

# Introduction of Micro Hydro Power



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**The** concept of generating electricity from water has been around for a long time and there are many large hydro-electric facilities around the world. What is new to most people is the idea that this same concept will work on a smaller – and even individual – scale. With the rising costs of utility power and refinements to micro-hydro systems, it is now not only possible, but also very practical, to look at water as the source for your electricity.



This booklet will provide you with a basic understanding of small-scale hydroelectric power generation. The information will help you determine the power generation potential for your site, acquaint you with the various components necessary for a small scale hydro-electric system, and explain the basic differences between common micro-hydro turbines so that you can choose the best one for your system.

Whether you have an existing application with known electrical requirements or just want to know if that stream running through your property can be used to generate electricity, this booklet will provide you valuable insights into the world of small scale hydro-electric power generation. We hope that you find it informative and enlightening.

Worldwide there are literally hundreds of thousands of micro-hydropower sites (up to 100 kW) that could be developed to supply environmentally friendly renewable energy. Two factors limit how many of these sites are developed; cost and local technical knowledge.

If you could choose any renewable energy resource to use, hydropower would be the way to go. With the right location, hydro systems can produce many times the power a similarly priced wind or solar system could generate. With special precautions, they can be used virtually year-round, summer or winter. Even a modest output from a hydro system, producing steadily 24 hours a day, will add up to a large cumulative total.

Often, peak power use is in the evening when the sun isn't shining and the wind is not necessarily blowing. Batteries can be completely drained by morning with a solar or wind system. With a hydro system located on a year-round creek or river, power is produced steadily around the clock. These are just some of the benefits of hydropower ...

**Micro** hydro refers to hydro power systems with a power rating of 100kW (In our company, it's especially means those less than 50KW) or less. A 100kW system will produce 100 standard units of electricity in one hour. Micro hydro systems differ from large hydro power since the flows of water required are much smaller. The considerable benefits of micro hydro power include the following:



- 'Fuel-free' source of power
- Different to large hydro since environmental impacts of installation are negligible.
- Renewable energy source therefore helping to reduce greenhouse gas emissions and having a net positive impact on the environment.
- Constant generation over long periods unlike wind and solar power
- Good correlation with demand (more hydro energy is available in winter when heating loads are high)
- Long lifetime of systems, typically 20 years or more
- Low maintenance requirements and running costs
- Reasonable payback for grid -connected systems, often 5-8 years or less

**Hydro** power plants capture the energy of falling water to generate electricity. A turbine converts the energy of falling water into mechanical energy. Then an alternator converts the mechanical energy from the turbine into electrical energy. The amount of electricity a hydropower plant produces is a combination of two factors:

1. How far the Water Falls (Head):

Generally, the distance the water falls depends on the steepness of the terrain the water is moving across, or



the height of a dam the water is stored behind. The farther the water falls, the more power it has. In fact, the power of falling water is 'directly proportional' to the distance it falls. In other words, water falling twice as far has twice as much

energy. It is important to note we are only talking about the vertical distance the water falls – the distance the water travels horizontally is consequential only in expense of the system and friction losses. Head is usually measured in 'meter'.

**2. Volume of Water Falling (Flow):**

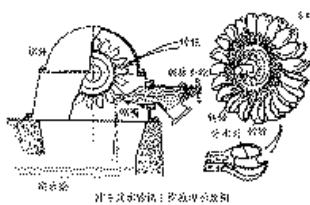
More water falling through the turbine will produce more power. The amount of water available depends on the volume of water at the source. Power is also 'directly proportional' to river flow, or flow volume. A river with twice the amount of flowing water as another river can produce twice as much energy. Flow volume is usually measured in 'liter/second, or 'cubic meter/second'.

For Micro Hydro systems, this translates into two categories of turbines:

For high head and low flow volume sites, impulse turbines are the most efficient choice. The power produced by an impulse turbine comes entirely from the momentum of the water hitting the turbine runners. This water creates a direct push or 'impulse' on the blades, and thus such turbines are called 'impulse turbines'. There are three types of impulse turbines, Pelton, Inclined & crossflow.

For low head and high flow volume sites, a reaction turbine is the best choice. The reaction turbine, as the name implies, is turned by reactive force rather than a direct push or impulse. The turbine blades turn in reaction to the pressure of the water falling on them. Reaction turbines can operate on heads as low as 2m, but require much higher flow rates than an impulse turbine. There are also three types of reaction turbine, Francis, propeller(Kaplan, Nagler, Tubular).

**Pelton & runner:**



**Inclined & runner**



**Propeller & runner**



## Hydro Power Basics

Power is measured in watts or kilowatts.  $1\text{kW} = 1000\text{W}$  .

Flow:  $1\text{ m}^3/\text{s} = 1000\text{ l/s}$ .

Gross head: Head of the water

Net head: Deducted the energy loss from forebay through penstock to hydro turbine, a little smaller than gross head.

## Calculation of Hydro Power

The hydro power in a stream or river can be calculated as follows:

$$\text{Hydro Power (kW)} = \text{Net Head (m)} \times \text{Flow (m}^3/\text{s)} \times 9.81^*$$

(\*9.81 is acceleration due to gravity which can be assumed to be constant).

For example, if the available flow is 0.15 cubic metres per second and the Net head is 4.7 metres, the hydro power is  $4.7$

$$\times 0.15 \times 9.81 = 6.9\text{ kW}$$

If a flow in litres per second (l/s) is used, then the power will be given in watts instead of kilowatts.

To estimate the electrical power produced by a generator, the efficiency of the system must be taken into consideration.

Efficiency is the word used to describe how well the power is converted from one form to another. A turbine that has an efficiency of 70% will convert 70% of the hydraulic power into mechanical power (30% being lost). The system efficiency is the combined efficiency of all the processes together. The system efficiency for electricity generation using micro hydro is typically between 50% and 60%.

## Electrical Power = Hydro Power x System Efficiency

i.e. as a rough estimate, if there is found to be 6.8 kW of hydro power in a small river, the electrical power is

$$6.9 \times 50\% = 6.9 \times 0.5 = 3.45\text{ kW}$$

## Components of a Micro Hydro System, Key features

