Potentials for Renewable Energies in Sri Lanka

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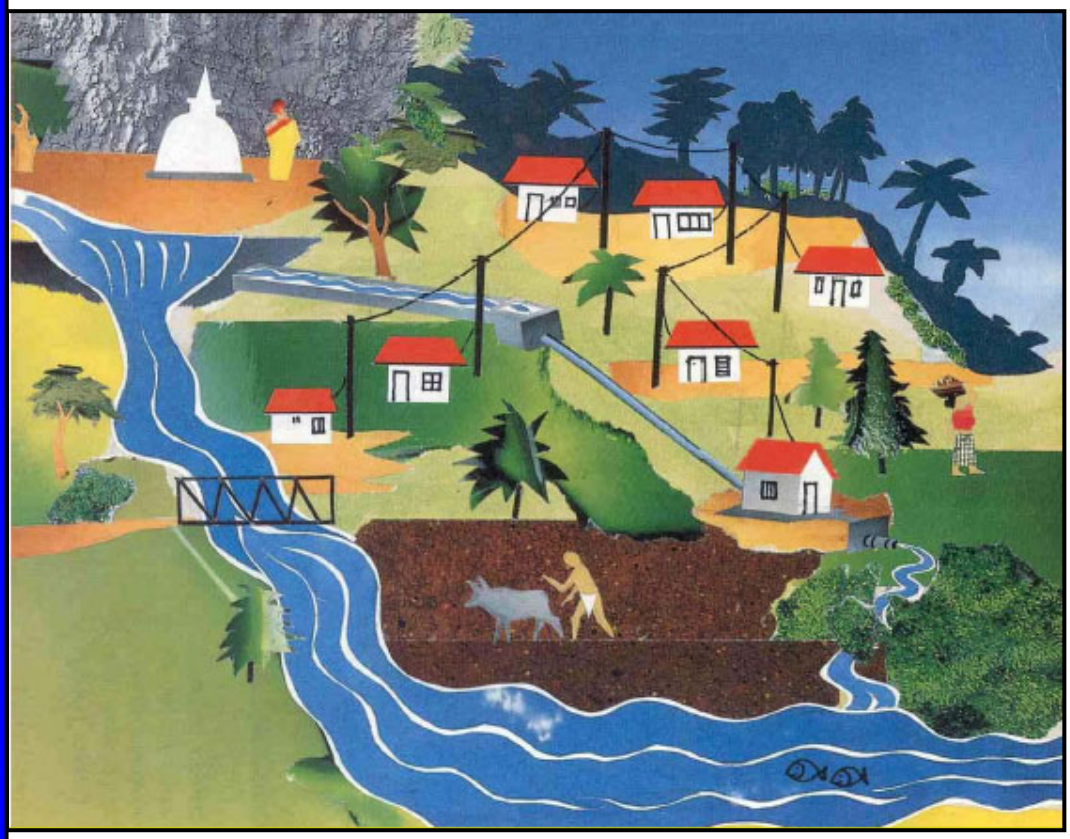

Extension Possibilities to Harness Small- and Micro Hydropower in Sri Lanka

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Foreword

"All is born of water; all is sustained by water."
Johann Wolfgang von Goethe

We know the physical term "Resonance", however, we find similar phenomena as well in biology, psychology and philosophy – and therefore, we can apply the laws of resonance just as to the relation between all the water of our earth and us human beings: To get in resonance with somebody or something, one has to broadcast appropriate signals of which contents can be accepted and replied.

And how do we treat our daily water? We take it for granted! We disregard and waste it thoughtlessly; we reject it in terms of taste and like it only with external additives such as coffee, tea or lemonade; we are not affected personally by the soil contamination in the cultivation; it must be available always and inexpensive, without taking the necessary manipulations and naturally unfavourable treatments in account; we completely don't care whether it has a future – forgetting about our children and we appreciate our own comfort more than respect the element water.

Which reactions do we expect? How long do we want and are able to persist in the opinion, that we stand above the Creation instead of feeling again, that we are a part of it, a guest of this earth and that without following the appropriate rules we soon will be kicked out by our "Mother Earth". Or would you tolerate a guest, who steals your reservoirs, pollutes and poisons your rooms and finally walls up your windows and exploits your last strengths?

Just express thanks for your good glass of water, be pleased about the refreshing rain and enjoy a walk by the sea or a river! This is the first step to restore a good resonance between you and the water.

To work together with the nature in a win-win situation, we still need to comprehend it more!

This is a water crystal of water that was exposed to the word "Peace".

Acknowledgement

Long since I believe the following:

- All I need to know does reveal to me.
- All I need comes to me.
- Everything is good in my world.

I feel big pleasure and happiness to gather here knowledge and to make it available to those walking on the same path.

I aim this dedication to all the people who showed me that what I know: to my parents, to my loves, to my friends, to my teachers, and the Divine and Infinite Intelligence, to channel through me that what the others need to know.

I also wish to express my appreciation to the supervisors of this report. On the one hand Dr. Eng. Jürgen Blumenberg and Dr. Eng. Markus Spinnler from the Technical University of Munich and, on the other hand first Prof. Dr. Eng. Rahula Attalage, the former and second, the new Head of the Mechanical Engineering Department of the University of Moratuwa in Sri Lanka, Dr. Eng. A.G.Thusita Sugathapala.

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Table of Contents

Executive Summary

Sri Lanka has been an agricultural country for more than 2,500 years. Still, most village folk are involved in cultivation as a livelihood. She continues to be an island of villages in rural landscape with 30% living in urban areas. Furthermore, 62% of the inhabitants do have access to the national grid while the electrification rate through all means is about 68%. In remote areas without electricity kerosene lamps for lighting or car batteries, which they have to recharge sometimes several kilometres away are used for minor electrical appliances such as television or radio.

The country has an installed capacity of about 2,000 MW (in 2004) with energy consumed by the different sectors (domestic 41%, industrial 37%, commercial 22%) and a forecast of 8% of annual growth of electricity demand. In comparison, the total installed capacity of Swiss or Germany is about 17,000 MW or 115,000 MW. Having exploited the techno-economically and ecologically viable part of more than the half (1,140 MW) of her commercial major hydro capacity, Sri Lanka is now looking at costly non-hydro sources of power. The reason is the long drought in 1996 in hydro reservoir areas which resulted in power cuts up to six hours a day. The inadequate owner forced the government- monopoly Ceylon Electricity Board to increase electricity generation, mainly through use of expensive thermal and gas resources. However, cost of electricity is a key element in attracting foreign investments into the island for its economic development. Furthermore, the use of imported fuel caused and is still causing electricity price increases and unfavourable environmental effects. This prevailing energy crisis in Sri Lanka is a manifestation of more deep-rooted problems in the governance and development policies. These developments emphasize the need for renewable energy sources which have also the advantage of serving the poor in remote, off-grid areas. This is very important in a country where over 50% of the population receive government subsidy, 70% live in rural areas and nearly half of these without grid-electricity or sometimes even road access. In Sri Lanka, hydropower would continue to be the main and the cheapest source of electricity generation in the medium term. Therefore the development of small hydro (up to 10 MW, SHP) and medium hydro power plants (up to 25 MW), having altogether an estimated exploitable potential of 450-500 MW, has been gaining more and more momentum in the past 15 years. However, it should be promoted with an increased intensity and also took in consideration in Sri Lanka's energy expansion plans for the future.

Principal Results

The country's main concern in the moment is to meet the growing demand of the industrial and the urban commercial sector. In countries with available water resources the electricity demand is met either by constructing only large power plants or by building small and micro hydro power (MHP) stations in rural and remote areas to supplement fewer large ones and so better use all available resources without harming the environment. Many countries, including the more developed ones like e.g. Swiss, Austria, Sweden or Norway are finding the second alternative more attractive. Fortunately, the geo-climatic conditions in Sri Lanka's wet zone is characterised by persistent rainfall lasting for nearly nine months of the year and by a large number of small but steep streams. Therefore, Sri Lanka has a relatively high potential for small-scale hydro power compared with her present installed nationwide capacity. Unfortunately, this decentralized source of energy is not considered to meet the country's major energy demand, even if there is a total estimated potential of about 500 MW. It has been estimated that there are about 200 MW of small water power sites up to a capacity

of 5 MW and a further 250-300 MW sites between 5 MW and 25 MW. This total potential of around 500 MW is over 25% of the island's installed grid capacity as at 2003. Besides reactivating the older ones, it would be advantageous to construct many new small or off-grid micro hydropower stations.

But according the United Nations University, the expansion of hydropower for the coming 20 years is expected to be around 220 MW in major development and 200 MW of small hydro, which does not yield firm power. Therefore, only coal and petroleum oil thermal plants appear for them to remain as the only viable electricity generating options. Additionally, the Finance Minister of Sri Lanka Dr. Sarath Amunugama said in one speech in 2004, that the "plan is to raise supply from SHP units of 10 MW to a total of 300 MW by 2008."

Nevertheless, the Ceylon Electricity Board (CEB) does mainly consider thermal sources in their electricity generation expansion plan for the period 2003 – 2017. They try to reduce the actual provision of hydropower in the electricity sector. The CEB is the monopoly power supplier in Sri Lanka and there is no independent power sector regulator. That means, that no other entity is allowed to produce power for sale to a third party.

The Government has so far undertaken two projects with the assistance of the World Bank to promote small hydropower. One is titled The Energy Services Delivery Project (1997-2002) and the other Renewable Energy for Rural Economic Development (RERED). The ESD Project was instrumental in the installation of 18,600 solar home systems (totally 875 kW), 56 off-grid Village hydro projects (aggregate capacity of 574 kW) benefiting 2,800 homes and 15 grid-connected small hydro projects generating a total of 31 MW.

The RERED Project actively supports Sri Lanka's vision of expanding rural electricity access to at least 75% by 2007. The project builds further on the demand driven market based approach initiated by the ESD Project and the collective capabilities of many stakeholders. Up to date there are 21 grid-connected small hydro projects with an aggregate potential of 58 MW and 68 off-grid village hydro projects (748 KW) approved and in development.

Nowadays, especially because of the ESD and RERED project, micro hydropower for off-grid electrification is getting more and more attractive. In November 2003 for instance, there were 161 off-grid micro hydro power (MHP) stations with a total capacity of 1622 kW in operation providing basic electricity needs of 3,687 households. Even if the power outcome is relatively low this is seen very successful due to remarkable achievements in terms of the number of units and households electrified. It is estimated that there are still about 1.023 micro hydro power off-grid locations having an aggregate capacity of about 41.5 MW. This could serve at least 100.000-200.000 households in remote areas to decrease the total number of about 2 million un-electrified households nationwide.

There is a long history of small-scale hydro plants in Sri Lanka starting in 1887 when the country was then known as Ceylon. Until 1959, there were more than 350 hydro plants installed. With a combined total capacity of 10 MW they were providing mechanical and electrical power for the country's tea plantation factories. None of them were connected to the national grid. After the early 1960s many of these schemes fell into disuse because of grid extension.

During the last years a sudden increase of MHP development activity was recorded. This is due to the growing interest among the Sri Lankan government, multinational donor agencies, private sector institutions and local and international NGO's. For example the ESD and RERED project financed by the World Bank had a big impact in the MHP sector. These kind of actions made the wider replication of these micro hydro community based

electrification experience possible. But this increased activity created also a worsening in quality in the recent MHP systems and services. This could endanger the whole concept if no appropriate actions are taken.

"An investigation by ITDG (Intermediate Technology Development Group, a NGO) and the Energy Forum carried out to identify ways and means to overcome this, through a series of workshops with key stakeholder of the sector namely the off grid micro hydro electricity consumers, project developers, equipment manufacturers and suppliers, and provincial council officers, has revealed the urgency for the setting up of a regulatory standards, building technical capacities of the manufacturers, and the adoption of technological developments in other countries, as some of the timely needs of this sector."

The cost for a new installation of a small hydro station is site-specific and varies from US$1,200 -3,000 per installed kW depending whether the turbine if it is manufactured locally or not. The cost for refitting old small hydro systems depends also from the location and varies from scheme to scheme. There is a total number of Old Estate Sites located mainly in the plantation sector.

Even if the total potential for small-scale hydropower (up to 5 MW) is around 200 MW, compared with the islands' actual installed capacity (2,000 MW), it offers a viable source of energy to supplement Sri Lanka's electricity demand. Its field is more located in rural areas without access to grid electricity or grid connected industries in the plantation sector, who once abandoned their small-hydro facilities because of CEBs grid expansion activities.

Potential Type	Potentials in Sri Lanka
MHP up to 100 kW	41.5 MW (1023 locations)
SHP 100 kW - 5 MW	150 MW (~400 sites)
SHP 5 MW - 10 MW	50 – 100 MW
Total SHP 0 - 10 MW	**About 240 – 290 MW**
Medium Hydropower 10 - 25 MW	**200 – 250 MW**

Table 1: Summary of Sri Lanka's Recorded Small-Scale Hydropower Potentials (2005)

Please note that the data for SHP is partly from the year 2000. The total national potential would certainly be higher than the present estimate, which is based on the data available to the author. Meanwhile it could also be that some planned SHP plants under the ESD project or even RERED are contributing to the national grid. Therefore, the author estimates the recorded potentials for SHP between 240 MW and 290 MW.

There are certainly still many low head locations (irrigation systems) which are not considered in the previous assessment surveys. Nevertheless, there are enough sites nationwide recorded, especially MHP locations waiting to be harnessed.

5.7 Protection, Mitigation and Enhancement Strategies

However, suitable design techniques make all these problems capable of being mitigated. The end product is a remarkably long-lasting, reliable and potentially economical source of clean energy.

Additionally, these three groups can help to improve the environmental effects of a SHP development.

Protection refers largely to land areas surrounding a hydro project including natural habitat which need to be protected by legislature, for example.

Mitigation strategies are either used to reduce an existing or unavoidable negative environmental effect or to compensate the caused damage. A mitigation measure would be, for example, the artificial restocking of a part of a river/stream, where the population of this particular species of fish has been drastically reduced due to a SHP system.

Enhancement methods are taken in order to minimize or alleviate impacts or maximise positive effects on the environment. Such enhancements minimize technically or naturally non-desirable effects by altering habitat conditions e.g. through creating a fish passage.

Another enhancement method is the following.

5.8 River Water Cleaning Through Hydropower Stations

In order to protect besides the turbine also the river water from all the debris that is commonly found in rivers, whether natural (such as leaves, branches and even tree trunks) or man-made (supermarket trolleys, plastic fertiliser bags or general garbage) a screen is put in the intake area. There are even self-cleaning intake screens available in the market (p. 111).

In the developed world, garbage collection and disposal carried out at a hydro installation is serving to clean up a river considerably. Everyone downstream is benefiting from this river-cleaning method, *"but usually at considerable expense to the operator. A major operating cost element is cleaning these screens, especially in low head situations where large flow rates pass through. Understandably, though slightly unjustly, the hydro-plant operators are usually prohibited by law from returning the rubbish collected on their screens back into the river.*[138]

From this point of view MHP and SHP is playing an important role to maintain the natural quality of the river water. River water is very important for every country as fresh water has became hot good in the actual period of our "blue planet" and rivers are the veins of this planet. Only 0.3% of the whole water on the planet earth consists of fresh water.[139] Fresh water is source for irrigation, drinking water for six billion people and has more other functions like e.g. keeping the flora and fauna alive. The rivers play hereby the important role as they are the veins of the earth.

An important scope for the future could be to investigate which other ways exist to purge anything from the water, which could have negative effects in any matter. Hydropower stations could be used as a station for a remarkably long-lasting, reliable and potentially economical source of clean and fuel-free energy and as a counter we can clean the water

[138] Quotation from *small hydro deserves to have its development accelerated in most parts of the world,* Peter Fraenkel, Renewable Energy World, March 1999.

[139] Compare *Wasser, das Lebenselexir. Wie Sie mehr aus dem wichtigsten Lebensmittel machen*, Ulla Kinon, Germany 1998.

within the same station through new kind of measures. Consequently, infrastructural costs can be shared through energy generation and cleaning in one and the same station.

Additionally, a lot of hidden economic costs are saved, too. On the one hand energy generated by fossil fuels have a proven bad impact on the environment, not only through CO2 emissions, there are also many other harming gases and particles emitted. Besides, even wars are made, to have the control over this "black gold", and wars cost a lot of money. On the other hand a cleaner water represents also high advantages for the cultivation sector and most important, for the population and flora and fauna.

Can Water Save Information?

More and more people consider not only the physical or chemical qualities of water. They believe that water can also save information, due to its complex and extraordinary structure (hydrogen bonds and dipole etc.). Dr. Masaru Emoto has been conducting numerous experiments in the past twelve years. Based on the same effect of different crystalline structures of snow, he made magnified pictures of frozen water crystals, of water collected from springs and cities or even water which was before stimulated by music, words and even feelings. The experiments show through high resolution pictures, that water can save information and so, has different qualities in terms of "good or bad information".[140]

	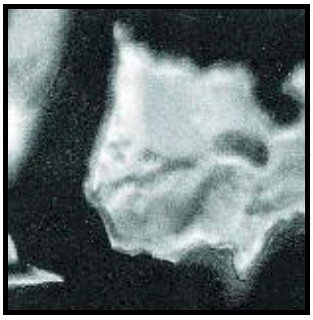	
Spring water of Saijo, Hirosh: The area around this city is well known for is good quality fort he Sake brewing. The crystal is branching out wonderfully	**Berlin (Germany): This is the energy structure of Berlin's drinking water The missing crystal structure concludes to not a good quality in the moment.**	**Thanks: In this experiment the word thanks was stuck on the glass. This resulted in a crystal with a very beautiful, good balanced shape.**

Table 32: Different Type of Water Crystals, Macro Pictures from Berlin, Saijo & Stimulated Water

Maybe, there is a chance to produce water with "healing" qualities, which certain spring water sources of our earth seem to have. This could best done through "multi-purposing" small and micro hydropower stations, or even large hydropower stations as all of them have turbines which could affect water in a more positive way as they do in the moment.

But to reach this scope, much has to be done in order to comprehend the complete nature of water and to find innovative methods to purify water.

[140] Compare *web page of Masaru Emoto*, online under: http://www.masaru-emoto.net [2005.02.02].