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Small Hydro: Too Small for a National Mission?

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As India braces itself for an over-ambitious Jawaharlal Nehru National Solar Mission, it also has to deliberate the prospects of developing other renewable energy resources. Of all the non-conventional renewable energy sources, small hydro represents the highest density resource and stands in the first place in generation of electricity from such sources world-wide. Also, the recent social and environmental consciousness has been responsible for shifting the focus from large hydro dams to small scale hydro power generation. It is in this backdrop that we need to look at the evidence on the potential and performance of small hydro resource to indicate whether this alternative source, like solar energy, qualifies for a national mission.

Tracing the trend of renewable energy development is impossible without taking into account the geopolitical factor of climate change. With the responsible ambition to work in line with 'Going Green' and 'Sustainable Development', India has been focussing on horizontal capacity addition from the non-conventional energy resources. But has it been an even and fair deal? On what factors has the priority list of renewable energy strategy been decided? These aspects have more impact and influence on understanding the renewable energy situation in India than the easily verifiable indicators like potential capacity and generation.

For the ease of comprehending the criteria for national mission or any other thrust of the same scale, comparing all the renewable energy resources on the verifiable parameters becomes essential (See Table 1.1).

Table 1.1[1]

RENEWABLE ENERGY COMPARISON				
SOURCE/ PARAMETERS	**BIOMASS**	**SOLAR PV**	**WIND**	**SMALL HYDRO**
Potential Capacity MW	61000	50000	45000	15000
Grid Interactive Installed Capacity (MW)	1083	46	14989	3153
Off-Grid interactive Installed Capacity (MW)	122 MWeq	2 MWp		
Estimated Capacity Factor	70%	20%	14%	50%
Electricity Generation Cost (Rs./kWh)	4 - 5	12 - 20	3.5 - 4.5	3 - 4

Objectively, solar energy ranks the lowest in terms of financial viability, capacity addition, and grid application. Although the weightage given to each parameter might change the ranking, still a national mission for solar energy might not find a rational ground for justification. But then, would the others make the grade for a huge scale developmental thrust and attention? Still unaware of the grounds on which solar resource development was made a national mission, evaluating other non-conventional sources both on objective and subjective grounds may be deemed necessary for planning and managing sustainable development of non-conventional energy resources.

From the point of view of profitability, off-grid application, social advantages and, moreover, its comparison to large hydro power, assessing small hydro for meeting the criteria for a national mission won't be unreasonable. Especially, in the light of the recent controversies over large hydro dams for causing irreversible environmental and social impacts, an alternative solution such as small hydro has gained prominence. Deliberating small hydro's eligibility for acquiring government's attention, funds and policies has the potential to unleash the entire discourse of renewable energy policies, design, implementation and development, with its commonalities to other renewables, other than solar which already is a national mission.

SMALL HYDRO POWER

Small hydro works on the same principle as large hydro for electricity generation. The turbine converts the energy from falling water into rotating shaft power, which in turn gets converted into mechanical and electrical energy. In most of the cases, Small hydro is 'run of the river'; in other words, any dam or barrage is quite small, usually just a weir and generally little or no water is stored.[2]

Historically, India has had knowledge of small hydro power generation for decades now. The first hydro power project commissioned in Darjeeling in 1897 for 130 KW marked the development of hydropower in India.[3] This was closely followed by the Sivasamudaram project of 4500 KW in Mysore district of Karnataka in 1902 which supplied electricity to Kolar gold mines. Till Independence in 1947, the cumulative installed capacity of small hydro power in India had reached 532 MW.

Traditionally, defining small hydro has been difficult even in the international arena since there are various degrees of 'smallness' of hydro power. In India, the widely accepted definition of small hydro power is projects up to the station capacity of 25 MW. Further, the Central Electricity Board and Bureau of Indian Standards have classified small hydro according to their power output:

Table 1.2: Classification of Small Hydro in India

CLASS	STATION CAPACITY IN KW
Micro Hydro	Up to 100
Mini Hydro	101 to 2000
Small Hydro	2001 to 25000

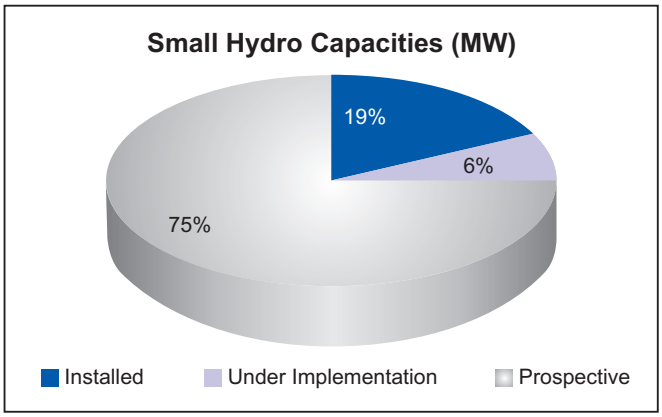
In India, as a result of careful contemplation, small hydro has been classified under 'other renewable energies' and large hydro is considered separately in all resource and energy statistics and evaluations. However, many of the studies and reports group them together, especially when mentioning potential capacities. This may be misleading and therefore it is required that the distinction should be made more clear and comprehensible.

CURRENT STATUS OF SMALL HYDRO POWER

Small hydro stands at 15,384 MW potential, out of which 2953 MW has already been implemented through 801 public and private projects. Further, 271

projects are under construction with an aggregate capacity of 941 MW.

Figure 1.1: Current Status and Prospects of Small Hydro Power in India.[4]

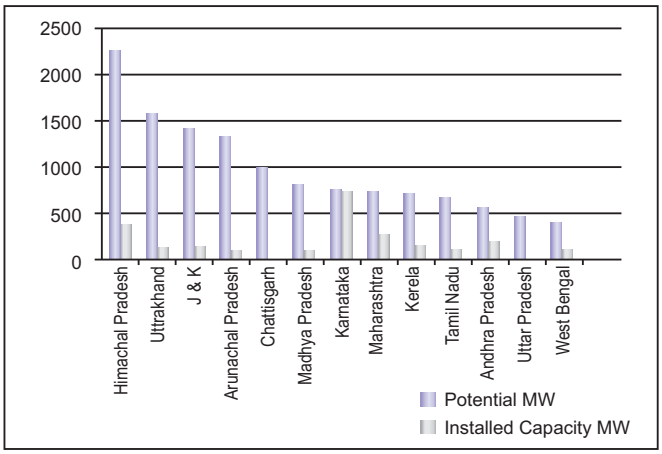


As visible from the chart (Figure 1.1), 75% of the capacity is still untapped, which logically should attract investments. Given the dynamics of the technical feasibility, costs, benefits, policies and governance, the above calculated potential capacity substantially reduces.

Breaking up the potential capacity into states (Figure 1.2) reveals an uneven distribution of the resource. However, each state's strength in executing the small hydro projects is independent of the resource potential capacity. For instance, Karnataka, brilliantly, has been able to harness almost all its small hydro potential having only 4.8% of the total potential capacity; whereas, the state with the maximum potential capacity (14.74%), Himachal Pradesh, has shown only 28.3% development. Given such a huge gap between the potential and its realization, policies, regulations, incentives and subsidy schemes should be reviewed for all states.

Is the decentralized form of resource management disrupting the development or is it that since it is decentralized, thereby at least few of the active states have managed to harness the small hydro potential? This needs to be looked into more deeply to grasp the course of small hydro development in India.

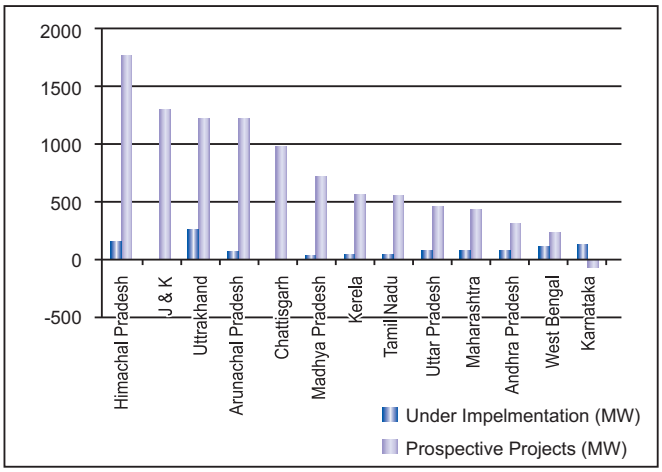
Figure 1.2: Potential and Installed Capacity of small hydro Power in India.



Source: MNRE, 2011

After seeing the glass half full, glancing at the glass half empty hardly adds any positivity to the story. The projects under implementation scored 6% of the total potential. Looking at the state-wise distribution (Figure 1.3) reinforces the same question mentioned above about the decentralization of resource management.

Figure 1.3: Comparison between the Projects under implementation and the prospective projects.[5]



Source: MNRE, 2011

According to the graph (Figure 1.3), the only states showing active participation in small hydro development are Himachal Pradesh, Arunachal Pradesh and Uttarakhand. Although the cumulative project capacities under implementation add up to around 914.81 MW, this is hardly of any significance. A comparison of the individual state policies, regulation and governance needs to be measured and lessons could be compiled vis-à-vis Karnataka to derive

strategies for small hydro development in the country. The current status of small hydro definitely asserts the fact that this resource has a vast potential. But connecting it to the larger context of renewable resource development and the possibility of making it a national mission, we need to look at the other dimensions.

SMALL HYDRO: DEBATING THE POTENTIAL

It would be simple to paint an idealistic picture for the potential of small hydro but it would be far removed from the ground reality. Objective indicators are verifiable but subjective—social and environmental—concerns cannot be neglected in assessing the resource potential.

Small hydro projects are economically more viable than competing sources of renewable energy such as wind and biogas.[6] The cost of power from small hydro is comparable to the cost of coal generated power which is around Rs 2-3/kWh. Also, small hydro does not have any variable fuel cost as compared to conventional thermal power plants which rely on coal or natural gas. Primary costs such as depreciation, return on equity and interests are derivatives of the capital cost. Even operation and maintenance costs are comparatively low when determined as a percentage of the capital cost.

Given the economic rationale, the importance of small hydro increases manifold in its rural application. It is significant for off-grid, rural, remote area application in far flung isolated communities lacking grid connection. Small hydro being operationally flexible is suitable for peaking support to the local grid as well as for stand-alone applications in isolated remote areas.[7] It offers great potential for not just achieving sustainability but also conforming to national priorities like rural electricification, capacity building and infrastructure.[8] Given the rural energy scenario, extension of the grid system is comparatively uneconomical in remote and hilly areas. Therefore, promotion of mini, micro and small hydropower projects offers a practical solution to the issues of inadequate, poor and unreliable power supply.

To add to the social aspect of small hydro, the fact that it is the most environmentally benign renewable energy resource makes it even more lucrative for power generation. It is non-polluting; emits least amount of CO2; it has least impact on flora, fauna and biodiversity when compared with large hydro power projects. It does not even require deforestation, submergence of land or rehabilitation.[9] Small hydro projects face fewer environmental clearance hurdles compared to large hydro power projects and, therefore, are generally not contested by social and environmental groups.

Further, the United Nations Framework Convention on Climate Change (UNFCCC) categorizes stand-alone small-and micro-scale power generation projects as "Type 1: Renewable Energy projects"[10] to assist the small hydro projects in different countries. It, thus, qualifies under the 'Clean Development Mechanism' (CDM) and other national renewable promotional initiatives such as Renewable Energy Certificate (RECs). Approximately Rs. 0.5/kWh electricity generated from small hydro can be gained in the form of carbon credits.

Compared to large hydro projects, small hydro projects have a shorter gestation period; higher return on investment due to low capital investment and operation and maintenance cost; they are easier to construct and commission due to simpler designs; hence, they keep the costs down.

After discussing these prominent and critical merits of small hydro projects, it is imperative to assess the question: Does small hydro qualify to be a national mission? Given the small hydro potential of 15,000 MW, it would be naïve to argue that small hydro power is the answer to India's growing power shortages. In the

broader context, India's energy basket consists of less than 2% of renewable energy generation capacity (solar, wind, biomass, small hydro etc.) and actual generation is less than 1%. Out of this, small hydro takes only a small share.

Secondly, majority of the small hydro power projects are stand-alone and lack connection to the grid. Therefore, transmission and sale of the surplus power to the larger grid is often not possible. Decentralised uses such as electrification of rural households and small scale economic activities is much discussed but demand is often much lower than anticipated. In such cases plant load factor is low, thus resulting in poor revenue collection.[11]

Thirdly, according to industry experts, most of the financially feasible sites have already been allotted to public developers. Many of these projects are under implementation. The remaining sites are either in the North-east and technically non-feasible or they are economically non-viable.

Fourthly, high capital cost of Rs. 7-8 crores/MW for small hydro projects which is comparable to that of large hydro reduces their relative attractiveness for investors in the absence of capital subsidies and incentives. Since the small hydro sector does not receive benefits or incentives as do other sources of renewable energy such as solar power, the private sector does not find this sector lucrative enough for business.

Finally, despite the additional fiscal benefits from CDM, small hydro project bankability has been questioned. The cost variables vary depending on location, infrastructure and connectivity to the grid. The only projects seen making any profits are the gird-connected ones. Also, since REC (Renewable Energy Certificate) is not applicable to the off-grid projects, they fail to meet the financial objectives and, thereby, the underlying social objectives of community development and rural electrification are not met.

CONCLUSION

In light of the above assessment of small hydro, it can be concluded that its potential as a major source of energy is limited. However, it can be an attractive source of clean and economically viable source of energy for rural communities in certain geographic locations. If appropriate incentives are provided, it can also become an attractive business opportunity for the private sector. Given that it easily qualifies for CDM benefits, it can also attract foreign investment. The key to developing decentralised energy solutions such as small hydro is to look at them holistically as a means for economic development rather than merely as a source of energy supply.

The high capital cost remains a major constraint in developing small hydro unless there is a technology breakthrough. However, on the other hand, the environmental and social benefits of small hydro have the potential to offset the high capital cost, given a strategic design and proper implementation. Since, in any given development project, social and environmental externalities can no longer be discounted, as demonstrated by large hydro power projects, development of small hydro can serve as a role model for developing other decentralised energy solutions.

Learning from the small hydro development discourse, it is evident that more focus is required in the research and development of technologies to harness the renewable energy potential. Specifically, storage technology (both grid and off-grid level) would provide steadier energy prices and more efficient power-plant networks. Also, even partial breakthroughs in next-generation storage development should be freely shared across nations.

Integrated resource development approach may add more feasibility to the alternate energy development projects. For instance, small hydro projects combined

with the biomass energy generation plants may cater to each other's demerits and provide a practical solution to unreliable, inadequate energy supply to the far flung areas with no grid connectivity. Such innovative models need to be experimented with and reviewed.

Another important area that needs urgent attention and focus is decentralized alternative energy solutions. Since most off these resources are unevenly distributed and have greater off-grid application, development of a strategic business model is required for a decentralized region-specific and resource-specific energy solution. This, obviously, requires intensive resource data collection, environmental modelling and impact assessment, basic engineering, social impact assessment and technical support from the Government of India.

Most of the issues discussed with small hydro are common with the other sources of renewable energy. Objectively and subjectively speaking, there is no reason for prioritizing one or the other resource; rather, they should be encouraged equally at a national level. Therefore, there is a need for an assimilated national mission for the development of alternative energy forms in India.

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