

# Developing Small and Mini Hydro as a Tool for Sustainable Development

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## ABSTRACT

Hydropower is a renewable and environment friendly source of energy which inherits a number of advantages over other source of energy. Small hydro is best in terms of their suitability for off-grid and remote located sites having little impact on local environment and fragile ecology. During recent years, small & mini hydropower are gaining momentum due to inherent advantage on smaller investment, short gestation period, grid isolated power solution and lesser conflict with social issues. Recently, Government of India has taken initiatives to involve private developers by formulating a long term policy for encouraging the development of small and mini hydro schemes. Ministry of New and Renewable Energy Sources and various state governments have offered attractive plans and incentives for faster development of SHP up to 25MW. With total estimated potential of more than 15000 MW of SHP on natural streams, canal falls and dam toes, Indian states and MNRE has generated enthusiasm among private entrepreneurs providing a unique opportunity for a profitable investment.

Himalayan and other hilly region of the country have fast perennial streams where hydropower can be harnessed at very low cost. Many states have taken lead role in developing their small hydro potential but the states like Arunachal Pradesh, UP & Uttaranchal, Jammu & Kashmir, Sikkim are lagging behind. Sikkim has become focus of attention for hydro developers investing for bigger projects but large potential of SHP is yet to be put on priority. The state government is hounding for the development of small, medium and large power project on Rangit, Teesta and its tributaries. Many states have shown their priority for eco-tourism which can be put on balance by developing small and mini hydro. Non-availability of hydrological data and lack of pre-investment study report of newly identified sites is major constraint for the development of SHP. Although projects are site specific but sharing of available knowledge will augment the growth of such projects in the region and will lead to economic prosperity in the remote areas.

## 1 INTRODUCTION

Use of water for deriving energy is the marvelous example of mankind's zeal to control this freak of nature. Hydropower inherits a number of advantages over other source of energy. The increase in population and the rise in the living standard of the people have put the policy makers and planners in a state where solution of power demand can be matched with the criteria of sustainable development and conservation of natural resource in their respective country. The renewable energy sources including small hydropower is an obvious answer to the future energy need of the people due to inherent advantages. Various hilly state are keen for the development of small/ mini hydro sites as it can fulfill the need of electric power for grid isolated population and have possibility of least interference with the site of tourist attraction.

## 2 ADVANTAGES OF SMALL HYDRO:

The small hydro project eliminates many weak issues involved in the development of big hydro scheme. The extent and the effect of the pre/post construction activity of a small/ mini hydro project are limited. Hence, the problem due to relocation of the people, socio-economic and institutional issues or the conflict relating to the right of ethnic minorities or indigenous people hardly arises. Small hydro projects are generally planned as run of the river scheme. They are located on the running streams where big reservoirs are avoided and thus proneness to the reservoir induced seismicity does not occur. Other advantages can be listed as below:

- Limited invested likely to be affordable by small private entrepreneur.
- Off-grid and remote area application can boost development in isolated area
- Almost negligible problem of resettlement & rehabilitation
- Shorter gestation period and early financial return
- very small head (up to 2m) can be exploited
- least environmental impact on flora and fauna
- Negligible problems like deforestation and threat to wildlife due to project.
- Increased public participation creates a sense of belongingness to the project
- SHP sector (up to 15MW) has the potential of claiming Clean Development Mechanism (CDM) benefits under Kyoto Protocol

## 3 DEFINITION OF SMALL/MINI HYDRO

The definition of Small/ Mini hydro plant is generally based on total station capacity which differs widely from country to country. The upper limit of station for the definition of small hydro stations in some countries are as below in Table-1.

**Table-1: Developed Small hydropower Potential**

Country	Definition of SHP (MW)
New Zealand, Philippines	= 50
Russia	= 30
India, China	= 25
Canada, Australia	= 20
Nepal, UK, USA	= 5
Pakistan	= 1

In India, the classification of small, mini and micro schemes has been done by the Central Electricity Authority (CEA) on the basis of total station capacity as well as unit rating (Table-2). Indian standard code IS: 12800 (Part-III)-1991 defines small hydro up to 15MW station capacity. After declaration of hydro policy in 1988, the Government of India has transferred the responsibility of hydropower development up to 25 MW to the Ministry of New and Renewable Energy (earlier known as Ministry of Non-conventional Energy Sources, MNES) and the definition has changes accordingly.

**Table-2**

Type of scheme	Station Capacity (kW)	Unit Rating (kW)
Small Hydro	= 25000	1001-5000
Mini Hydro	2001-25000	101-1000
Micro Hydro	101-2000	= 100
Pico Hydro	10-100	

## 4 POTENTIAL AND DEVELOPMENT IN INDIA

The total feasible hydroelectric potential in India is 148,000 MW which is more than 8% of world hydro potential. In addition to this, the country has 97,524 MW and 14,530 MW potential from pumped storage and small schemes respectively. As on 31.12.2006, hydro capacity of 33641.8 MW (26.33% of the total

installed capacity) has been developed in the country. The total installed capacity of electricity from all sources shows 12.2% deficit with respect to the peak energy demand in the country.

Small hydropower potential (SHP) of approximately 180000 MW is available throughout world out of which 22% have been developed. In India, 14530 MW SHP potential exist on perennial river system, streams and vast canal network. 1826 MW capacity have been developed at 556 sites of small Hydro project whereas projects totaling up to 600 MW installed capacity are under various stages of development. Karnataka is the top in terms of their installed small hydro capacity as well as highest capacity of small projects under implementation. During recent years, states like Kerala and Himachal Pradesh has shown their aggressiveness toward development of small/ mini project but other states like Sikkim, Uttaranchal and J&K are lagging behind in their effort.

## 5 STATUS OF SMALL/MINI HYDRO IN SIKKIM

Sikkim is a small Indian state sandwiched between Nepal and Bhutan and is located in eastern Himalaya. The state is a part of inner ranges of the mountains of Himalayas with elevations ranging from 300 to 8583 mtrs above mean sea level and consists of lower, middle and higher hills; alpine zones and snow bound peaks. Sikkim is best known for its pristine beauty and points of tourist attractions thus rightly called 'Small but Beautiful'. Tourism and hydropower sector is the main source of income for the State.

The topography of the Sikkim and lack of mineral resource in the region makes development of thermal or petroleum based project very inefficient and costly. Attention made by the planners in recent years has put this tiny state on the hydropower map in the country. The Government is hounding for the development of medium and large power project on Rangit, Teesta and its tributaries. Till 1993, the state government was focused on the small hydro project to fulfill the energy need of the state. The attention has now been shifted to the development of bigger projects as a source of state revenue.

Sikkim is one of the hydro-rich State of India. The first hydro power station was constructed in year 1964. Teesta and Rangit river system has potential of nearly 8000 MW with firm base of 3000 MW. Presently, hydro capacity of 100.70 MW exists in the state which includes 60MW Rangit-III H.E. Project constructed on great Rangit River. The state government has already awarded 29 big hydro projects totaling up to 5287 MW and the projects are under different stages of construction or investigation by the government or private agencies. All projects, except 510 MW Teesta-V HEP which is nearing its completion, are expected to be completed during 11<sup>th</sup> five year plan (2007-2012). According to the Power Survey done by the CEA, the peak power demand is 52 MW in the state at peak load during year 2004-05. The Rangit Power Station which was commissioned in the year 2002 gives share of 12% free power. After the construction of Teesta (stage-V) this year and other hydroelectric projects in future, the surplus power will enable the state to earn substantial amount of revenue.

Approximately 202.75 MW small/ mini hydro potential exist at 68 identified sites in the State out of which only a part of it has been developed. Nearly 37.70 MW small hydro projects are in operation by Sikkim Power Development Corporation whereas other 16 MW projects are under various stage of development at 4 sites. A list of construction and operating small power stations and their installed capacity is given below in Table-3.

**Table-3: Small/ Mini Hydro Project in Operation and Construction in Sikkim**

S.N.	Name of the Station	Installed Capacity (MW)	Firm Capacity (MW)
	<b>Projects in Operation</b>		
1	Lower Lagyap	12.00	6.0
2	Ronginichhu-I (Jali Power Station)	2.10	2.0
3	Rongini Chhu-II	2.50	2.0
4	Rimbi-I	0.60	0.4
5	Rimbi-II	1.00	0.5
6	Chaten	0.10	0.1

7	Lachung-I	0.20	0.2
8	Mayongchhu	4.00	2.0
9	Upper Rongnichhu	8.00	2.6
10	Rangpo Khola hydel	2.00	1.0
11	Rothak project	0.20	N.A
12	Kalej Khola	2.00	1.0
13	Rabom Chu-I	3.00	N.A.
	<b>Total</b>	<b>37.70</b>	
	<b>Project under construction</b>		
1.	Manglay	2.0	
2.	Lachung-II	3.0	
3.	Relli Khola	6.0	
4.	Rongli Khola	5.0	
	<b>Total</b>	<b>16.0</b>	

A list of other important small / mini hydro schemes, which have been identified and investigated by CEA, is given below in Table-4

**Table-4: Identified SHP schemes in Sikkim**

Name of the Schemes	River/ Stream	Diversion Level (msl)	Available Head (m)	Firm Power (KW)	Installed Capacity (MW)	Annual Energy (MU)
Tarum Chhu-I	Tarum Chhu	2800	180	1975	4.00	25.22
Tarum Chhu-II	Tarum Chhu	2600	500	8320	15.00	99.41
Rahi Chhu-I	Rahi Chhu	1600	320	6617	15.00	95.81
Rahi Chhu-II	Rahi Chhu	1120	200	4716	14.00	85.81
Rangli Khola	Rangli Khola	760	80	648	2.00	12.07
Kayum Rangit	Kayum Chhu & Rangit	1840	160	1408	4.00	23.51
Kalet Chhu	Kalet Chhu	720	160	4864	13.50	81.85
Raothok Khola	Raothok Khola	560	160	921	2.50	14.95
Manpur	Manpur khola	480	200	896	2.50	14.78
Ong Chhu	Ong Chhu	1600	240	2534	6.00	37.62
Rishi Chhu-I	Rishi Chhu	920	300	2316	6.00	36.65
Rishi Chhu-II	Rishi Chhu	600	160	1536	4.50	26.11
<b>Project which has already investigated</b>						
Rabom Chhu-II	Rabom Chhu	2349	327	3497	7.00	43.62
Hee Khola	Hee, Burung & Keyang	900	390.30	1500	3.00	13.14

The detailed project reports of Kalej khola-II (6 MW), Upper Rimbi (7.5 MW) and Bermek Khola (3 MW) are also ready. Six small projects viz. Upper Rimbi (7.5 MW), Kalej khola-II (6 MW), Hee khola (3 MW), Chatten-II (2MW), Kissim khola (2 MW), Barmelee khola (3 MW) and Ringyong khola (1 MW) have been awarded by the State Government. Unlike big schemes, the Government is developing small projects mainly through own resources however, fast result can be obtained by promoting private developers.

## 6 POLICY AND PLANNING FOR DEVELOPMENT

In India, SHP development is the part of new and renewable energy resource which has total potential of the order of 122,000 MW. Present installed capacity of small/ mini hydro project constitutes nearly 5.43% of the total installed hydro capacity in the country but the government aims is to add another 10% by year 2012. The government has plans to achieve 2% share from small hydro power stations that is being installed at grid interactive power generations. This would need another 1400 MW capacity addition during

11<sup>th</sup> five year plan (2007-2012). The Central Government is steadily increasing financial allocations over the successive five year plan periods for promoting renewable energy sources including small hydro.

The Ministry of New and Renewable Energy (MNRE), Government of India has formulated several policies for faster development of renewable energy sources including small/ mini/ micro hydro schemes. The Ministry offers several financial and fiscal incentives to the developers of small hydro schemes through its agencies like- Indian Renewable Energy Development Agency (IREDA) and other financial institutions in the following areas:

- a. Survey and Investigation of the project
- b. Preparation of Detailed Project Report
- c. Interest subsidy for commercial projects
- d. Capital subsidy for the government sector project
- e. Renovation and modernization of the old projects
- f. Development / up-gradation of the water mills (Mechanical/electrical mode)

The available subsidies from MNRE are linked to use of equipment as per IEC/international standard in order to maintain quality of construction.

The State Governments are also extending their support and concessions to the developer in the state. The GOI offers highest subsidy for the projects located in the North eastern state and Sikkim. Capital subsidy up to 90% cost of the project cost (subject to Rs. 75000/KW) are available for scheme below 500 KW located in the NE region. The subsidies are available on rational basis according to the location and size of the project. Under the Rural Village Electrification Programme, MNRE provides incentives up to 90% of the total capital cost (up to Rs 60000/ KW) for off grid application only. A brief list of the incentives available for North Eastern region, Sikkim and A&N islands is given below in Table-5. However, existing policy and detailed list of incentives available from MNRE can be found at the website of the Ministry.

**Table-5: Subsidy available from MNRE for SHP Project in Hilly Area & Sikkim**

Project capacity → Scheme ?	Below 500 KW	0.5 MW-1.0 MW	1.0 MW-5.0 MW	5.0 MW-15.0 MW	15.0 MW-25.0 MW
Survey & Investigation	Up to Rs. 1.00 Lakh		Up to Rs. 2.00 Lakhs	Up to Rs. 3.00 Lakhs	
Detailed Project Report	Up to Rs. 0.75 Lakh		Up to Rs. 1.00 Lakhs	Up to Rs. 2.00 Lakhs	
Interest subsidy for commercial projects	7.50%		5.00%	3.00%	2.00%
Capital Subsidy for Govt. Sector Projects	90% of project cost up to Rs. 75000/- KW	90% of project cost up to Rs. 60,000/- KW	75% cost of the project upto Rs. 45000/- KW	Equipment cost +25% of civil cost limited to Rs. 22.50 crore/ project	Nil
Renovation & Modernisation of old projects	Up to Rs. 200 lakh/MW		Limited to Rs. 10 crores/ MW		Nil
Development/ upgradation of water mills	Rs. 30,000 (Mech. mode) Rs. 60,000 (Mech./Elect. mode)				

(10 Lakh = 1 Million, 1 crore = 10 Million)

The newly enacted Electricity Act 2003 provides that the State Electricity Regulatory Commission (SERC) would promote generation of electricity from non-conventional sources by providing for suitable measures for connectivity to the grid and sale of energy to any person and also to purchase a certain percentage of total consumption of electricity in an area. In view of this, many states (16 nos) have announced their policy and have offered incentives for private sector participation in the development of small hydro

potential. The administrative and financial framework has been liberalized. States like Himachal Pradesh, Andhra Pradesh, Karnataka, Kerala have taken the lead but gloomy situation exist in north eastern states.

## 7 PRESENT LIMITATION AND FUTURE STRATEGIES

Most of small/ mini hydro sites are un-gauged hence there is lack of basic hydrological data. Small projects often lack of pre-investment study. Following are other limitations to the development of small/ mini hydro projects:

- i) Cost of the system is highly site specific and there is lot of variation in the estimate
- ii) Standardization and benchmarking of technologies need to be achieved
- iii) The Government has main focus toward development of other renewable sources
- iv) Small hydro projects are very limited to fulfill large gap between demand and supply of electricity in big states.

Presently, renewable energy sources meet nearly 3% of commercial energy demand in India. Wind power contributes major part of it but small/ mini hydro projects can take lead if proper thrust is provided. Properly constructed small hydro projects can put balance between energy need and conservation of ecology of the area. Mature and reliable technology, long operational experience and technical guidelines are available in India and neighboring country. Local people are showing their concern for the 'loss of identity' due to big hydro project. Very often, indigenous people are aggressive toward implementation of big scheme and they put forward small hydro as a solution. Advantages gained after development of community based small/ mini scheme can pave the way for bigger project also. Technical supports and consultancy services are available from institutions like Alternate Hydro Energy Centre (AHEC), NHPC Ltd and independent hydro consultants. Similarly, financial institutions like-IREDA, Rural Electrification Corporation (REC), Power Finance Corporation (PFC) or State renewable energy departments are providing soft loans.

## 8 CONCLUSION

South Asia has been projected as the region of highest energy consumption by the start of next decade. There are needs for fast development of energy sources but criteria of sustainable development and maintaining sanity of ecological and social conditions should be prioritized. Fortunately, hydro sector has capability to fulfill major part of the electricity demand especially in a country having large network of rivers, rivulets and canals. Environment driven search for green energy has put small hydro sector as the prime source of renewable energy. Small hydro projects are unique source of electricity for off grid and remote located mountain people. As the mountains are source of tourist attraction, development of small hydro can maintain harmony between two. The development of small/ mini/ micro hydro schemes through private agencies or by NGO seems inevitable in order to harness the potential at faster pace.

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