



Micro-Hydro Power Basics

Scaling down the world's most widely-deployed renewable energy resource

Key Points

- Produces no pollution in operation
- Uses the energy in falling water
- Water is returned to the river afterwards
- Installations can have a very long lifetime
- Near-continuous and dependable operation

How does it work?

Hydro power works by using falling water to drive a turbine and a generator. The amount of energy produced by a hydro scheme depends on how far the water is falling (the **head**) and the volume of water passing through the intake each second (the **flow rate**). For small hydro schemes, a head of 2.5—3.0m is a typical minimum starting point.

Micro hydro power systems usually have a water intake above a weir or dam. Some of the water flowing along a river is re-directed into the intake, which screens for debris and fish to prevent them entering the turbine. From the intake, water runs through a channel or pipe (called the penstock) where it falls down through one or more turbines. The kinetic and potential energy of the falling water is extracted by a turbine, which drives a generator to produce AC power. The water is returned to the river afterwards—see the schematic on the right.

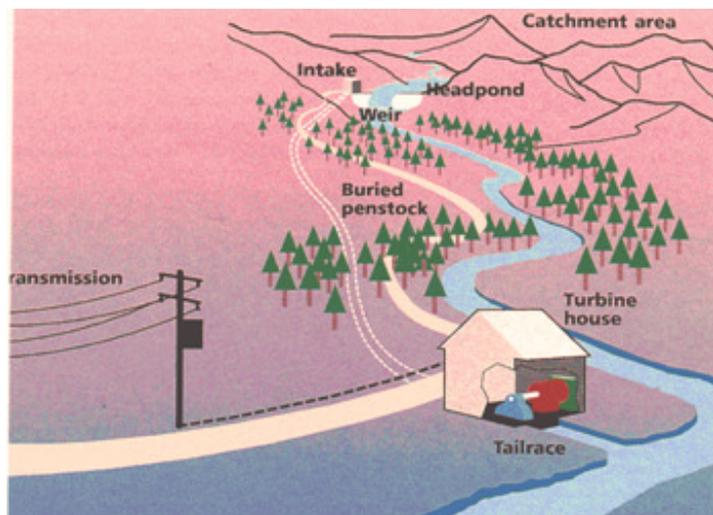
How much can it generate?

Hydro projects have been constructed right up to multi-gigawatt scales, but are generally categorised in terms of their maximum energy production as follows:

- Large hydro - Over 5MW (5,000 kW)
- Small hydro - Under 5MW
- **Micro hydro - Under 100kW**

This fact sheet primarily discusses the last of these categories, and hydro schemes as small as 5kW are now increasingly common.

If correctly sited, hydro power represents a fairly steady and reliable renewable energy source, as its output is only affected by seasonal changes in the river's flow rate. Seasonal variation is an important factor, since it would not usually be economic to have a hydro system offline in the summer months due to a lack of water.



A layout for a 'run of the river' hydro system: the intake can be quite close to the turbine if the head is significant (i.e. a sudden drop like a waterfall), or larger distances as depicted'

Why is it important?

Small-scale hydro power can provide clean, safe, distributed energy. Hydro power produces no pollution in operation and does not emit carbon dioxide, so it is a climate-friendly energy option.

Major hydro-electric dams can provide enormous quantities of energy, but often incur serious environmental consequences, such as flooding large areas of land and displacing populations. At a community level, micro hydro systems are a clean, safe and low-impact alternative.

What does it look like?

The turbine and the majority of the machinery for small hydro power systems can be hidden in a small building by the side of the river. This may be designed in a traditional style to blend in with the surroundings.

Similarly the pipes can be buried, reducing any visual impact that they might have.



Turbine and generating equipment can be housed in a small building—or even a wooden box!



A potential low-head site, where existing civil structures could be used

Costs and incentives

It is difficult to generalise the cost of hydro systems, as every site is unique. Whilst the turbine and generating equipment may be similar at two sites, pipe runs and required civil works can vary greatly, impacting costs.

In general, the capital costs of small hydro schemes are quite high, with figures in the region of £3,000-£6,000 per kW capacity being typical. Higher output sites tend to have a lower cost per kilowatt of capacity, and all hydro installations tend to have long working lives and low on-going maintenance costs.

Whilst the economics at the smallest scales have proved challenging in the past, the arrival of **feed-in tariffs** means that the economics are better than ever. The following fixed unit rates are payable from April 2010, for accredited hydro systems installed after July 2009:

- | | |
|------------------------------|-------------------|
| • Micro hydro (< 15 kW) | 19.9 p/kWh |
| • Micro hydro (15—100 kW) | 17.8 p/kWh |
| • Small hydro (100—2,000 kW) | 11.0 p/kWh |

These rates are paid for all units generated, and are index-linked and guaranteed for 20 years.

Environmental impacts

Hydro schemes produce carbon-free and zero-pollution electricity. Whilst larger hydro systems involve substantial construction work, micro hydro schemes do not, and disruption is therefore minimal and temporary. Some civil works are required to install the pipes to and from the turbine. But careful design can mostly conceal the hydro-power plant and pipes.

The environmental impacts associated with construction and possible alterations to the river environment should be minimal for a micro hydro power project, if the scheme is well designed. Nevertheless, sites should still be chosen carefully.

Water used to run the turbine is returned to the river and is aerated by passing through the turbine and tailrace. This means that the turbine can actually improve water quality in the watercourse. Fish screens are fitted to the water inlet for the hydro power turbine to prevent them entering the turbine and avoid injury to aquatic life.

Where should it be sited?

A good flow rate (Q) and a decent head (H) remain key. Once estimates of these are known, available power (P) output can be estimated by the simple formula below—this is for a scheme of 70% water-to-wire efficiency:

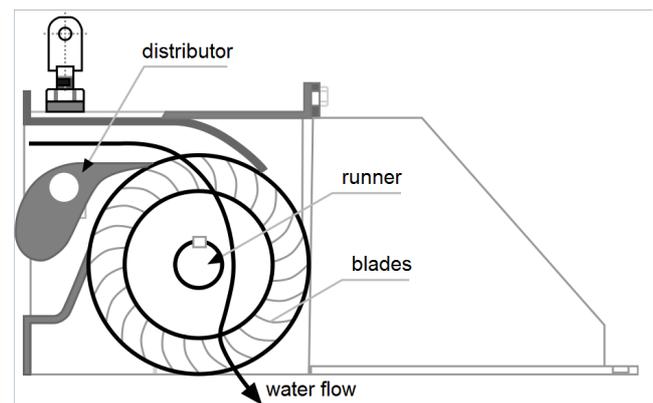
$$P \text{ (kW)} = 7 \times Q \text{ (m}^3\text{/s)} \times H \text{ (m)}$$

Environmental criteria are also very important in deciding whether a site is suitable for hydro power. The following permissions are usually needed before proceeding:

- **Planning permission** from the local authority
- **Water abstraction license** from the Environment Agency
- **“Works in Rivers”** consent

One way to identify sites is to look for old water mills (or place names including the word “mill”). Because old mill sites may have some of the structures in place already, the key civil works costs for turbine housing and water flow redirection can be greatly reduced.

Although it is possible to use existing waterwheels to generate electricity it can be expensive and inefficient due to gearing required to get from the low revolutions per minute (rpm) of the waterwheel to the 1,500 rpm (typical) required by the electricity generator.



Schematic of a cross-flow turbine type, popular at small sites

Further Information

Microgeneration Certification Scheme

Find approved products and installers
www.microgenerationcertification.org

British Hydropower Association

www.british-hydro.org

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