# The watermill battery charger

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Throughout the Himalayas, many people living in remote areas use water-powered mills on a seasonal basis to grind wheat, corn, millet, and other grains into flour. It is estimated that there are 25 000 water mills operating in Nepal (referred to as ghattas), over 200 000 in India (referred to as gharats or panchakis), and many more in the mountainous regions of China, Pakistan, and Turkey. Each traditional mill has a power output of 200 to 500 W (Figure 1).

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*Figure 1: Traditional water mill*

Today, much of these mountainous regions remains non-electrified, despite the interest in and demand for basic electricity. The aim is to create an opportunity for an individual entrepreneur to provide electricity to his immediate community by using part of the indigenous infrastructure: the water mill.

Even the smallest amount of electrical power can have a big impact on this part of the world. For most Himalayan homes, kerosene is the only available source of light after sunset. Houses are rarely well-ventilated, and kerosene inhalation poses a real health threat. New lighting technology can completely replace the use of kerosene for lighting. Both Compact Fluorescent Lights and the more exotic white LED lights are available today in the local market. There is enough power in the traditional water mill to power these kinds of lighting systems as well as other small household appliances, even small incandescent lighting systems. Extending the mill's functionality to include electricity generation also has the added benefit of providing an entrepreneurial mill owner with an additional source of income.

Just as in the industrialized world, entrepreneurship can be an excellent way to introduce and disseminate technology in developing nations. When engineering a product for the individual entrepreneur quickly in the Himalayan region, low cost becomes the dominant criteria. For a mill owner (Figure 2), expensive induction generators and transmission lines may be simply out of the question. A battery charger is a much more viable solution. The mill owner bears the cost of the inexpensive charging system, while the individual households bear the cost of batteries, as they are able. Even the more remote and isolated homes are able to participate in this scheme, as long as they are within walking distance of a mill. Although issues of transportation and disposal remain, battery use seems the quickest and most economic path to bring basic electrical lighting to the mountains.

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*Figure 2: Mill owner with water wheel*

Himalayan water mill technology is centuries old. It continues to be built and maintained using local materials. Although each mill is to some degree unique, all share fundamental similarities. Water is diverted from a stream or river and flows down a chute towards the mill's turbine. The vertical shaft of the turbine runs up through the floor of the mill house and turns a rectangular metal "key." The key supports and turns the top stone of a pair of grinding stones. There is also a lever extending from below the turbine into the mill house that enables the mill owner to raise or lower the top grinding stone as he sees fit. It can be raised up high enough to spin very quickly without touching the bottom grinding stone.

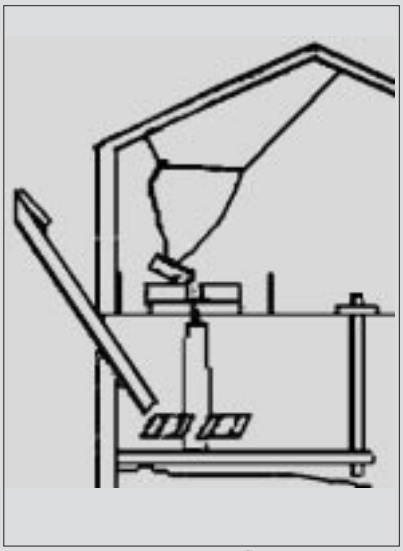

*Figure 3 – sketch of water mill*

Non-Theme

Batteries simply can go where a transmission grid cannot. Indeed, the precedent has already been established; villagers in parts of eastern Nepal are currently carrying 12V car batteries into grid-connected towns for recharging. A battery-charging extension to the mill could both alleviate the need for these long trips and make such a strategy available to other, more remote areas of the mountains.

The mill is also an ideal site for a battery-charger. During much of the year, a steady stream of people arrive at their local mill with grain and leave with flour, as has been done for centuries. It will not be a dramatic change of routine for rural villagers to bring their batteries to the mill as well (Figure 4). They can have a battery charged and their grain ground in the same trip. The battery charger extension can also be operated during the currently non-utilized time of the mill, which varies by season. The availability of a battery-powered light also allows the mill to operate at night, either for grinding or battery charging.



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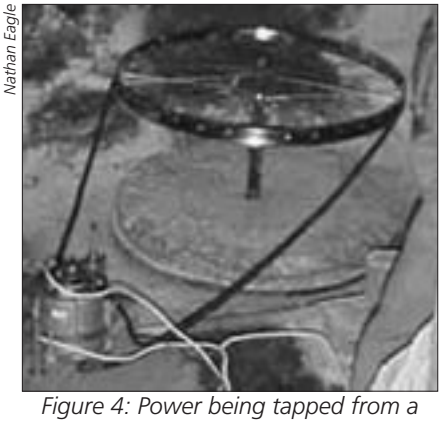

*Figure 4: Power being tapped from a water mill*

An inexpensive battery charger can be made using a car alternator, a bicycle rim, a belt, and a mill key. The key sits on the rotating turbine shaft and supports the top grinding stone. By attaching a small square post to its top, the turbine shaft can effectively be extended. The bicycle rim has a square pipe welded to its axle that can be slipped over the square post. The turbine thus drives the bicycle rim, and the rim in turn drives the smaller alternator pulley using the long car v-belt. With the top stone raised up, the water mill's energy goes not into grinding, but into powering the alternator.

A car alternator is an excellent choice for a battery charger as is it has been specifically engineered to provide a regulated voltage ideal for recharging 12V batteries. It can supply up to 500W of power, which is conveniently the maximum estimated power output of most traditional water mills. Although the alternator needs a fairly high rotational speed (rpm) to generate electricity, it can be run below car idle speeds. The bicycle rim and alternator pulley provide enough of a ratio to allow the alternator to produce power at water mill speeds (60-90 rpm).

For the rural regions of Nepal and surrounding countries, the cost of an alternator may still seem prohibitively high. Although it does account for much of the total cost (US$50), there is evidence that this is affordable. Nepal's Center for Rural Technology has successfully launched a programme to sell higher efficiency mill turbines for approximately US$80 to rural water mill owners. Over 600 new turbines have already been purchased and installed; sales are currently averaging over 250 per year. There should be a considerable market for a battery charger in a similar cost range.

The initial low cost of the battery charger is not the only advantage of the simple design. With the device's removable shaft, the mill owner can quickly switch between battery charging and the traditional grinding operation. With the bicycle wheel removed, the mill looks and operates exactly as it always has for centuries. The only permanent modification to the mill itself is the addition of the small square post on its key. This post does not interfere with grain being fed in between the grinding stones, and is completely out of sight.

***Specifications for water mill battery charger***

***Water Mill Battery Charger***

| | |
|---|---|
| Cost: | 3540 NRs (US$50) |
| Power: | up to 0.5kW |
| Voltage: | 14.4VDC |
| Pulley ratio: | 13:1 approx. |
| Belt type: | V-style car belt |
| Generator: | Car alternator |

The most significant advantage of using an inexpensive mill add-on to bring electricity to the mountains is sustainable maintenance. Maintenance is always a large concern when introducing new energy technology to remote areas of the world. Typically it cannot be maintained without additional infrastructure and technical expertise.

The Himalayan water mill, however, has been built and repaired locally by the mill owner and his family for centuries. They are already technical experts for most of the battery charging system. The electrical portion, the alternator, cannot be repaired by the mill owner, but it can be repaired by any auto garage shop in the country. There is no need for assistance outside the country, and no need for a major centralized repair centre. All parts of the system come from locally available, off-the-shelf components.

Renewable energy projects can be costly in the developing world. A considerable amount of time and capital is needed to create local expertise and manufactured parts. The Himalayan region, however, does not need to wait for such assistance. The technology infrastructure already exists to support basic power generation.

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