MICRO-HYDRO SYSTEMS

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Introduction

Hydro electricity can be one of the cheapest methods of providing off-grid renewable electricity, but it is also very site specific.

The best sites are on steep hills, with fast flowing water. One advantage is that on a good site you may not need batteries or an inverter (to step from DC to AC voltage), as the turbine will produce 240 volts AC and can just be turned on when needed. Our *Electricity for Off-grid Homes* information sheet has more advice on calculating your energy demand and sizing batteries.

The capital cost of hydro power schemes is quite high, but if you have a suitable site it can be a good investment. As of Spring 2010, 'feed-in tariffs' give a good price for electricity generated - a reasonable size scheme can recoup costs in 5 years or so.

How much electricity can I generate?

A good hydro site depends on the 'head' of water (the vertical drop) and the flow rate.

To estimate the energy in a water source, multiply the flow (in litres per second) by the head (in metres) by 10 (acceleration due to gravity). Halve the result, to account for losses and inefficiencies, to get an idea of potential power generation (in watts).

As this equation makes clear, a greater head will provide more power. Also, as a high head turbine will spin very quickly, there may be no need for complex gearboxes or belts.

Most micro-hydro schemes are 'run-of-river' - they don't have a reservoir and only take water from the stream when it is available. You usually need a drop of over 10 metres for a scheme to be viable. High-head 'Pelton' turbines are comparatively cheap, easy to install and work well in fluctuating flow. Crossflow turbines are more suitable for lower heads. Other turbines are available; suitability depends on a combination of the available head and flow of water.

What will it cost?

Hydro installations are extremely site-specific. Prices vary widely depending on the type and size of system and how much work you are willing to put in yourself.

The basic equipment for a 1kW off-grid battery charging system might cost £5,000 to £6,000 plus installation costs. It might be possible to DIY a small scheme for under £10,000. In some situations this will be cheaper than paying grid-connection costs.

The total cost of a Pelton turbine producing 5kW on a 25m head site might be around £25,000 professionally installed, less on a DIY basis. Larger systems can cost tens of thousands of pounds. There is an economy of scale - a 5kW system may only cost 50% more than a 2kW system.

Because of the investment required, it makes sense to minimise energy use first; efficiency measures are a more cost-effective way to reduce domestic carbon emissions. See our *Energy Efficiency in the Home* and *Saving Electricity in the Home* sheets for advice.

After that, low-carbon heating systems such as a wood-fuelled boiler or a heat pump may be a good way to reduce emissions. See our other information sheets for more advice.

Will it pay?

The *feed-in tariff* (FiT) scheme for renewable electricity generation can make micro-hydro a very attractive option.

Under this scheme, a generator receives a certain payment (19.9 p/kWh for systems installed in 2010/11) for every unit of electricity generated from micro-hydro power, whether you use it yourself (and save on bills) or sell it to the grid (for another 3 p/kWh). For a 5 kW hydro scheme, this could work out to annual payments of £5,000 to £10,000, guaranteed for 20 years. However, to be

eligible for FiT income, the hydro scheme has to be installed by a professional accredited under, and using turbines registered with, the Microgeneration Certification Scheme (MCS, contact details below).

Waterwheels and old mill sites

Old watermill sites are not usually good for generating electricity. A large, slow-moving body of water gives a high torque (turning force) and waterwheels make use of this to operate machinery directly. Low rotational speeds makes it difficult to use them for electricity generation; it's easier to make electricity with a fast flow of water that can be channelled to hit a turbine at high pressure. Waterwheels are also expensive to construct compared to water turbines and need lots of maintenance.

However, some 8,000 mills or mill sites are recorded in Britain, and as a small number may be suitable for generating electricity, it may be worth looking into. A hydro turbine installed at Gants Mill in Somerset generates up to 12kW of electricity and feeds into the local grid (see *www.gantsmill.co.uk*). Another example is a waterwheel adapted to generate electricity at Pedley Wood in Cheshire (see *www.pedleywheel.org.uk*).

The most suitable type of waterwheel for conversion to electricity production is the overshot style, as it has the highest head.

It often proves worthwhile to increase the head by raising the headrace and/or lowering the tailrace. Some types of waterwheel can operate at a very low fall of only a few metres – you'd then need large flows of water to get reasonable amounts of power out of them.

Generators operate most efficiently at high speeds. Motors or generators that run at very low rpm (revolutions per minute) are large and expensive - a 1000rpm motor is much bigger than a 1500rpm one. Therefore, it may be more practical to gear up to a faster turbine, or consider installing a micro-hydro turbine instead.

Low head sites

'Zero head' turbines can be placed in rivers, or other flowing water, and will respond simply to the flow - producing a small amount of electricity for trickle-charging a 12 volt battery. For example, the Ampair underwater generator will generate up to 100 watts in fast flowing streams. It is also possible to purchase turbines that have been designed to be towed behind yachts.

Other considerations

The Environment Agency (listed in local yellow pages) is responsible for UK watercourses. Permission must be sought from them prior to installation and for an abstraction license. They'll ask you to assess effects on river ecology & flooding.

It's also worth discussing details with local planning officials, as the powerhouse and pipework may require planning permission.

If you don't own all the land involved, you'll need to seek permission from landowners.

Further information

For more detail, our book *Going with the Flow* is a comprehensive guide to small-scale water power. It takes you step-by-step through the whole process - from the principles of micro-hydro power, through site evaluation, technical design and construction to the legal, environmental and economic aspects of small-scale hydro generation.

CAT mail order sell these and many other practical books on hydro power: *01654 705959; http://store.cat.org.uk*

CAT runs many **short courses** on renewable energy, including hydro power: *01654 704952; www.cat.org.uk/courses*

If you wish to discuss a particular project in more detail, our **consultancy service** may be of help. Our engineers can undertake site assessments of potential hydro sites. *01654 705991; consultancy@cat.org.uk*

Contacts

British Hydropower Association
01258 840934 - www.british-hydro.org

Microgeneration Certification Scheme
020 7090 1082
www.microgenerationcertification.org
Lists turbines and installers accredited for feed-in tariffs.

Grants might be available in some areas:
Energy Saving Trust
0800 512 012 - www.est.org.uk
Advice about local funding opportunities.