Micro-Hydro Systems

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Introduction

Hydro electricity can be a very efficient and convenient form of renewable electricity, but suitable sites will not be that common. The best locations will be on steep hills, with fast flowing water. The capital cost of hydro power schemes is quite high, but if you have a suitable site it can be a good investment. 'Feed-in tariffs' now give a good price for electricity generated on grid-connected sites, and 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 larger head provides more power. Also, as a high head turbine will spin very quickly, there may be no need for complex gearboxes or belts.

Most 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. For low heads, there are *Crossflow* or *Archimedes Screw* turbines. The suitability of these or other turbine types depends on a combination of the available head and flow of water.

Off the Grid?

If you don't have a grid connection, a micro hydro scheme can be one of the cheapest ways to provide electricity. An 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. See our *Electricity for Off-grid Homes* sheet for more advice on calculating your energy demand and sizing batteries.

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

The total cost of a Pelton turbine producing 5kW from a 25m head might be £25,000 professionally installed, less if DIY. 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 Conservation* sheet for advice. Low-carbon heating systems such as a wood-fuelled boiler or a heat pump may also be a good way to reduce emissions. See our information sheets on these topics for more advice.

Will it pay?

The *Feed-in tariff* (FIT) scheme for renewable electricity generation can make micro-hydro an attractive option.

From 1st Oct 2017, you can receive a FIT payment of 7.78p for each unit (kWh) of electricity generated from a small micro-hydro scheme (under 100kW), whether you use it (and save about 16p/kWh on bills) or export it to the grid (for which you'll get an additional 5.03p/kWh).

For a 5kW hydro scheme, this could give annual payments of several thousands of pounds, guaranteed for 20 years. To be eligible for FIT income you'll need to seek accreditation through the 'ROO-FIT' process via Ofgem. See: *www.ofgem.gov.uk/fits*

Waterwheels and old mill sites

Old watermills are not ideal for generating electricity. A large, slow-moving body of water gives a high torque (turning force), which waterwheels can harness to operate machinery directly, but the low rotational speed 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 more expensive to construct, compared to water turbines, and need more maintenance.

However, there are many thousands of water mill sites in Britain, and some will be suitable for electricity generation, so it may be worth looking into. 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.

A recent development is the use of Archimedes Screw turbines on low head sites. The case studies on these webpages give an idea of the flow rates required:
www.mannpower-hydro.co.uk
www.westernrenew.co.uk

Zero-head turbines

These are placed in rivers or other flowing water (for example towed behind a yacht) and respond simply to the flow - producing just a small amount of electricity for trickle-charging a 12 volt battery. However, the output will be very low compared to a system where water is channelled in a pipe (or penstock) to a turbine. The 'head' (drop in level) and penstock in a conventional hydro power setup allow you to harness much more energy from a flow of water.

Other considerations

The Environment Agency (offices listed in local yellow pages) is responsible for UK watercourses. You must get permission from them before 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

Unfortunately, the book *Going with the Flow* (Langley & Curtis) is currently out of print – but you may be able to find it through a library or second-hand. It's a comprehensive guide to small-scale water power, going step-by-step through the whole process - from the initial principles, through site evaluation, technical design & construction, to the legal, environmental and economic aspects of small-scale hydro.

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Other Contacts

Ofgem
www.ofgem.gov.uk/fits
ROOFIT@ofgem.gov.uk
Information about claiming feed-in tariffs for a micro-hydro scheme.

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

Energy Saving Trust
0300 123 1234; www.est.org.uk
More information about feed-in tariffs.

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