Small Scale Renewables

Practical Guide

There are many opportunities for small scale renewables to provide a source of heat or power for the farm.

Using renewables reduces the demand for energy produced by burning fossil fuels. This results in less harmful greenhouse gas (GHG) emissions, savings on fuel bills and may help to reduce the farm's carbon footprint.

With the introduction of Feed-in Tariffs (FITs) and the Renewable Heat Incentive (RHI), renewables have become more widely adopted. Under the FITs scheme, a fixed rate payment is made for every kWh of electricity generated. Any excess electricity can be 'sold' back to the national grid. The RHI makes a payment for eligible heat use from renewable sources.

Small scale renewables are worth considering, especially if you are planning any renovations, building a new house or converting a steading. New developments should consider orientation in relation to solar gain and cooling, natural day-lighting and ventilation, plus the energy efficiency of the construction materials to make the most of energy use.

Renewable technologies can be useful for remote properties where the farm is 'off-grid' and unable to connect to mains electricity or gas. On-farm renewables can also form part of a wider group investment or community scheme.

Top tips for every farm:

✓ Assess current energy use. An energy audit will identify losses and assess energy and heat needs

✓ Consider renewables when planning a new building or a conversion - it's usually easier to install at the start rather than retrofit

✓ Small scale renewables may be useful for off-grid situations

✓ Most schemes, especially wind, hydro and solar would require back up from another source of energy

✓ For FIT payments, you need to use an MCS (Micro-generation Certification Scheme) accredited installer.

This Practical Guide gives an overview of small farm scale renewable systems

Farming for a Better Climate

Our Practical Guides cover five useful topics:

1. Use energy and fuels efficiently
2. Renewable energy
3. Lock carbon into soils and vegetation
4. Making the best use of nutrients
5. Optimise livestock management

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www.carbontrust.co.uk

www.energysavingstrust.org.uk

https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy

www.microgenerationcertification.org

www.snh.gov.uk/docs/A301202.pdf

www.renewableenergyonfarms.co.uk

www.agrecalc.com

The European Agricultural Fund for Rural Development
Europe investing in rural areas

Scottish Government
Riaghaltas na h-Alba
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Potential risks

- Renewable energy systems are unlikely to be able to provide power 100% of the time. Fluctuations in wind speed, reduced water volume for micro-hydro or low sunlight levels for solar could affect output; additional space and water heating systems may be required to supplement supply.

- Payment and incentive schemes are reducing as demand for technologies increases.

- Distance to and the availability of grid connection may be an issue, especially for larger schemes.

- Check what is required in terms of planning and environmental considerations.

A Kilo What?

kW—kilowatt. Is a unit of power equivalent to 1000 watts.

kWh—kilowatt hour. Measure of energy. For example a 100 watt light bulb will use 1kWh electricity over 10 hours.

kWp—kilowatt peak. Peak or maximum power output of a device under standard test conditions. Often used to compare solar devices.

kWe—kilowatt electric. The Electrical power output of device (used with CHP systems, which will also have a heat output, kWth).

Solar water heating

Solar water heating uses the energy from the sun to warm a liquid in special panels or tubes called solar collectors. Solar panels are typically mounted on un-shaded, south facing roofs.

Technological improvements in the past few years have increased efficiency. There are currently two systems on the market – flat plate and evacuated tube.

Flat plate collectors are basically an insulated box with a black metallic sheet on the back with pipes in front with liquid, which is heated and circulated to a connected overhead water tank by convection.

Evacuated tube systems comprise of a series of tubes which contain fluid inside an absorber tube which is in a vacuum. Heat cannot easily travel through the vacuum so the tubes transfer heat from the collector to a storage tank via a manifold.

Evacuated tube systems are more efficient than flat plate systems but are more expensive.

Typical supplementary systems can cost from £3,000 upwards. A correctly sized unit may provide 100% of your hot water during the summer months. However, over a whole year the solar collectors will only meet one third of demand, therefore an additional system will be required.

Planning legislation has changed recently and planning permission may not be required for all installations. However, guidance from the local planning office should always be sought.

Micro hydro schemes

Hydro-power systems convert *potential energy* stored in water within a stream, river or pond to *kinetic energy* used to turn a turbine and produce electricity. Key factors affecting viability are the height over which the water falls (the head), the catchment area of the waterbody, the distance of the stretch of water and the flow rate of the water course.

The term 'micro' usually applies to schemes producing less than 100 kW - many of the schemes considered at a farm scale are in this category.

In remote areas where an-off grid system is to be implemented, power can be supplied directly or via a battery bank and inverter. A back-up power system may be required to compensate for seasonal variations in water flow.

Hydro schemes must be designed and sized accurately to ensure maximum efficiency. Some systems could be up to 90% efficient, although a more realistic figure for small scale installations is perhaps around 50%.

Micro-hydro scheme costs are very site specific and are not always related to energy output. For a low head system, which uses for example, an existing pond, the costs may be in the region of £4,000 per kW installed.

For installations with medium head costs are typically £25-30,000 for a 5 kW unit.

The source should be situated close to where the power is to be used or near to a suitable grid connection.

The environmental impact of micro-hydro schemes is also of prime importance; environmental concerns include fish migration and keeping a minimum volume of water in the water body all year round.

It would be worth discussing your plans with both SEPA and the local planning office before any work commences. See specific SEPA guidance at: http://www.sepa.org.uk/regulations/water/hydropower/

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Key Facts...

- The cost of renewable energy systems vary. A wood burning stove with a 5 kW rating could cost around £1,000; a 5 kW wind turbine could be in excess of £25,000
- Under the CARES scheme, rural businesses and communities can apply for a 95% loan to help with pre-development costs
- The introduction of Feed in Tariffs (FITs) and the Renewable Heat Incentive (RHI) has helped to boost the uptake of renewable heat and power
- Most renewables could be expected to have a 20 year lifespan - however, a micro-hydro scheme could run for 50 years plus, with routine maintenance
- Suitability for renewables will depend on the site and identifying the right technology
- Generating energy from renewables means less fossil fuel based energy sources are required. This could lower the fuel bill and the carbon footprint.

Heat pumps

Heat pumps are basically refrigerators running in reverse. They collect low temperature heat from a large area and provide higher temperature heat over a small area. Systems range from Water to Water, Air to Water, Air to Air, etc. with the most popular being a Water to Water system.

Heat from sunlight helps to maintain a constant soil temperature at a 1m depth of between 7°C and 13°C. A ground source heat pump (GSHP) can transfer this heat to a building, contributing towards space heating and hot water requirements. For a GSHP, a system of pipe-work is laid at a depth of approximately 1.5 m. The pipes contain a liquid which absorbs the stored heat within the ground and transfers it, via a heat pump, to hot water storage tanks. These tanks then supply the building heating system and hot water cylinder. GSHP do require electricity to run, but for every 1 kWh of energy supplied in a well designed system, provides up to 4 kWh of usable heat in return.

Borehole-type systems are available for smaller sites. These tend to be a more expensive option, however, can also be more efficient.

Although water temperatures produced from a GSHP are less than a typical oil or gas boiler, GSHP systems are ideal for new build or conversion work using under-floor heating, because the mass of the concrete floor slab can act as an effective radiator.

Although costs will be site specific, installation of a typical 8 kW system, suitable for an average house, could be in the region of £8,000 - £10,000 plus additional heating and radiator systems.

An alternative to Water to Water GSHP is the installation of an Air to Water Heat Pump (ASHP), which can extract the heat from ambient air temperature to warm water with a feed to a buffer tank and under-floor heating as described above. These systems are less expensive to install, ideal for smaller sites and overall are only slightly less effective. However, their seasonal efficiency is not so good because they work less well when the outside air temperature is low.

Air to Air systems are becoming more popular, especially for smaller dwellings up to a maximum floor area of 150m^2. An additional heat source may be required during the colder months.

ASHP units work in the same way as an air conditioning unit but in reverse, feeding warm air into the premises. The installation cost could be as little as £2,500 dependent on number of units and output required.

Small scale wind turbines

Small scale wind turbines are becoming an ever more popular option for farmers and rural households. If considering a wind turbine, you will first need to think about possible sites. Monitoring to establish actual wind speeds at selected sites will indicate feasibility and help you to select the most suitable location and type of turbine for your requirements on the farm.

Typical small scale installations range from 5 kW to 50 kW installed capacity with possibly the most common of the smaller turbines being a 15 kW unit with a hub height of between 15 m off the ground and rotor blade diameter of approximately 8.0 m. This will have a total generation meter with a connection to the local electricity network, which allows all unused electricity to be sold back to a power company. Typical installation cost for this system is approximately £40,000 and schemes installed between April and June 2017 would qualify for a generation payment of 8.19 p/kWh, the generation tariff is revised down each quarter.

Siting in relation to neighbouring dwellings, proximity to grid connection, existing tree belts and prevailing wind direction are all important considerations. Planning permission will be required though can be less onerous for smaller turbines than for the larger scale wind turbines. See the Farming for a Better Climate Practical Guide on wind energy for more details.

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Feed-in Tariffs (FITs)

The FIT scheme provides a minimum payment for electricity generated by the system, as well as a separate payment for the electricity exported to the grid, allowing you to 'sell' surplus energy.

For example, a 6 kW wind turbine would currently qualify for 8.19p per kWh generated over a 20 year period plus an export tariff of 4.91p per kWh (Apr 2017).

Micro hydro, solar PV, wind and anaerobic digestion all qualify as supported renewables under the FIT.

Anaerobic Digestion (AD)

AD produces energy from a 'feedstock', as bacteria breakdown organic matter in a controlled environment to produce biogas. Suitable feedstocks include slurry and manures, maize or grass silage or other green or food waste from sources off the farm.

AD plants can be costly to set up and do need daily management, but in the right circumstance could provide a useful opportunity for generating gas for heating, hot water or electricity production.

Renewable Heat Incentive (RHI)

The RHI provides financial support to renewable heat generators and producers of biomethane.

Technologies eligible for support under the RHI include biomass boilers, ground and water source heat pumps, biogas combustion and solar thermal installations. More information is available from Ofgem.

Biomass

There are various biomass systems available on the market. These include domestic log burning stoves and stoves with back-boilers, which can heat water, to much larger pellet or woodchip burners that can provide space and water heating for larger domestic and farm buildings. A range of biomass systems are eligible for support under the Renewable Heat Incentive (RHI).

Biomass systems are widely deemed to be a low carbon technology as they return the same amount of CO_2 to the atmosphere as the trees locked up while they were growing (though, this will depend on other variables such as harvest method and transport).

There are a number of things you will need to consider if looking at biomass heating. The boiler needs to be correctly sized for the heat requirement. Wood pellet and wood chip burners are similar in price, however fuel cost and availability may differ depending on your location. Some chip boilers can also burn pellets.

Delivery and storage of chip or pellets also needs consideration. Are there regular, local deliveries in your area? Pellets are available in bags as small as 25 kg. Woodchip requires more volume for bulk storage though may be more readily available than pellets and is cheaper.

Solar Photovoltaics

Solar photovoltaic (PV) systems produce electricity directly from daylight. PV can be located on independent structures adjacent to property, retrofitted to existing roofs, incorporated into the roof design as tiles in the external layer or mounted at ground level forming a bank of solar arrays for larger schemes.

PV panels should be sited in a south facing direction; the best system is a PV array connected to the national grid with an inverter to change power from DC (direct current) to AC (alternating current). This will also allow two-way metering, allowing power to be sold off to the grid when a surplus of energy has been generated or bought in when demand exceeds the current level of generation.

Although PV panels are a fairly expensive option, prices are falling as technologies become more mainstream.

A typical installation cost for a domestic roof-mounted installation rated at 2.5kWp could be in the region of approximately £3,500 and could pay for itself in 8 to 10 years.

In remote areas where a grid connection is not feasible, the use of PV cells plus batteries for energy storage may be considered as an option for providing light and power to dwellings and farm buildings. A mixture of renewable technologies often proves beneficial in these circumstances.

Planning legislation has changed recently and planning permission may not be required for some installations. However, guidance from the local planning office should always be sought at an early stage.