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The potential significance of micro hydro systems

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Today 1.7 billion people in developing countries do not have access to electricity, most of them living in rural areas. This number is increasing despite the rural electrification programs because such programs are not sufficient to cope with the population growth. Despite the fact that eighty percent of the world's population lives in developing countries, they consume only twenty percent of the global commercial energy; this, according to the European Small Hydropower Association (ESHA), a non-profit organization that is a founding member of the European Renewable Energy Council (EREC), which works closely with the European Union[1]. An ESHA publication on hydropower for developing nations also notes that:

> According to the World Bank, most of the world's poor people spend more than 12% of their total income on energy, that is more than four times what a middle-income family in the developed world spends. Achieving the United Nations "Millennium Development Goals" will require significantly expanded access to energy in developing countries[2].

Bangladesh is one such developing country. It is severely challenged by environmental and economic problems, ranging from catastrophic flooding to a very low per capita income; this, coupled with a population that is one of those with the highest density in the world. According to research carried out by Arun P. Elhance, author of the influential book, *Hydro-Politics in the 3rd World*, Bangladesh's capital city of Dhaka, a city of 8.8 million, is otherwise typical of other, less well-known, cities in Bangladesh; like them, suffering from "severe shortages of drinking water, domestic fuel, and electricity."[3]

These shortages have an economic root. But, most importantly, according to Elhance, they could be alleviated by utilizing the hydro-electricity potential that exists in the Ganges-Brahmaputra river system. Elhance states: "the shared waters also have the potential to contribute substantially to the economic development in the basic by providing an abundant, inexpensive and renewable source of energy through hydroelectric generation. The basin is endowed with tremendous hydroelectric potential of the order of 200,000 to 250,000 megawatts, of which nearly

[1] ESHA, "small hydropower for developing countries", 3.
[2] ESHA, 3.
[3] Arun P. Elhance, "hydro politics in the third world; the Ganges-Brahmaputra-Barak basin", 161

one-half could be easily harnessed."[4]

Given this potential, and provided Bangladesh can work out a mutually beneficial transboundary management plan with the upstream states of India and Nepal, the best answer to Bangladesh's energy crisis appears to be Micro Hydro Systems. According to an ESHA analysis, "Small Hydro Power (SHP) is a renewable energy source and suitable for rural electrification in developing countries... It can be connected to the main grid, used as a stand-alone option or combined with irrigation systems and can adequately contribute to the electricity needs of the developing world. Furthermore, the substitution of conventional sources of energy with renewable energies like SHP can help decrease CO_2 emissions... and also contribute to poverty alleviation and economic development by supplying electricity needs...[5]"

"Hydropower throughout the world provides 17% of our electricity from an installed capacity of some 730GW and another 100GW is currently under construction, making hydropower by far the most important renewable energy for electrical power production. The contribution of SHP to the worldwide electrical capacity is more of a similar scale to the other renewable energy sources (1-2% of total capacity), amounting to about 47GW and 25GW (53%) of this capacity is in developing countries[6]."

The ESHA study goes on to analyze the various types of SHP plants that are viable for developing countries: "Although there is still no internationally agreed definition of 'small' hydro; the upper limit is usually taken as 10MW (SHP definition supported by ESHA and the European Commission) and for large countries such as India and China this rises to 25 and 50MW respectively, in general SHP has minimal environmental impacts through the use of 'run of river' schemes. Also within the range of small hydropower, mini-hydro typically refers to schemes below 1MW, micro-hydro below 100kW and Pico-hydro below 5kW...[7]"

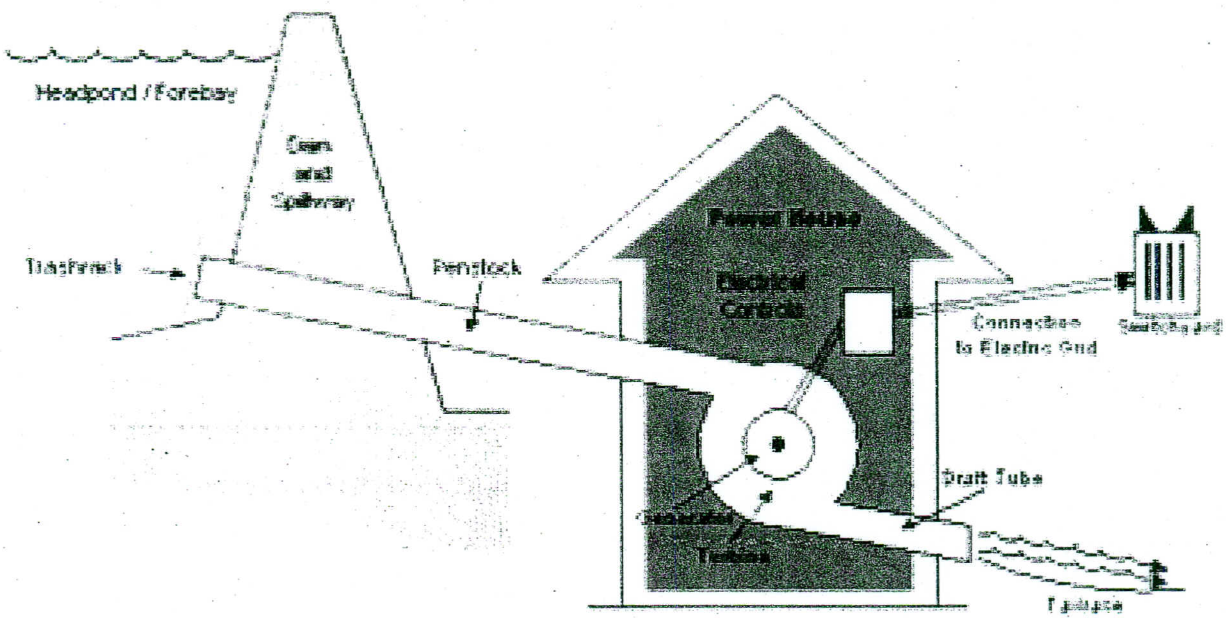
SHP plants can harness the hydropower potential of rivers and streams or brooks in hilly terrains, as has been shown very successfully by some Indian manufacturers of micro-hydro-turbines e.g. Jyoti Limited at Baroda [Vadodara] in Gujarat, India, who are one of the pioneers of

[4] Ibid., 163.
[5] ESHA, 3.
[6] Ibid., 4.
[7] Ibid.

this technology in this part of the world[8]. These micro hydro systems generate only kilowatts of power not Megawatts, and one can suffice for a small village, or a community. However the investment is low, running costs are lower and the efficiency is high.

According to the International Small-Hydro Atlas, hydropower systems "use the energy in flowing water to produce electricity or mechanical energy. The water flows via channel or penstock to a waterwheel or turbine where it strikes the bucket of the wheel, causing the shaft of the waterwheel or turbine to rotate. When generating electricity, the rotating shaft, which is connected to an alternator or generator, converts the motion of the shaft into electrical energy. This electrical energy may be used directly, stored in batteries, or inverted to produce utility-quality electricity[9]."

The same organization also describes the working of an SHP plant.



Parts of a small-hydro facility

"A small-scale hydroelectric facility requires that a sizable flow of water and a proper height of fall of water, called head, is obtained without building elaborate and expensive facilities. Small hydroelectric plants can be developed at existing dams have been constructed in connection with

[8] Jyoti Limited. "Major orders", Jyoti.com.
[9] International Small Hydro Atlas, "What is small hydro?" www.small-hydro.com.

river and lake water-level control, and irrigation schemes. By using existing structures, only minor new civil engineering works are required, which reduces the cost of this component of a development[10]."

According to the Canadian Renewable Energy Network (CANREN), SHP systems provide many benefits[11]; primarily, SHP plants do not take up much space or require the diversion of rivers, or changes made to shorelines. The fact that SHP plants provide low-cost energy alternative to fossil fuel for modern day living cannot be discounted. CANREN also claims the following benefits are accrued[12]:

- They use a local resource and therefore produce electricity at a stable price that is not subject to the fluctuations of the international oil market.
- They provide more economic benefits to the region by way of construction employment and use of local services, 10% to 25% of capital cost.
- They provide greater opportunities for local residents to learn and upgrade their construction skills.
- They provide an opportunity for wealth creation, notably, for First Nations.

CANREN does also mention that it is imperative to study fish migration patterns and habitats for spawning before implementing the design of any SHP plant; it is possible to cause no harm to aquatic organisms simply by ensuring either artificial spawning areas or fish diversion or passage structures[13].

ESHA has produced publications that are in tune with this idea, and have developed the following methods to ensure safe fish migration: (i) Constructing a fish ladder (i.e. dividing up total head into low passable steps between small basins), (ii) Constructing fish bypass systems, imitating the morphology as well as the hydraulics of small water courses and finally, (iii) Constructing fish lifts[14]. ESHA also propagates SHP systems that have an optimal environmental integration i.e. fish-friendly turbines. The research and development that ESHA has carried out, has focused on very-low- head and low-head turbines, as these sites make up the important remaining potential in developed and emerging countries. Notably, pico and micro hydro

[10] International Small Hydro Atlas.
[11] CANREN, "Technologies and Applications: small-scale hydro", www.canren.gc.ca.
[12] CANREN, "Socio Economic benefits"
[13] CANREN, "Environmental Impacts and Preventive measures."
[14] ESHA, "Environmental integration of Small Hydropower plants", 7.

turbines are developed to meet the demand for rural electrification and small isolated network[15]. ESHA also states that SHP systems can play a role in flood control, by raising the river banks while building the plant itself, which will in turn increase the amount of flow a river is capable of[16], though this is in no way a stand alone flood mitigation method. An ESHA publication also underlines the role played by SHP systems in irrigation:

> A lot of small hydropower plants have been erected and are still being realized in irrigation networks or channels, especially in plains where dozens of low head plants exploit the water resource both for irrigation and energy production purposes, supplying energy to the grid or to match electricity demand directly for irrigation (e.g. pumping stations)[17]

Thus we see that for Bangladesh, SHP plants have a lot to offer by way of low-cost energy, irrigation and flood control. Additionally, these resources will be provided with no environmental costs incurred. Small Hydropower plants could hold the solution to the woes of Bangladesh in the future.

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16 ESHA, "Environmental integration of Small Hydropower plants" 10.
17 Ibid.

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