings

Costs for installing a hydro system vary a lot, depending on the location and the amount of electricity it can generate. A typical 5kW scheme suitable for an average home might cost £20,000 - £25,000 including installation. Depending on the site and water availability the costs can be greater.

Savings depend on the amount of hydroelectricity that is used in place of electricity bought from another source. If the hydro system replaces electricity bought from the National Grid then typical savings could be substantial, but initial costs are high. It's important to get expert advice on the suitability of the site and the effectiveness of any system considered.

Maintenance costs vary but are usually low as hydro systems are very reliable.