ENERGY TECHNOLOGY FACTSHEET

UNEP

Small Scale Hydro (SSH)

The energy in falling water can be converted into electrical energy or into mechanical energy to pump water or grind grain. The amount of energy that can be captured is a function of the vertical distance the water drops (the *head*) and the *volume* of the water. One hundred cubic metres of water falling 10 metres (a low head application) represents the same energy potential as 10 cubic metres of water falling 100 metres (a high head application).

In the past, hydropower stations were often built as a part of large dam projects. Due to the size, cost, and environmental impacts of these dams (and the reservoirs they create), hydro developments today are increasingly focused on smaller-scale projects. Although the definition of *small-scale* varies, only projects that have less than 10 megawatts (MW) of generating capacity are considered here. This definition also includes mini-hydro (<1 MW), micro-hydro (<100 kilowatts, or kW), and pico-hydro (<1 kW).

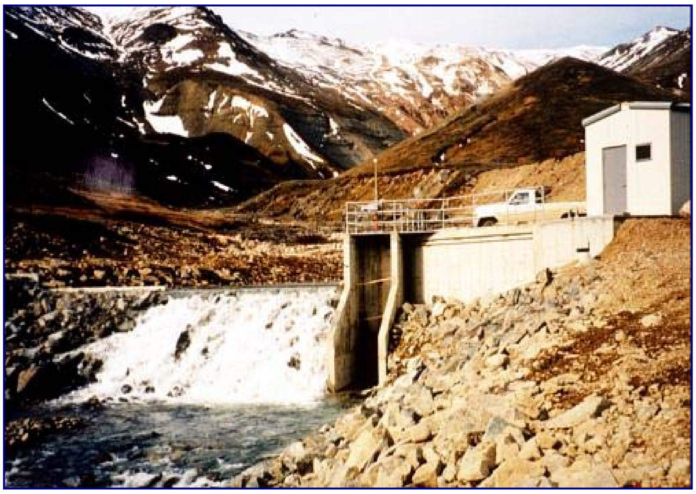
The Technology

The main components of a small-scale hydro (SSH) system are the turbine and the generator. Other components include the physical structures to direct and control the flow of water, mechanical and/or electronic controllers, and structures to house the associated equipment.

Different types of turbines are available and the optimum choice depends strongly on the head and the water flow rate. Generally, a high head site will require smaller, less expensive turbines and equipment.

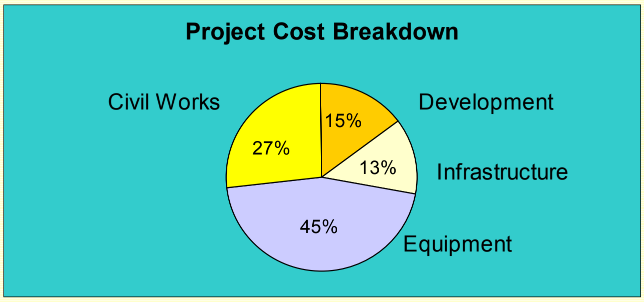
For most hydro projects, water is supplied to the turbine from some type of storage reservoir, usually created by a dam or weir. The reservoir allows water to be stored and electricity to be generated at more economically desirable times – during periods of peak electrical demand, for example – when the electricity can be sold for a higher price. In these systems the amount of electrical power that can be generated is determined by the amount of water that is stored in the reservoir and the rate at which it is released.

The most environmentally-sound hydro system does not impact the amount or pattern of water flow that normally exists in the river or stream. Such "run-of-river" systems may use a special turbine placed directly in the river to capture the *energy* in the water flow.



This small scale hydro system can provide power for a community of 800 people. (Photo courtesy Warren Gretz and NREL).

	Costs
Turbine Cost:	US$450-$600/kilowatt (kW)
Project Cost:	US$1000-$5000/kW
Construction Time:	2-3 years
Life Cycle Cost:	US$ 0.05-$0.15/kilowatt-hour



Key Points:

- *Hydro is a well-proven but very site-specific technology used throughout much of the world.*
- *Systems can often be installed at existing weirs and dams, often at relatively low cost as the large infrastructure costs are already incurred.*
- *The amount of power provided by falling water is a function of height of the system and the volume of water passing through the turbine.*
- *Hydro systems have long life and high availability.*
- *Systems can have negative as well as positive local environmental impacts.*
- *Environmental investigations are essential to obtaining construction and operating permits.*
- *Well-planned systems generally have minimal impact when operating.*

A conventional SSH plant may also operate as a run-of-river system if the natural variability of the river flow is maintained. However, this type of system may generate less power during times of low water flow.

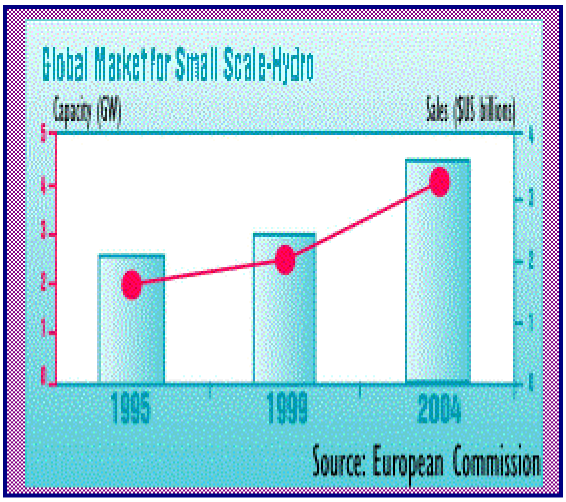
Small-scale hydro systems are modular and can generally be sized to meet individual or community needs. However, the financial viability of a project is subject to the available water resource and the distance the generated electricity must be transmitted.

Hydro systems do not create any pollution when they are operating, and generally offer highly reliable power. They also have very low running or maintenance costs, and they can be operated and maintained by trained local staff.

Hydro systems generally have a long project life. Equipment such as turbines can last 20–30 years, while concrete civil works can last 100 years. This is often not reflected in the economic analysis of small hydropower projects, where costs are usually calculated over a shorter period of time. This is important for hydro projects, as their initial capital costs tend to be comparatively high because of the need for civil engineering works.

Although significant potential exists for further SSH development, the availability of suitable new sites is limited, particularly if dams or other structures must be built and where local land use and planning laws may limit such development.

A substantial number of weirs and other in-stream structures are in place already and can be retrofitted with hydro equipment. About 3,000 MW of these low-cost applications are estimated to exist globally. The additional environmental and land use impacts of these projects are often very low.



Project Risks

Technology:

SSH is a mature industry with a technology risk similar to the risk for conventional thermal generation technologies.

Environmental:

Environmental issues can present major risk to a SSH developer. Impacts on fauna and flora need to be thoroughly assessed. Impacts on water quality, fish habitat, and stream access are potential issues. Flood hazards can also present an environmental risk to installed systems.

Planning:

SSH project development requires access to the water resource, which may require a lengthy planning process. Retrofitting SSH systems to existing weirs and dams is generally a simpler process.

If a small scale hydro system is to be operated as an independent power producer, a power purchase agreement with the local electric authority may be necessary. Delays in these processes often constitute the greatest risks to a small hydropower developer.

Hydro developers generally need to invest in detailed analyses before a project can proceed. Regulatory authorities may require structures or systems that prevent adverse effects on flora and fauna, particularly fish. Conversely, some hydro systems may enhance local environments through, for example, the creation of wetlands.

The Industry and Market Trends

Over one hundred companies manufacture SSH systems with the most active industries being those in Europe and China. Already China has an installed capacity of 20,000 megawatts and is planning to install 1,500-2,000 megawatts per year in the period 2001-2005. Southeast Asia and Latin America are also promising markets.

Although SSH is a mature technology, there is considerable scope for improvement. Electronic controls, telemetry-based remote monitoring, new plastic and anti-corrosive materials, new variable speed turbines for use in low-head applications, and new ways to minimize impacts on fauna, particularly fish, are helping to make systems more cost-effective and extend the range of potential sites.