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A COMPREHENSIVE ASSESSMENT OF SMALL HYDRO POWER IN INDIA – CURRENT SCENARIO AND FUTURE POTENTIAL

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ABSTRACT

India is fortunate to have enormous hydro-electric power, standing fifth in the global market with regard to exploitable hydro-potential. For employment of rural communities and to reduce global warming, small hydropower (SHP) is an apt renewable energy resource for generating electricity. This review demonstrates the present capacity of small hydro power instated across various states and its progression in India. The SHP's actualization as a renewable energy source is impeded by challenges in meeting the energy demand, providing clarity in public–private partnerships and exploiting the untapped potential. The Ministry of New and Renewable Energy Resources (MNRE) says that the promotion of small hydropower is the important area for generating grid quality power. In spite of SHP witnessing considerable growth recently, we are yet to exploit about three-quarters of the total identified potential of 20,000Mega Watts(MW). India has to take serious steps to speed up the development of small hydropower, as it is important to mitigate poverty in rural and remote areas, by providing employment opportunities.

KEYWORDS: Small Hydro Power, Mtoe-Million Tonnes of Oil Equivalent, Mou-Memorandum of Understanding, MNRE-Ministry of New and Renewable Energy Resources, PPP-Public Private Partnership, Twh-Tera Watt Hour & CAGR-Compound Annual Growth

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Original Article

INTRODUCTION

Energy being the fundamental element in the universe, the human survival with all their activities depends on the available energy sources. A country's energy demand plays a major factor in determining the socio-economic, employment and market growth [1, 2]. In the past decades, there is a world-wide problem of fossil fuel depletion, climatic change, and increased electricity demand. Since these problems are increasing day by day, especially the demand for energy, the human beings are made to find alternatives for depleting energy resources. Hence, renewable energy sources such as solar, wind, tidal, and hydropower plants give us a hope to meet the future energy demand [3]. In the 70s, larger sites were developed by hydro engineers, enabling the energy production at a low cost so that thermal power are produced which are fueled with low-cost oil. Steady rise in oil prices and rapidly depleting fossil fuels led the attention to the previously noneconomic small hydro power. SHP reduces the emission of harmful $CO_2$and greenhouse gases [4, 5]. In remote parts of the country, SHP implementation helps in reducing poverty by providing employment and power to the rural people [6, 7]. SHP installation does not prevent natural river flow, because it uses 'run of river' type weir and water stands in such dams is of small quantity. With the installation of small hydro plan, deforestation and resettlement associated with large hydro power plants can be avoided[8]. The maximum limit of small hydro power is between 10 and 30 Mega Watts (MW). The US National Hydropower Association sets a minimum limit of 5 MW [9]. In the United States, Canada and China SHP's capacity can be up to 50 MW[10]. The capacity of 100 to 1,000 can be referred to as mini hydro and the capacity of 5 to 100 kW are called micro hydro. Because of the promising potential of standardized equipment and low-cost approaches to design the sites, each hydropower site is different. In a developing country, the low-cost equipment enables lower costs per unit of energy output compared to small petrol or diesel generators, wind turbines or PV (photo-voltaic) systems [11]. Significant supply of electricity for irrigation or potable water pumping, lighting, health or educational purposes can be obtained from small-scale hydroelectric facilities. Asia possesses more than 50% of the world's potential small hydro power, with both the African and American continents having the potential for more small hydropower in the future[4, 12]. To achieve the maximum capacity utilization, it is essential to focus on the SHP programme so that the costs of equipment are lowered and reliability is increased. Inadequate, poor and unreliable supply of energy services are characteristic of the rural energy facilities in. Promoting mini hydro projects is the objective of the SHP programme in India based on the fact that mini hydropower projects are capable of providing a solution for the energy problem in rural, remote and hilly areas where it is uneconomical for extension of grid system.

Classification of Small Hydro Power Plants

Compared to large hydro power plants, the small hydro projects are known for their less construction work designed with little or no reservoir and low environmental impact. SHPs are classified based on their mode of operation and installed capacity. No proper consensus is in place in the classification of SHPs based on their sizes. Another major factor used for classification is the height of water fall (head) that determines the flow rate necessary to run the turbine. Hence higher the head, smaller the flow rate needed to run the turbine, producing the same amount of electrical power. The overall production capacity depends on the seasonal and yearly differences in the availability of water. Per Electricity Authority and Bureau of Indian standards, Small Hydropower plant are classified based on the following factors:

(i) Mode of operation, (ii) Based on capacity, and (iii) Based on head.

Mode of Operation

Run of River

- Water storage not required
- Reliability of discharge and geological conditions are essential
- Instantaneous flow and output are ensured

Canal Based

- The water flow from canals running from sloppy areas are considered
- Main canal or in bye-pass canal can be used
- Nearby drops should be clubbed in existing canals
- concentrated drops should be included in canals under construction

Dam Based

- In India, dam toe schemes are most common
- For power generation, water stored during monsoon is used

Current Scenario of Small Hydro Power Generation in India

Accounting for nearly 60% of the total installed capacity, the Indian power sector is dominated by coal. In 1991, the economic liberalization showed the path for the entry of private sector into the power sector. Before the liberalization, the power sector was dominated by public sector and state electricity boards. As of now, the power sector is dominated by the private sector [13]. The storage-based hydro power plants have the ability to meet peak power demand. For its predictable energy characteristics, long-term reliability and less harmful environmental effect, SHP is the most cost-effective in energy storage technologies [14]. The estimated hydro potential in India is about 149 GW, including the plants of less than 25 MW capacity [15]. Generation of energy using the small hydro power plant started from 1897in India. Sidrapong with a capacity of 130KW, the first hydro power plant, was constructed in Darjeeling. In India, there is a total potential of about 20,000 MW of small hydro power projects. A database of small hydro sites was created by the Ministry of New and Renewable Energy (MNRE), identifying 6,474 potential sites having an aggregate capacity of 19,749.44 MW for project capacity of up to 25 MW. During 2007-2012, there are plans (11th plan) to generate an additional capacity of 78,700 MW, which can be obtained by MNRE from various conventional sources. The plan is to generate 15,628 MW of large hydro projects and 1400 MW from small hydro power plants (25MW capacity each). The country's total hydroelectric power potential is approximately 150,000MW, which is equivalent to 84,000 MW at 60% load factor.

The Western flowing rivers installed capacity is 9,430 MW, and for Eastern flowing rivers of Southern India it is 14,511 MW. The largest delta in the world is the Brahmaputra river system, the Sunder bans, covering an area of 58752 sq.km. With an installed capacity of 66,065 MW, the Sunder bans originates from Chemayungdung glacier in the Kailash range. The installed capacity of the Central Indian River System is about 4,152 MW. According to Central Electricity Authority (CEA), about 1,48,701 MW of hydro potential can be generated, which was evaluated by identifying suitable sites and water availability corresponding to a 90% of the year. In addition, the CEA had identified 845 economically feasible schemes in various river basin of the country [16, 17].

State -Wise Distribution of SHP Projects in India

In India since water is a state government in charge, developing small hydro projects lies in the hands of state governments with the support of the Government of India. The barriers of legislative clearances as such land acquisition, forest and irrigation clearances should be cleared by the respective state governments to allot potential project sites that can be investment friendly, proving to be a sustainable environment friendly SHPs destination. Through policy, regulatory support and financial assistance and through an established framework of sustainable and renewable criteria, the MNRE supports SHP development in states, with extended support for site analysis, renovation of existing SHP plants, up gradation of water mills, research and development activities in micro plants [13]. From March 2016, the hydroelectric schemes in operation account only for half of the total potential that are utilized. Both Canada and Brazil tapped 55% of their feasible potential (in 2009 itself), but many states in India is lagging in project implementation mainly because of its 70-80% un-tapped hydro potential, especially Himachal Pradesh (27%), Madhya Pradesh (10.5%), Arunachal Pradesh (7.8%), Jharkhand (2%), Chhattisgarh (4.5%) and Meghalaya (13.5%) wherein less than 30% of their total potential is utilized. In India, the total hydro electrical potential is about 69%(including both large and small hydro projects and those installed/under installation). In our country, the SHP potential is mostly utilized only after solar power for rural electrification schemes.

According to the MNRE, the Electricity Act2003, the National Electricity Policy2005 and Tariff Policy2006 govern the policy for Small Hydro Power (SHP) and private sector participation. For the SHP project development, power is considered concurrent, wherein 23 State Governments announced policy so that private sector can participate. Tariffs in their respective states are decided by the State Electricity Regulatory Commissions (SERCs), including Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, J&K, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, Uttarakhand and West Bengal [18]. Because the Central and State governments did not show clarity in public-private partnerships (PPP) policies, attracting investors for the development and faster implementation of hydro projects resulted in a major failure. Only few states like Odisha (2007), Arunachal Pradesh (2011), Uttarkhand (2012) and Andhra Pradesh & Gujarat being exceptional as they had framed PPP policy. There are states that depend only on government projects for their electricity schemes. Moreover, the reasons for standstill projects are land acquisition problems, clearance and approval procedures, incapability of developers, etc. [19]. According to the Ministry, the estimated potential for power generation in the country from small / mini hydel projects is 19749 MW from 6474 identified sites. Of this, about 50% lies in the States of Himachal Pradesh, Uttarkhand, Jammu & Kashmir and Arunachal Pradesh. Sizeable potential are also reported in the plain regions of Maharashtra, Chattisgarh, Karnataka and Kerala. Attention is focused on these States through close interaction, monitoring of projects and reviewing policy environment private sectors are attracted for investments [18]. In the year 2000, the total installed capacity of small hydro projects was 1275 MW. During the year 2000-2010, an increase of about 150% in the installed capacity has been reported, showing a constant and steady growth in the sector. While implementing the 9th Plan, the total capacity was increased to 269 MW, which was in turn increased toto 536 MW in the 10th Plan and 1419 MW in the 11th Plan. During the 11th Plan, the average capacity was increased to 284 MW per year. In 2013-14, this declined to about 170 MW. So far, 1001 small hydropower projects aggregating to 3,832 MW have been set up in the country, of which 320 comprised projects of 1662 MW from private developers [7]. An additional capacity of 500 MW per year to reach a target of 3000 MW has been planned for the 12th Plan. The MNRE is providing financial subsidy for both public and private sectors to set up SHP projects. It is mandatory that all projects are to be tested for its performance by an independent agency to improve the quality and reliability of projects, achieving the envisaged energy generation of 80% before releasing the subsidy. In India, as of today, the SHP programmes is basically driven by private investment. Small-scale hydropower units are providing business opportunities for the private sector entrepreneurs[20]. Figure 1 demonstrates the sector wise break up of installed capacity of SHP projects in both government and private sectors.

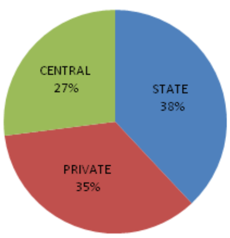

Figure 1: Sector Wise Breakup of Installed Capacity in Mw [13].

The 10th and 11th Plan witnessed a rapid increase in installed capacity of SHP projects, mainly due to the participation of private sector. The viability of these projects is directly dependent on the capacity of the project. Those states with reasonably high SHP potential are allotting the projects to the private sector for implementation and operation [21]. Unlike the big hydropower projects, the SHPs do not have major problems in their social, economic and environmental feasibility assessment. Social and environmental challenges such as dam construction, mass scale deforestation, mass displacement and rehabilitation, livelihood issues, disaster risk reduction, and so on are encountered by many big projects. In the long run, these adversely affect the economic cost and benefit sharing from installation to power generation.

Arunachal Pradesh

To set up 52 small/mini/micro hydro power projects with a capacity of 714.40 MW (up to 25 MW) between 2007-08 and 2014-15, the private developers and the State Government signed a memorandum of agreement. The projects are yet to be commissioned Due to certain pending clearances from the environmental tribunal and forest department.

Chattisgarh

The State Renewable Energy Development Agency (CREDA) of Chattisgarh identified in 2010 about 68 potential sites for SHP/Mini Hydro Power (MHP) project (2,997 kW) development and also started 50 SHP projects of 612.25 MW butas of December 2014not even a single project had been commissioned mainly due to the delay in obtaining no objection certificate (NOC), local issues and non-execution of power purchase agreement (PPA).

Himachal Pradesh

- In June and July 2009, the Himachal Pradesh Energy Development Agency (Himurja) issued 37 consent letters but even after five years in 2014 the independent power producers (IPPs) are yet to submit the DPRs. Himurja collected the fee of 1.79 crore (up to December 2013) on 37 IPPs, of which only six IPPs had paid full extension fee of 0.25 crore, 25 IPPs paid partly (0.33 crore) and six IPPs did not pay at all. The Himurja cancelled 29 projects, that is, 14 were recommended for cancellation and 15 were given show cause notice.
- Between April 2003 and March 2013, the Himurja submitted 88 DPRs to the Department of Energy (DoE) for creating a total capacity of 278.76 MW. However, as of August 2014, none had been approved.
- The feasibility study report of 78 projects (total capacity 217.87 MW) allotted between February 2008 and March 2013 is not yet submitted. In February2015, it was discussed with the State Government for extension beyond the period mentioned in the policy. Because of the irresponsibility attitude of the IPPs, the projects were cancelled.

Karnataka

Considering the safety of the environment, the state government limited the mini hydro projects to only 5 MWs and only run-of-the-river projects were encouraged in Western Ghats districts/forest areas. According to MNRE, 167 allotments for establishing mini hydro power projects in the state were held up due to non-clearance from the forest department, which is becoming a major challenge for timely implementation of projects.

Uttarakhand

- At Gauri Chhina (Pauri), in February 2006, a 250-kW SHP project for 2.24 crore was approved with a Central Financial Assistance (CFA) of 0.93crore. After 7 years, based on the reports, only 15 *per cent* of the work was completed at an expenditure of 0.69 crore. The construction work was stopped in October 2013. In spite of the Uttarakhand Renewable Energy Development Agency (UREDA) providing assurance to MNRE that no forest land was involved at the site of the project, with a delay of two years in the transfer of forest land.
- In March 1987, Gangori SHP (4 X 200 kW) project was commissioned, but after 3 years the project was closed. The project was transferred to Uttarakhand Jal Vidyut Nigam Ltd (UJVNL) without the land records once the Uttarakand was formed. The UJVNL proposed in September 2003 for renovation, modernization and up gradation (RMU) of Gangori SHP project at a cost of 1.91 crore, which was approved after 4 years. In February 2014, the project was decided to be abandoned because of the rage of the local villagers claiming compensation for the land, which cannot be contradicted in absence of proper land deeds, incurring an extravagant expenditure of 1.60 crore.
- Of the 31 SHP projects sanctioned during 2007-14, 13 projects were not only delayed but were not completed till June 2014. The reason being lack of interest and poor coordination of sharing partners, leading to blocking of 6.51 crores.

Tamil Nadu

According to MNRE’s report dated 11 December 2009, Tamil Nadu Generation and Distribution Corporation (TANGEDCO) was entitled to receive subsidy and also capital subsidy for setting up the projects for installation of DPRs for the SHP projects. TANGEDCO is yet to receive the eligible amount of 25.90 crore in spite of it had claiming the eligible subsidy in 2010. As stated in July 2015, the MNRE did not consider the CFA as the TANGEDCO had not taken the prior approval/sanction for DPR and also work was awarded on a single tender basis, violating the provision of guideline.

Uttar Pradesh

With an estimated potential of 460.75 MW in Uttar Pradesh, the MNRE identified 251 sites, whereas the State Government identified only 57 sites with a potential of 167 MW for SHP projects. In 2004-05, DPR and pre-feasibility report were prepared for only 11 projects.

Punjab

Between August 1999 and January 2010, the Punjab Energy Development Agency (PEDA) allotted to six private developers19 MHP sites with a power potential of 17.13 MW on the basis of built, operate and own (BOO) basis, which need to be developed within two years of allotment. Even after signing implementation agreements (IAs) with PEDA and after getting extension ranging between 450 and 1,391 days, the private developers did not take any steps to perform their duty. Hence, between June 2009 and October 2013, PEDA cancelled all the agreements and encashed49 lakhs of performance bank guarantee. In addition, they also observed that of these 19 cancelled MHP sites, 7 sites with a power potential of 9.40 MW only were re-allotted during March 2010 to October 2013 but 12 MHP sites with a power potential of 7.73 MW were not re-allotted even after a lapse of 8 to 60 months and efforts were taken to harness the potential.

Bihar

In 1995-1996, the MNRE released a CFA of 1.31 to 3 crores for 9 SHP projects. Of these3 projects were held up for want of forest clearances. Neither Bihar State Hydroelectric Power Corporation limited (BSHPCL) nor MNRE monitored the projects. Since the project detail were not provided, the BSHPCL was liable to return the CFA along with interest for the principal amount of 3.20 crore.

Meghalaya

For the revival of the abandoned Sonapani SHP project, the MNRE sanctioned (March 2001) 7.39 crore. Only in October 2009, the Meghalaya State Electricity Board (MeSEB) could access the land, relieved of all encumbrances. As the Me SEB could acquire the required land only in January 2008, the Lakroh SHP project for 11.76 crore was allotted after a delay of more than six years, which was sanctioned in March 2001 by MNRE.. However, the project is yet to be commissioned as of September 2014.

Assam

In March 2000, the Lungn it SHP project was approved by MNRE. After waiting for four years, in February 2004, the State Government finally approached the Ministry of Environment and Forests (MoEF) for forest clearance, which was accorded in December 2004. The estimated cost of the project was 55.61crore and the contracted value was 47.08 crore. In spite of incurring 11.11 crores, as of November 2014, the project is the beginning stages. This was because of the contractor's negligence who received a mobilization advance of 4.32crores, terminating the contract in August 2012 without recovering 3.93crores. As of December 2014, the contract is yet to be re-awarded.

Mizoram

In October 2011, the MNRE approved five MW SHP projects for 56.93crore. Being very much essential for North Eastern Rural Development Blocks of Mizoram especially for Ngopa, Khawzawl and S. Khawbung, the project was planned to be constructed within 36 months. However, as of June 2014 the progress of the construction work was reported to be very slow. The reasons cited by Zoram Energy Development Agency (ZEDA) in its reply (January 2015) included late tender process, non-inclusion of items of work like bailey bridge, transmission lines in the contractors package and non-release of mobilization advance by the state government.

Future Energy Demand

Significant energy poverty and pervasive electricity deficits are characteristics of India as a country. With population growth and economic development in recent years, India's energy consumption has been at its peak, in spite of the low base rate [22]. The most part of untapped hydro potential lies in a north-bound trajectory where growing demand is huge. According to International Monetary Fund(IMF), Fitch and World Bank, India's electrical demand will take a leap of 15GW/annum in the year 2022 [11]. As demonstrated in Figure 2, in 1980 the oil consumption was 1000 barrels/day, which in 2000 tripled by about 3200 barrels/day, increasing to 4000 barrels in 2010. This is expected to reach a peak of upto5000barrels/day in the future. Per India's twelth five-year plans, an additional capacity of 75,785 MW is required, arriving at a total capacity of approximately 276,000 MW.

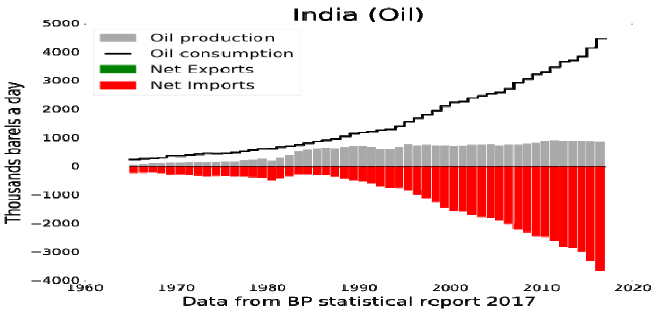

Figure 2: Statistical Report of Oil Consumption [23]

The plan target has been fixed at 88,537 MW so that the gap between demand and deficit is reduced and older, inefficient energy plants are allowed to retire. To achieve this, it is necessary to increase the private sector share of this additional capacity to 53 per cent, up from 19 per cent in the eleventh plan. If the revised growth rate of 8.2 per cent (against the original 9.0 per cent) is taken as the target, it will allow for around 10 per cent downwards. Based on this added capacity, the Plan estimates that 79 per cent of the thermal energy can be obtained from coal and lignite, compared to 76 per cent in the previous plan. Hydro-power is expected to generate 10,897 MW (12 per cent of the estimated additional capacity). In the period 2012-2017, the overall projected growth rate in power generation is expected to be 9.8 per cent [9]. Among the worldwide end-uses of energy, electricity is considered the rising force, accounting for up to 40% of the rise in final consumption to 2040, which is the same share of growth that oil took for the last twenty-five years [24]. India’s energy policy mainly defined by the country's expanding energy deficit, with increased focus on developing alternative sources of energy, particularly nuclear, solar and wind energy. In 2014, India was ranked 81st position, with the overall energy self-sufficiency at 66%. India is ranked third biggest in the primary energy consumption after China and USA, with 5.5% global share in 2016 as shown in Figure 3. In the calendar year 2016, the total primary energy consumption from crude oil (212.7 Mtoe; 29.38%), natural gas (45.1 Mtoe; 6.23%), coal (411.9 Mtoe; 56.90%), nuclear energy (8.6 Mtoe; 1.19%), hydroelectricity (29.1 Mtoe; 4.01%) and renewable power (16.5 Mtoe; 2.28%) is 723.9 Mtoe (excluding traditional biomass use). In 2013, India's net imports are nearly 144.3 million tons of crude oil, 16 Mtoe of Liquefied natural gas (LNG) and 95 Mtoe coal totaling to 255.3 Mtoe of primary energy which is equal to 42.9% of total primary energy consumption. According to the 12th Five-Year Plan, the total electricity production will be 669.6 Mtoby 2016-17, e and 844 Mtoe by 2021-22, reaching around 71 per cent and 69 per cent of expected energy utilization, with the balance to be met from imports (projected to be about 267.8 Mtoe by 2016-17 and 375.6 Mtoe by 2021-22) [25]. In fiscal year (FY) 2013, in India the electricity demand is estimated to grow from ~1127 Terra watts hour (TWh) to ~3793 TWh in FY2032 at a CAGR of 6% [26]. This will require India to spend around US$ 550 billion in increasing power generation capacity and another US$ 400 to US $ 500 billion in upgrading the transmission and distribution (T&D) infrastructure which accounted for loss of 25.47% in 2008-09.

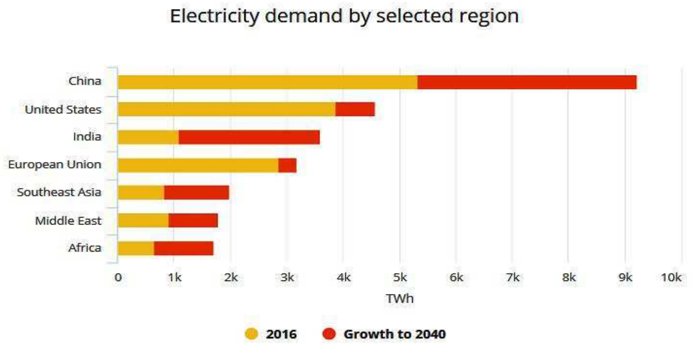

Figure 3: Future Projection of Global Energy Demand [24]

Since India is largely dependent on fossil fuel imports to meet its energy demands, about 70% of India's electricity generation capacity is from fossil fuels. by 2040, its dependence on energy imports is expected to exceed 53% of the country's total energy consumption. The Ministry has received only a total of Rs. 497.18 crore to SHP against the demand of Rs.824.00 crore for SHP projects up to the year 2015-16. The Ministry is expected to utilize the full allocated amount for SHP project installations and for liquidizing the past liabilities of the completed SHP projects [18, 24].

National Mission on Small Hydro

To enrich remote and rural areas in power generation, the National Mission on Small Hydro is considered a joint initiative of the Government of India and state governments. In order to meet the escalating power needs of remote and rural areas of the country, the government has turned its focus on Small Hydro sector by launching National Mission that will set up 5000 MW of small hydro projects in the next five years with a cumulative achievement of 1, 75,000MW (including solar, wind and biomass). The objective of the National Mission on Small Hydro is to address issues responsible for decline of SHP sector in the country and to renew the interest of private sectors to invest in this renewable energy sector. To control the increasing project costs, technological innovation, new methods of civil construction, standard designs and automation can be helpful. In the next two years, the Mission would target to achieve 500 MW of capacity, further aiming towards adding 4500 MW in the subsequent three years [7]. The Mission would set up 1000 MW SHP projects on canal drops, dam outlets, spillways and water out fall structures. The Mission would also help in modernizing the existing SHP projects to improve their capacity and efficiency. Another important goal of the Mission is to identify new potential sites. For activities like livelihood, agro/cottage/small industries, education, health and clean drinking water, etc., the mission intends to provide off-grid power supply. In hilly and forest fringed areas, the SHP projects will provide the communities there the opportunity of using cheap electricity as a substitute for fuel for which a sizeable human resource is used, causing high-level emission of carbon-di-oxide and other harmful gases to human health. It is essential to work out the feasibility of local grid [18].

To accomplish this, the Mission targets are to

- Build an enabling policy structure along with the state governments for the deployment of 5,000 MW of small hydro projects by the year 2019 and a stage for long-term sustainable development in small hydro sector.
- Persuade and facilitate all the states to participate in the National Mission of Small Hydro for setting up new SHP projects, provide favourable policy and institutional support for SHP projects by private sector.

- Assess all existing government sector small hydro projects with a view to refurbish, modernize and revise (RMU) them, and, if required, to develop effectiveness and add capacity where ever possible.
- Develop new technologies and engineering solutions to set up low and ultra-low head (below 3m) small hydro projects on canals, dam outlets and water.

Till date, no year-wise/phase-wise physical targets have been fixed for small Hydro under the National Mission. By 2022, it is estimated that the total installed SHP capacity will be enhanced to 5000 MW [27]. In order to encourage the development of small hydro projects, MNRE provides subsidy for building new SHP projects (upto 25MW station capacity) to the Government sectors/State Electricity Boards/local bodies.

CONCLUSIONS

India is known for its vast potential for hydro-power, with major part of the unexploited potential in the Himalayan and North Eastern regions. To meet the future energy demands, it is essential to tap all possible sources of small hydro energy using decentralized power generation. The MNRE should focus on small hydro power projects that are shelved or underperforming, so that solutions are found to the problems hindering the completion of these projects. To ensure that a project does not stop midway in need of funds, the budget allocation should be sufficient process of clearances should be streamlined and made time-bound. There should be direct, more frequent interaction with the states who are developing SHPs themselves and private developers. Based on the analysis of this paper, it is understood that the share of hydro power in our country is declining persistently, from 46% in the year 1960 to 16.33% in the year 2015. Small-scale hydropower is a concentrated energy source with a long-lasting and robust technology, and its systems' life can extend to up to 50 years or more without any major new investments.

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