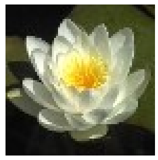
micro-hydro



what is it?

A micro-hydro system converts the potential energy in a stream of moving water into electrical energy. The principles of hydropower are the same whatever the system size. Micro-hydro refers to small systems that can be installed by individual homes, businesses or farms. A system consists of a turbine that generates electricity from flowing water (via a generator); an intake structure some distance upstream of the turbine, where some water is diverted from the stream to the turbine via a pipe; and an outlet to discharge the water back into the stream. Power generated depends on the flow of water and how far it drops (head). Efficiencies of micro-hydro systems are typically over 70%.

History

Hydropower has been utilised since ancient times, via waterwheels for milling grain and lifting water for irrigation. Turbines that generate electricity were first developed in the late 19th century. Early electrification of street lighting in many towns in the UK was down to hydropower, until the National Grid was rolled out, after which, many hydro plants were closed down, as their power output wasn't up to grid specification (this isn't the case nowadays – large and small hydropower plants are providing a lot of electricity to the Grid).

Types of turbine

Pelton: typically used for high-head sites (large vertical drop, usually in the upper courses of rivers); operating head starts around 50m and can be over 1000m, with flow over 2000 litres / second. They're like breakfast bowls mounted on a spindle, hit with a jet of high-pressure water.

Turgo: similar to the Pelton, but with the jet of water hitting the 'breakfast bowls' at an angle.

Francis: a propellor inside a tube, for medium-head sites.

Crossflow: typically used in medium-head locations, the blades are similar to cross-sections of metal pipe, mounted on circular plates rotating on a shaft, so that the water catches them.

Kaplan: another propellor-type turbine, for low-head sites.

Archimedes screw: used at low-head sites in the lower courses of rivers, they involve a large spiral wound around a central tube. Used with a head from 1-10m, and up to around 20m³/s flow. Over 10m head, the screw can start to flex.

In most cases, a weir will need to be built across the stream at the point of water intake, with a fish pass to allow fish to move past the weir. A dynamo can also be added to an old-style water mill to generate electricity.

what are the benefits?

There are all the usual benefits of renewable energy, in that it avoids the burning of fossil fuels, with their associated pollution and carbon emissions. Plus it's one of the more efficient renewable technologies. The load (or capacity) factor on small hydro is typically around 45% (load factor is the ratio of energy output per year to the maximum output if the system works at full-rated capacity all year round). PV is typically around 8-9%, and a 250kW wind turbine is in the 18-22% range, depending on the site.

Cost per kWh delivered is site dependent, and are driven site access, grid availability, distance to grid, what civil engineering works have to be done – for example, is there a weir already in place? Is there a fish pass? Do you have to construct a new fish pass, or a new weir completely?

Hydro can provide an income for farm families (selling electricity to the grid) and can give a cost advantage to small-scale industry situated in an old watermill converted to generate electricity.

In the 18th and 19th centuries, when weirs were built across rivers for watermills, they didn't worry about fish passage; but now when they're converted to generate electricity, there's often a requirement in the planning approval to provide a fish pass. So converting old watermills helps fish passage up river valleys.

Because water is flowing constantly, and the turbine can be producing electricity 24-7, for about 80% of the year (i.e. not the hottest, driest months), it's ideal for running the pump of a ground source heat pump, and providing all your heating needs, as well as electricity.

They last much longer than any other kind of renewable energy systems. The life expectancy on a well-built, well-maintained system is three generations. Our advisor recently did some work on a system that was installed in 1890, and is still going strong.

Micro-hydro turbine in operation.

Old-style watermill, originally used for milling grain, can be used to generate electricity.

what can I do?

If you live near a stream and you're thinking of installing micro-hydro, first think about where your intake will be - do you own the land on both sides of the stream there (often a land boundary is in the middle of a stream, which means you can't build a weir across the stream if you don't own the far bank)? You want your input to be as far upstream as possible. So for small gardens, it wouldn't work (unless you have a waterfall, which is unlikely); for farms, the best location would the the upper boundary of the property. You'll need to ensure that you only divert a volume of water that keeps aquatic life safe. So you need to build a controlling structure, which is typically a weir across the river. There's an intake on the side, with a way to prevent fish, debris or silt from entering the pipeline / channel. This all has to be calculated and engineered. There's a lot of detail – e.g. the flow velocity through the bars of the intake screen mustn't exceed 0.3m/s when the screen is 50% blocked with leaves, because that's the escape velocity of small fish, who would be trapped against the screen and die.

A pipe runs from the inlet to the turbine, which can sometimes be over a kilometre in length. If you have an old mill site, the infrastructure is already there, and it's just about how you best utilise it. Designing a micro-hydro system is such specialist work, it will almost always involve the services of a professional. You can do some research so that you can undertake some of the work yourself. You may need the specialist a bit less, and save some money. A good place to start is the British Hydropower Association's Guide to UK Mini-Hydro Developments. But your most important decision is which specialist to go with – so try to talk with their previous clients. The British Hydropower Association has a database of companies.

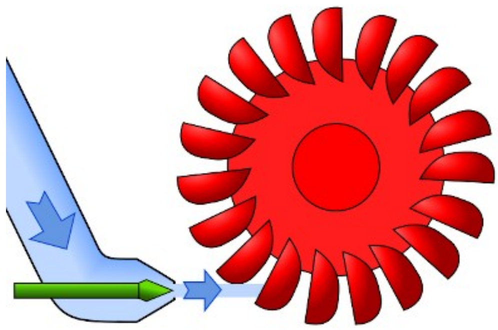
Every hydro site is unique, and requires a bespoke design - unlike PV or small-scale wind, where you can buy an off-the-shelf product.

The hydro industry is heavily regulated. You won't get approval unless you've demonstrated that you're not going to have a negative impact. In the UK, you'll need planning permission, and an abstraction licence from the Environment Agency that stipulates what percentage of the stream's flow you can divert to the turbine, to protect the aquatic environment. Because of this, sometimes turbines can be out of operation for about 20% of the year – the hottest, driest days. As you're going through the planning process, the planners will liaise with other stakeholders, including fisheries, plus anglers, canoeists and anyone else who might want to comment on the application.

There are very few moving parts, so apart from greasing bearings monthly, and clearing leaves from the intake screen, there's not much else in the way of maintenance. The electronic control panels also have components that will fail from time to time, and need to be replaced – but manufacturers tell us that spare parts represent half of one percent of their sales. Not much planned obsolescence in the hydro world.

resources

- see lowimpact.org/micro-hydro for more info, courses, links & books, including:
- Adam Harvey, *Micro-Hydro Design Manual*
- Scott Davis, *Serious Microhydro*
- N Smith, *Motors as Generators for Microhydro*
- british-hydro.org: British Hydropower Assoc.
- microhydroassociation.org: Microhydro Assoc.
- nrfa.ceh.ac.uk: National River Flow Archive



How a water flow turns a Pelton wheel.