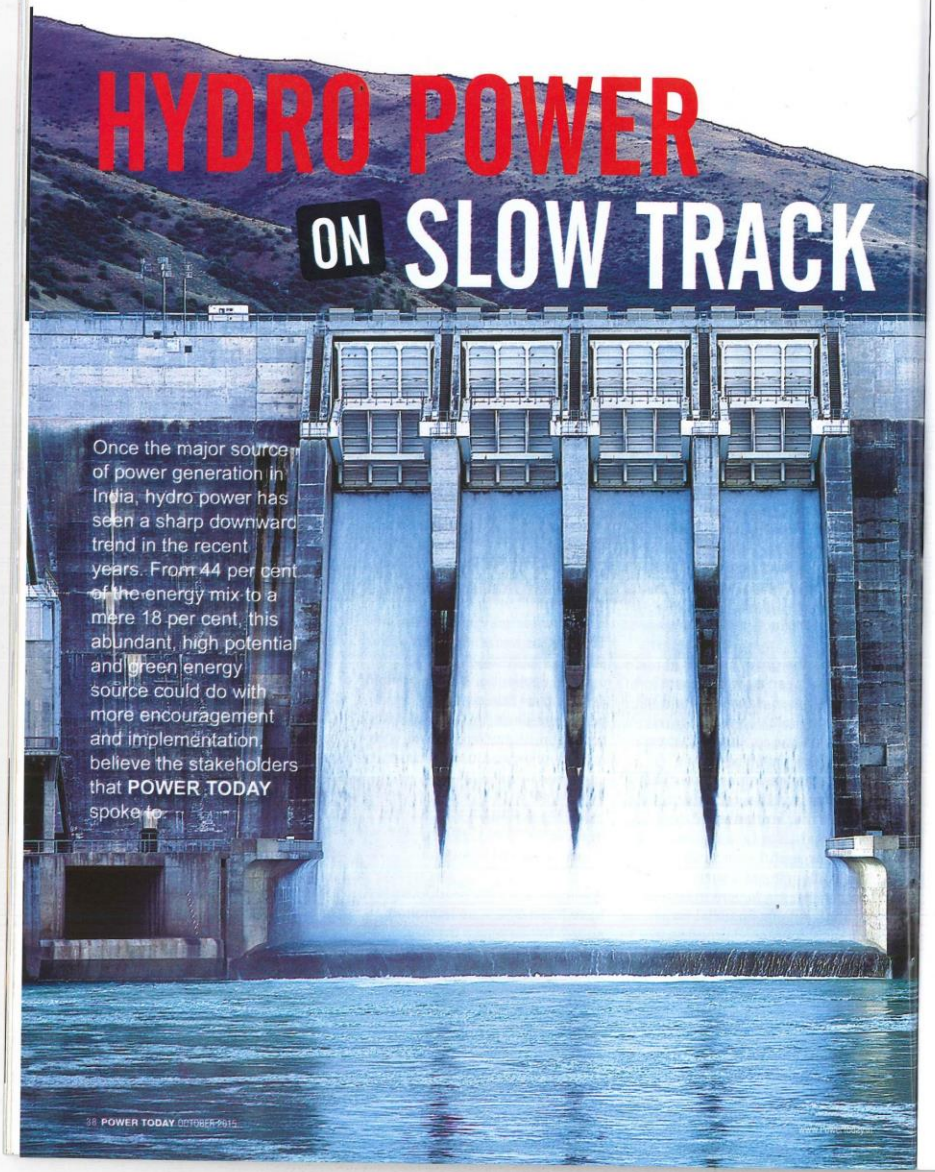
HYDRO POWER ON SLOW TRACK



Once the major source of power generation in India, hydro power has seen a sharp downward trend in the recent years. From 44 per cent of the energy mix to a mere 18 per cent, this abundant, high potential and green energy source could do with more encouragement and implementation, believe the stakeholders that **POWER TODAY** spoke to.

For decades, hydro power has been an important source of renewable energy world over. Today, it forms around 50 per cent of the electricity production in 66 countries and about 90 per cent in 24 countries. However, hydro power accounts for only 18 per cent of total power generation in India today, which is a steep decline from 44 per cent in 1970. Capacity addition has also been low and slow, despite high targets set by the government and India ranking fifth in terms of usable hydro power potential in the world.

In addition to the potentiality, several factors make hydro power an attractive proposition – its short development cycle, comparatively lower capital investment, long productive cycle and the fact that it is a renewable and eco-friendly source as compared to other energy sources. No doubt all the above factors have led to renewed interest in hydropower development in the country, but the progress has been at snail's pace.

"Compared to other energy sources, the growth of hydro power in the country has been decelerating of late. From 44 per cent in 1970, the share of hydro power in the energy mix has fallen to less than 18 per cent today. Only 5.5 GW of hydro power capacity was added out of the targeted 15.6 GW during the XI Plan period," points out **Rohit Mittal, Senior Energy Specialist, The World Bank.**

With a total potential of more than 148 GW (in terms of installed capacity), hydro power remains one of the critical options to address the energy or peak shortages and limit the carbon intensity of the power sector. The hydro power plant's ability to respond quickly to demand fluctuations make them the ideal source to cope with demand peaks and to stabilise system frequency.

"Hydro power can also provide

the balancing capacity required for large-scale integration of renewable energy sources into the grid that are otherwise characterised by high degree of generation variability. However, India is yet to harness its hydro power potential in an optimum manner," Mittal adds.

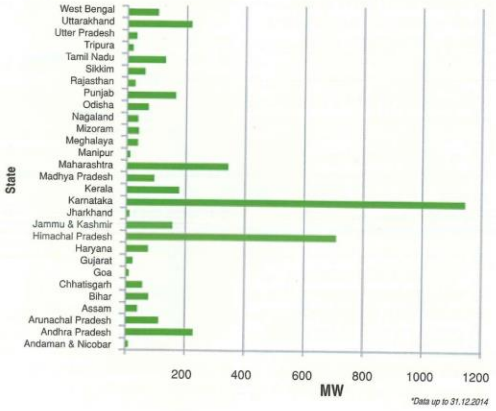
Seconds **Hitesh Sachdeva, Director, Infrastructure Corporate Finance, KPMG Advisory Services Private Limited,** "Hydro power exploitation in India has slowed down to a trickle over the last couple of years. The principal reason has been a large mismatch in the appreciation of benefits and risks of hydro development by key stakeholders."

Private sector developers typically underestimated the technical and managerial challenges associated with project execution, leading to a large number of projects running into time and cost overruns. This has, in some cases, raised questions on the project viability itself.

"The concessions that the state governments have lent are not enough to support hydro power exploitation in difficult to access regions. While project allocation has been carried out, no supporting logistics and/or evacuation infrastructure is available or is in sight," he observes.

Concurring that remote inaccessible locations and issues associated with hydro are a major barrier, **Dr Sunil Kumar Singal, Principal Scientific Officer, Alternate Hydro Energy Centre (AHEC)** says, "Main reasons for slow progress are difficult locations, short working season in hilly areas and acquisition of private and forest land for setting up the plants. Other issues would be natural calamities, geological

State-wise Small Hydro Power Installed Capacity*



*Data up to 31.12.2014

"WE AIM TO ADD 4,500 MW OF SHPs IN THE SUBSEQUENT THREE YEARS"

In an interaction with POWER TODAY, **BK Bhatt, Director, Ministry of New and Renewable Energy** talks about the status and development of SHPs in India.

What is the estimated potential of SHP in India?

The estimated potential for power generation in the country from small/mini hydel projects is 19,749 MW from 6,474 identified sites, 50 per cent of which are located in Himachal Pradesh, Uttarakhand, Jammu & Kashmir and Arunachal Pradesh. Sizeable potential also exists in the plains of Maharashtra, Chhattisgarh, Karnataka and Kerala.

Tell us about the Ministry initiatives in this direction.

The Ministry has taken several steps to promote SHP development and improve reliability and quality of the projects. Apart from subsidising state governments to set up SHPs, we have also attracted investments in commercial SHP projects by giving various physical and financial incentives. The Ministry is promoting the use of new and efficient designs in water mills for mechanical as well as electrical generation and setting up of micro hydel projects up to 100 KW for remote village electrification.

These projects are taken up with local organisations like the water mills associations, cooperative societies, registered NGOs, village energy cooperatives, and state nodal agencies. The Ministry has been providing Central Financial Assistance to states and the private sector to set up small/mini hydro projects and has also been organising technical support and training through Alternate Hydro Energy Systems (AHEC).

So far, 23 states have announced their policy for private sector participation in SHPs

What is the status of private participation in these projects?

The Policy for SHP and private sector participation, is governed by the Electricity Act 2003, the National Electricity Policy 2005 and Tariff Policy 2006. So far, 23 states have announced their policy for private sector participation in SHPs and the State Electricity Regulatory Commissions (SERCs) have been empowered to decide on various components of the policy such as tariff, wheeling, banking and third party sale for grid interactive renewable energy-based power projects in their respective states.

A large share of capacity addition is being achieved through private investment. Out of the 6,474 SHP projects in the country, 395 SHP projects with total capacity of 2,227.60 MW have been set up through private sector participation.

What has the National Mission role been in promoting SHPs?

The objective of the National Mission on small hydro is to address issues responsible for decline of the SHP sector in the country and to regenerate interest in it with the government, communities and private sector.

The Mission's target is to achieve 500 MW of capacity in the next two years and we aim to add 4,500 MW in the subsequent three years, for which preparation, including appropriate policy interventions, will be done in the first two years of the mission.

Other major objectives include creating an enabling policy framework along with the states for the deployment of 5,000 MW SHPs by 2022; evaluating all existing government sector SHPs with a view to renovate, modernise and upgrade them, if required; developing new technologies and engineering solutions to set up low and ultra low head (below 3m) SHPs on canals, dam outlets and water outfall structures; developing a network of water mills, individual household systems and micro hydro projects in remote and rural areas and identifying new small hydro potential sites, etc.

uncertainties, economic viability of isolated plants due to low load factor and time consuming process for allotment of sites and obtaining statutory clearances."

GOVERNMENT INITIATIVES

The Government of India (GoI) has, over the years, taken several initiatives to prioritise hydro power development like the New Hydro Policy 2008, which provides for transparent bidding, extension of cost plus tariff regime, earmarking of one per cent free power from every hydro-power projects for Local Area Development Fund, etc.

Foreign Direct Investment up to 100 per cent is permitted in the hydro sector, under the automatic route for generation, transmission, distribution and trading; AHEC, an exclusive academic center of IIT-Roorkee was set up by the Ministry of New and Renewable Energy (MNRE) in 1982 to boost the development of SHPs in India, in 1992 the sector was opened to private participation too.

Yet, the development of hydro projects have failed to gather momentum for various reasons cited earlier. Further, water in India is a state specific subject and each sate government has adopted varying policies. In addition, several projects with common river systems have been held up due to disputes on water-sharing. The Sutlej-Beas dispute between Punjab and Haryana and the Mullaperiyar dam conflict between Kerala and Tamil Nadu are two such typical cases. All these factors have led to several projects being stalled for years.

"Compared to other energy sources, the growth of hydro power in the country has been decelerating of late. From 44 per cent in 1970, the share of hydro power in the energy mix has fallen to less than 18 per cent today," Rohit Mittal, Senior Energy Specialist, The World Bank.

PRIVATE PARTICIPATION

These impediments and risks have naturally led to lukewarm response from private players, with the private sector contributing to only 11.5 per cent of the total capacity addition between 1991 and 2012.

Anil Sardana, Chief Executive Officer and Managing Director Tata Power lists out some of the challenges faced by private players, "Some of the typical challenges faced by private players in setting up hydroelectric plants are long gestation period of construction due to environmental issues, R&R problems, gap between investigations and field realities."

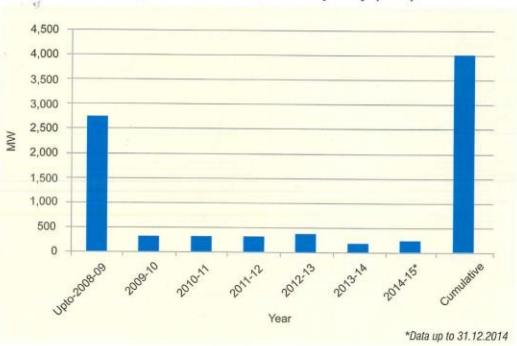
He further adds, "The capital intensive nature of these projects makes finding a balance between bankability and affordability a challenge. It is advisable to engage in details with stakeholder communities in advance of setting up a project for a successful R&R. The government might also look into the R&R directly and inform developers of what is required of them in advance of the bid for the project."

Tata Power, which commissioned India's first hydro-electric station in Khopoli in 1915, has entered into an exclusive partnership with Norway-based SN Power to develop hydro power projects in India and Nepal.

The public sector by itself does not have the financial and managerial capacity to exploit India's 145 GW hydro potential, which is why the role of the private sector is critical. And since the private sector involvement is critical to the development of hydro power, several measures have been suggested by industry pundits.

Emphasising the importance of private participation Sachdeva puts forward his suggestions, "the

Year-wise Small Hydro Power Installed Capacity (MW)



*Data up to 31.12.2014

encounter the problems of deforestation and resettlement associated with large hydel projects. They have the potential to meet power requirements of remote and isolated areas. These factors make SHPs one of the most attractive renewable source of grid quality power generation," says Bhatt.

Yet SHPs too have not progressed as envisaged. "The potential of SHP in India is about 19,750 MW out of which only 3,991 MW, has been developed so far," reveals Dr Singal.

"The term 'small hydro' has a wide range in usage, covering schemes having installed capacities of a few kW to 25 MW. In India, small hydro schemes are further classified as: micro hydro upto 100 kW plant capacity, mini hydro from 101 kW to 2,000 kW and small hydro up to 25,000 kW plant capacity," he explains.

"Most schemes are in the Himalayan region, with steep hilly terrain, no firm geology and avalanches and land slide prone areas. Due to these uncertainties, medium and high head schemes are considered more site specific," Dr Sunil Kumar Singal, Principal Scientific Officer, AHEC.

AHEC is in the process of establishing an international-level Hydraulic Turbine Laboratory to setup design and test facility in hydro turbines and other hydro mechanical equipment conforming to national and international standards and to carryout research and development.

SHPs have their plus and minus points says **Sandeep Singhal, Director (Projects), Uttarakhand Jal Vidyut Nigam (UJVN) Limited**. SHPs are easier to set up for various reasons. The techno-economic concurrence of the detailed project report of SHPs is not required from the Central Electricity Authority (CEA); nor is environmental clearance from the Ministry of Environment and Forest (MoEF) necessary - only forest clearance for diversion of forest land is required from the state forest departments.

Besides this, the R&R requirements are also minimised as private land acquisition is minimal. The hydrological data and geological investigations take less time, the tunnel length and size of other structures such as power house, weir, etc., are much smaller as compared to large projects, so is the length of transmission lines as the power is normally consumed locally, he explains.

However, he disagrees with the view that a number of SHPs are more beneficial than a large hydro project (LHP) and sets out the reasons as concluded by the cumulative environmental impact assessment studies done on Alaknanda and Bhagirathi River Basins by a consortium of AHEC, IIT-Rorkee, NIH Rorkee and HNB Garhwal University.

As per the studies, cumulative impact of 10 SHPs of say 20 MW each is much more than that of a single large plant of 200 MW. The tariff of LHP is normally lower than the tariff of a SHP. The Plant Load Factor (PLF) for SHPs is much lower (around 25 per cent) as compared to PLF of LHPs which is approximately 45 per cent. The chances of damage to SHPs due to heavy rains/floods or cloud burst are much higher as compared to large projects, which are designed for a return flood of not less than 1:100. The operating cost of a single LHP will be less as compared to that of a number of SHPs.

UJVN primarily responsible for SHP development in Uttarakhand today operates 13 hydro power projects in the state. It is also currently developing 6 LHPs and 22 SHPs in the state.

Hydro Power – Fast Facts

National

- Sidrapong Hydel Power Station, set up in 1897 near Darjeeling is the oldest hydel power station in India.
- India ranks fifth in terms of usable hydro power potential in the world.
- Today hydro power accounts for only 18 per cent of total power generation in India.
- Private sector contributed only 11.5 percent of the total capacity addition between 1991 and 2012.
- At present, a capacity addition of about 250 MW per year is being achieved from SHPs, of which, more than 70 per cent is coming through private sector.
- So far , 1047 small hydropower projects have been set up in the country and 206 projects are in various stages of implementation.

International

- Hydro power forms around 50 per cent of electricity production in 66 countries and about 90 per cent in 24 countries.
- Norway meets about 99 per cent of its electricity needs from hydro power.
- First hydro-electric power station in the world was built in Wisconsin, USA in 1882.
- Largest hydroelectric power station is in China - the 3 Gorges dam with a generating capacity of 22,500 MW.
- Tallest hydro power station is at Rogun dam in Tajikistan which is 1,000 feet tall.

Note: Collected from various sources

"For LHPs, pumped storage technology enables large scale storing of energy at lower prices. They respond quickly to demand changes, provide grid operators with flexible facility, and are also efficient," Anil Sardana, CEO & MD, Tata Power.

TECHNOLOGY TAKE

Technology no doubt plays a key role in hydro power development, not only in increasing the generating capacity and operational efficiency, but also in improving the environmental compatibility of hydro power. Hydro power plants too have their own impact on the environment. Large dams across rivers, apart from altering the character of the river, can affect fish and wildlife populations. They can cause floods leading to the displacement of project area people. In this context, integrated hydro-electric projects involving not only supply of electricity, but also providing for drinking water, irrigation and flood moderation, etc., are considered an ideal model.

The technologies now being used in India have their own pros and cons. The run-of-the-river technology is largely used for small hydro projects with capacity of less than 25 MW. Sardana elaborates, "This technology is advantageous as they can be set up with minimal investment and do not need large stretch of land for reservoirs. However, the disadvantage is that they are seasonal, generating more power during monsoon when river flows are high, and much less during summer or winter when the rivers are dry or frozen. Another issue here is that there needs to be a steep drop in the river and such potential sites are limited."

For LHPs, pumped storage technology is most commonly implemented as this uses reservoirs to store water, and generate power with the differential height between the upper and lower reservoirs. Sardana lists out its advantages, "this technology is simple and robust, and can easily be scaled to storing large quantities of energy at lower prices. The pumped storage turbines can respond quickly to demand changes and they provide the grid operators with a very flexible facility. Moreover, they are efficient, even reaching around 80 per cent for the storage and generation cycle."

Adds Bhatt, "Low head and ultra low head (less than 3 m) projects can be set up on canals, in sewerage treatment plants and for run of river micro hydel projects for village electrification. They have dual mode - off-grid and grid-connected capacity, so that they can be connected when grid is available, making off-grid projects viable for the long term."

Internationally, several new technologies are being explored and experimented. The tidal current energy is one such emerging form of renewable energy. Here tidal turbines are installed on the seabed at locations with high tidal current velocities,

Top 10 countries (in terms of hydro power capacity)

Country	Power Capacity (MWh)	Installed Capacity (MW)
Tajikistan	527,000	4,000
Canada	341,312	66,954
USA	319,484	79,511
Brazil	285,603	57,517
China	204,300	65,000
Russia	160,500	44,000
Norway	121,824	27,528
Japan	84,500	27,229
India	82,237	22,083
France	77,500	77,500

Source: Energy Alternatives India website

Table 3.5 - State-wise details of projects completed and under execution.
State-wise numbers and aggregate capacity of SHP projects (upto 25 MW) potential, installed & under implementation (as on 31.12.2014)

Sr. No.	State	Potential		Projects Installed		Projects Installed Projects under Implementation	
		No.	Total Capacity No. (MW)	No.	Capacity (MW)	No.	Capacity (MW)
1	Andhra Pradesh	387	978.4	68	221.03	13	32.04
2	Arunachal Pradesh	677	1,341.38	149	103.905	44	22.23
3	Assam	119	238.69	6	34.11	3	12
4	Bihar	93	223.05	29	70.7	5	17.7
5	Chattisgarh	200	1,107.15	9	52	4	115.25
6	Goa	6	6.5	1	0.05	-	-
7	Gujarat	292	201.97	6	16.6	-	-
8	Haryana	33	110.05	7	70.1	2	3.35
9	Himachal Pradesh	531	2,397.91	165	696.105	26	59
10	Jammu & Kashmir	245	1,430.67	38	149.03	6	16.15
11	Jharkhand	103	208.95	6	4.05	8	34.85
12	Karnataka	834	4,141.12	154	1,104.98	16	99.75
13	Kerala	245	704.1	27	168.92	8	39.25
14	Madhya Pradesh	299	820.44	11	86.16	3	4.9
15	Maharashtra	274	794.33	59	335.425	8	35.7
16	Manipur	114	109.13	8	5.45	3	2.75
17	Meghalaya	97	230.05	4	31.03	3	1.7
18	Mizoram	72	168.9	18	36.47	1	0.5
19	Nagaland	99	196.98	11	29.67	3	3.2
20	Odisha	222	295.47	10	64.625	4	3.6
21	Punjab	259	441.38	48	157.4	10	18.25
22	Rajasthan	66	57.17	10	23.85	-	-
23	Sikkim	88	266.64	17	52.11	1	0.2
24	Tamil Nadu	197	659.51	21	123.05	-	-
25	Tripura	13	46.86	3	16.01	-	-
26	Uttar Pradesh	251	460.75	9	25.1	1	10.5
27	Uttarakhand	448	1,707.87	101	209.32	44	139.54
28	West Bengal	203	369.11	23	98.4	17	84.25
29	Andaman & Nicobar Islands	7	7.91	1	5.25	-	-
	Total	**6,474**	**19,749.44**	**1,019**	**3,990.9**	**233**	**747.66**

or strong continuous ocean currents, where they extract energy from the flowing water. In 2008, the world's first commercial tidal current power plant SeaGen, was set up by the Marine Current Turbines in Northern Ireland.

India, however, should develop more indigenous technologies instead of using imported ones opines Sachdeva, "A significant part of India's hydro power potential is in the relatively young mountains of Himalayas, presenting distinct geological challenges. Thus, a direct reproduction of technology and ideas from the developed world may not be a recipe for success. India needs to focus on developing its own R&D institutions for hydro power construction and operations. Public sector organisations with vast experience in such terrain can take the lead here."

ROAD AHEAD

No doubt the hydro power industry has several road blocks to surmount. But these can be mitigated with suitable positive measures, aver industry professionals. Streamlining clearance processes and land acquisition modalities, favourable tax treatments, sound inter-state agreements for water sharing to avoid disputes, developing enabling infrastructure, transparent methods of allocation of hydro sites to developers, involvement of project affected persons (PAPs) and benefit-sharing with PAPs, etc., are some recommended measures.

"Hydro power is a critical leg on which the twin benefits of clean power and remote area development could be achieved. Stakeholders need to come together and build a framework in which associated risks like infrastructure creation, geological surprises, local area development and environmental considerations, are addressed. State governments need to support hydro power projects in remote areas by reducing/waiving royalties and funding infrastructure creation. The power sale framework also needs to be more robust in order to provide a stable revenue model that is reflective of the rising capital costs," states Sachdeva.

Mittal gives his suggestions to accelerate the hydro power development, "new projects need to be identified, reviewed and awarded in line with an overall river basin plan, as coordination at the river basin level would imply sharing of data, joint studies, collective decision making, etc., in line with international practices."

"There is a need to allocate more resources (time and funds) for undertaking detailed investigations on different aspects of the project design, using latest tools and techniques like preparation of Geotechnical Baseline Report (which allows for better construction planning); risk registers (for better allocation of risk between developer and contractor) and exploring the use for modern techniques for tunnel support during construction and mechanized options like Tunnel Boring Machines, etc.," he adds.

These measures will mitigate the risks of dealing with geological uncertainties and cost and time overruns. Contract management and mechanisms for timely dispute resolution and inclusive development which will allow for greater participation and benefit sharing with the local community are also necessary.

Considering India's huge hydro power potential and its benefits, there is no doubt that hydro power is the right way forward for India. But for the march in this direction to be successful, several right measures are required to be taken at the right time. PT

— JANAKI KRISHNAMOORTHI

"A capacity addition of about 250 MW per year is being achieved from SHPs, to accelerate the pace, both public and private sector participation for commercial projects and decentralized micro hydel for remote village electrification are being encouraged," BK Bhatt, Director, MNRE.

"SHPs are easier to setup as detailed project report is not required from CEA; nor is environmental clearance from MoEF necessary - only forest clearance for diversion of forest land is required from the state forest departments," Sandeep Singhal, Director (Projects), UJVN Limited.