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Green Growth and Hydropower in India

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1. Introduction

Hydropower is the second most important source of energy and accounts for 16.9% of the total installed capacity of 237742.94 MW as on 28th Feb, 2015 (CEA, 2014). India accounted for 4.4% of the global installed capacity and ranked 6th in the list of global nations for hydropower capacity and generation with a net installed capacity to the tune of 43.7 GW (REN 21, 2014). The importance of hydropower has gained wide popularity with the focus of moving away from fossil fuel generation dependence. Hydropower is considered a cleaner and greener source for generation of electricity compared to other energy sources. The significance of hydropower generation is described briefly below.

1.1 Need for Hydropower in India

1.1.1 Uniqueness of hydropower in terms of less pollution

Hydropower is unique as it is a clean source of energy, renewable and green as compared to fossil fuel generation power plants. It does not cause air pollution nor does it burn any fuel with near zero emissions. Hydropower is relatively cleaner as compared to other sources of energy and the emission rate per unit of electricity generated from hydropower excluding tropical reservoirs is way below than emission rates for fossil fuel technologies (Steinhurst, Knight, & Schultz, 2012). In comparison to other renewables on a life cycle basis, GHG emissions release from hydropower is lesser relative to that of electricity generation from biomass and solar. The emissions are almost equivalent to those from wind, nuclear and geothermal power plants. Since hydropower generation does not require burning or combustion of any fuels, the cost of operation are not susceptible to market price fluctuations.

1.1.2 Multipurpose aspects

Unlike other sources of energy, hydropower generation provides an abundance of unique benefits which can be those emanating from the generation of electricity itself or from side benefits associated with hydropower reservoirs. Such benefits can include a secure water supply, irrigation and flood control including increased navigation and increased recreational opportunities. There can be scope for development of fisheries and cottage and small scale industries. Multipurpose hydropower projects also help in subsidizing other major features of the project such as those indicated above. In spite of recent debates sparking greenhouse gas emissions from reservoir based hydropower projects, hydropower generation is still a relatively cleaner source of energy in comparison to fossil based generation

1.1.3 Maintain Peak delivery and reduced cost of generation

There is a variation in demand of power at different time intervals during the 24 hour cycle of a day and vary from season to season. For instance, peaks are usually high in case of summer days when air conditioners are in operation. As compared to other sources of energy like thermal, gas, oil etc the cost of generation for hydropower decelerates progressively in the course of operation of the hydropower plant. Both nuclear and fossil fuel power plants are relatively inefficient in producing power for shorter durations of increased demand during peak demand. The start-up times for them are longer as well in contrast to hydropower generation. In contrast to thermal power plants, hydropower plants can help to meet peaking delivery as on demand. Hydropower projects have an inherent ability for quick starting and terminating with features of instantaneous load acceptance and rejection which makes hydropower generation very apt and ideal to meet peaking power shortage. This special feature where hydroelectric generators can almost instantly start and stop make it more responsive than other energy sources in meeting peak demand. Both storage and pondage type hydro power plants have the option of varying their output almost instantly. Pondage based hydropower projects can be used to meet the peak load during the non-monsoon period since they operate to meet the base load during the monsoon season. The CEA anticipates a peak shortage of 2% for 2014-15 (CEA, 2014c). Hydropower reservoir based projects can store water overnight as per requirement and use it as per demand in order to meet peak load demand. This power mix of different energy sources offers opportunities for utilities to operate their plants more efficiently as hydropower plants can be used to meet the peaking needs while fossil fuel and nuclear plants can meet the base load demand.

1.2 Hydro potential in India

1.2.1 India Section

The basin wise assessed potential stands at 148701 MW (Table 1) out of which India is endowed with economically exploitable and viable hydropower potential to the tune of 84044 MW at 60% load factor which when fully developed would result in an installed capacity of about 150,000 MW on the basis of probable average load factor. Exhibit 1.1 below indicates the basin wise hydroelectric potential development as on 31st March, 2014. Up to date, India has exploited around 25% of its potential with another 9% under construction as per the latest available CEA data as on 30th November, 2014.

Potential of hydro schemes above 25 MW is 145320 MW. The overall share of hydro in terms of installed capacity rose from 37% at the end of 1947 to close to 51% during 1962-63 and thereafter declined to 17% in 2013-14. The hydropower generation for 2012-12 and 2013-14 stood at 12.5% and 14% of the total energy generation. As against the power generation target of 122263 MU for 2013-14, generation from hydroelectric power stations (above 25 MW Installed Capacity) was 134847.52 MU, which was 10.29% more than the target (CEA, 2014a). Another 6780 MW in terms of installed capacity from Small, Mini and Micro Hydel schemes have been assessed. Identification of 56 sites for pumped storage schemes with aggregate capacity of 94000 MW has also been undertaken. Himachal Pradesh has exploited 45.5% of the installed capacity as per CEAs study and are yet to take up 38% of the capacity. A total of 18820 MW and 971 MW have been identified as the total installed capacity for Himachal Pradesh and Punjab respectively.

Table 1 Basin wise status of hydroelectric potential development in India

BASIN WISE STATUS OF H.E. POTENTIAL DEVELOPMENT		
		(AS ON 31.03.2014)
River Basin	**Identified Capacity as per Reassessment Study (MW)**	
	Total MW	**Above 25 MW**
NORTHERN		
Indus	33832	33028
Ganga	20711	20252
Central Indian River System (CIR)	4152	3868
West Flowing Rivers System (WFR)	9430	8997
East Flowing Rivers System (ERF)	14511	13775
Brahmaputra (BRMPTR)	66065	65400
Total	**148701**	**145320**
Note: In addition 4785.60 MW PSS are under operation and 1080 MW PSS under construction		

Source: (CEA, 2014a)

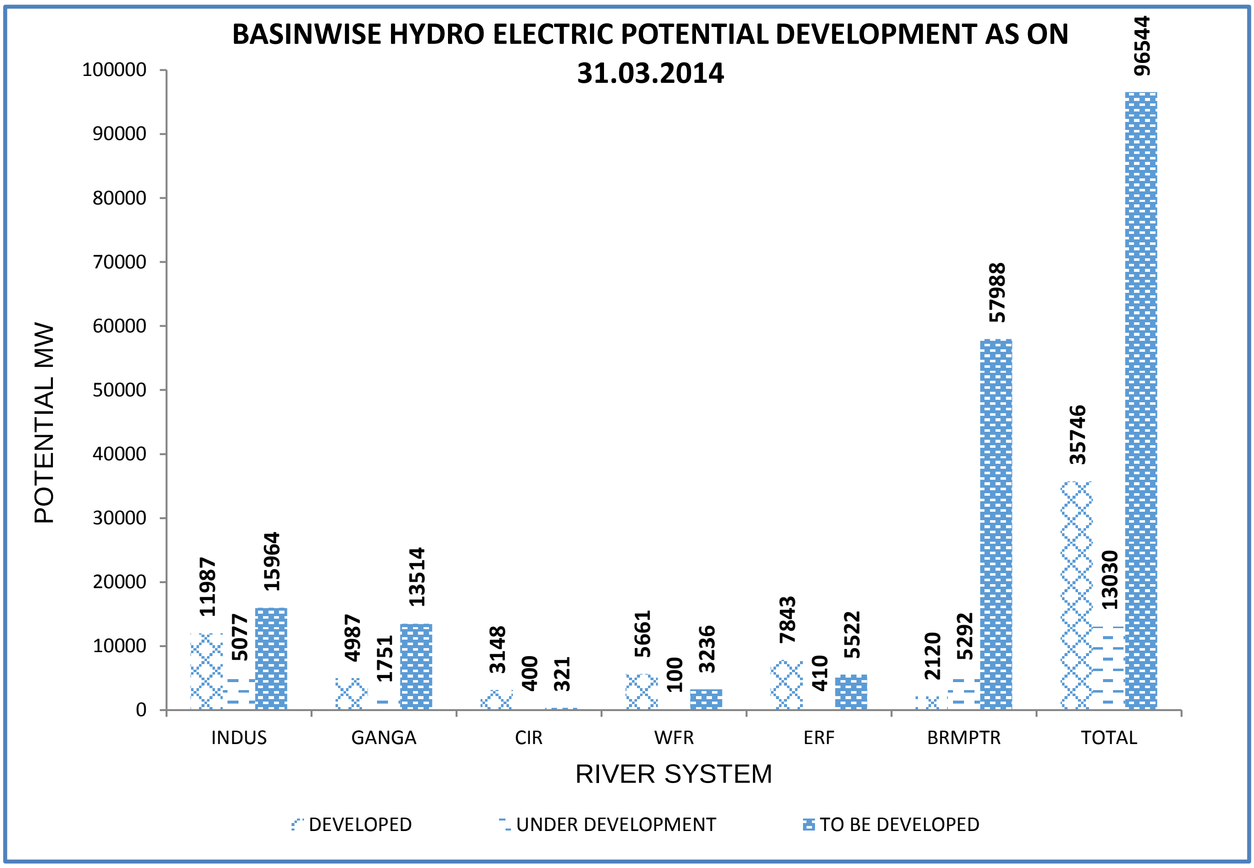

Figure 1 Basin-wise hydroelectric potential development as on 31st March, 2015

Source: (CEA, 2014a)

Table 2 below indicates the division of the power system in India region wise namely, the Northern region, the Western region, the Southern region, the Eastern region and the North-Eastern region. As per CEAs, reassessment study, Arunachal Pradesh alone accounts for a total potential of more than 50000 MW in comparison to all India's total hydropower capacity of 148701 MW as on 30th November, 2014. Close to 93% of the installed capacity of the North-eastern region is yet to be taken up for construction while the Southern and Western region has exploited close to 59% and 68% respectively of the installed capacity. The Eastern region and the Northern region have 26% and 13% respectively of the capacity under construction (CEA, 2014b).

Table 2 Status of Hydro Electric Potential Development as on 30-11-2014

(in terms of Installed capacity- Above 25 MW)					
Region	Identified Capacity as per reassessment study		Capacity developed	Capacity under construction	Capacity yet to be developed
	Total (MW)	Above 25 MW (MW)	(MW)	(MW)	(MW)
Northern	53395	52263	16653.6	6560.7	29048.7
Western	8928	8131	5552	400	2179
Southern	16458	15890	9426.9	510	5953.2
Eastern	10949	10680	3138.7	2782	4759.3
North Eastern	58971	58356	1242	2954	54160
All India	**148701**	**145320**	**36013.2**	**13206.7**	**96100.2**

Source: (CEA, 2014b)

Note: In addition to above, 2 Pumped Storage Schemes (1080 MW) are under construction and 9 PSS of 4785.6 MW are under operation.

1.3 Growth and share of Hydroelectric Installed Capacity and Generation

India's maiden hydroelectric power plant started off near Darjeeling in 1897 and over the period of time, development of hydropower started taking off with an installed capacity of 508 MW during the time of independence which formed 37.30% of the total installed capacity. It rose to a half of the installed capacity in 1962-63 but its share in total installed capacity has been plummeting and was recorded at 24% in 1998-99. The 1998 policy on Hydropower development acknowledged the importance of private sector participation to bolster investment and accelerate the development of the hydropower sector. A proposal in the policy was also made to enhance coordination and systematic approach to transfer of statutory clearances from the public to the private sector for station capacity above 25 MW. There was a slight jump seen in the share of hydropower in the total installed capacity during the period of 1999-2000 and 2006-07 to 26.2%. The hydropower installed capacity recorded at 40531 MW as on 2013-14 with a share of 16.7 % of the total installed capacity which includes stations with total station capacity above 25 MW only (Figure 2).

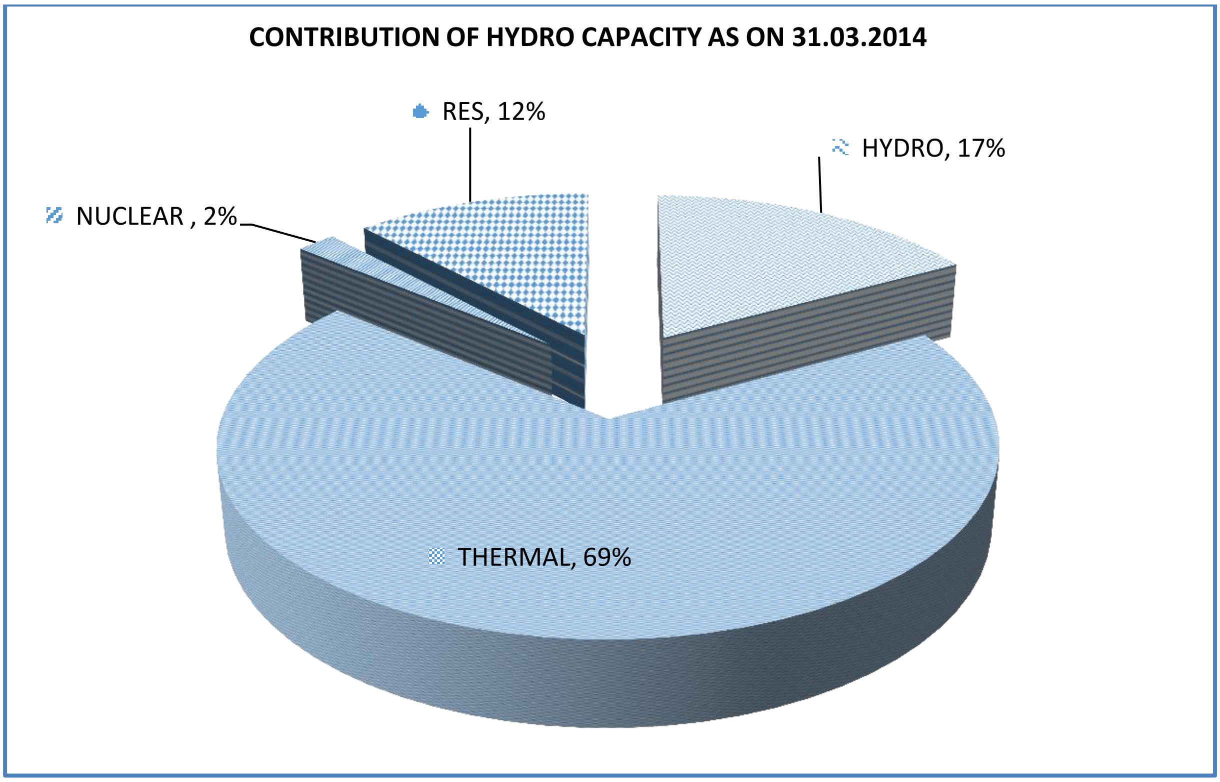

Figure 2 Hydropower contribution as a percentage to total energy sources

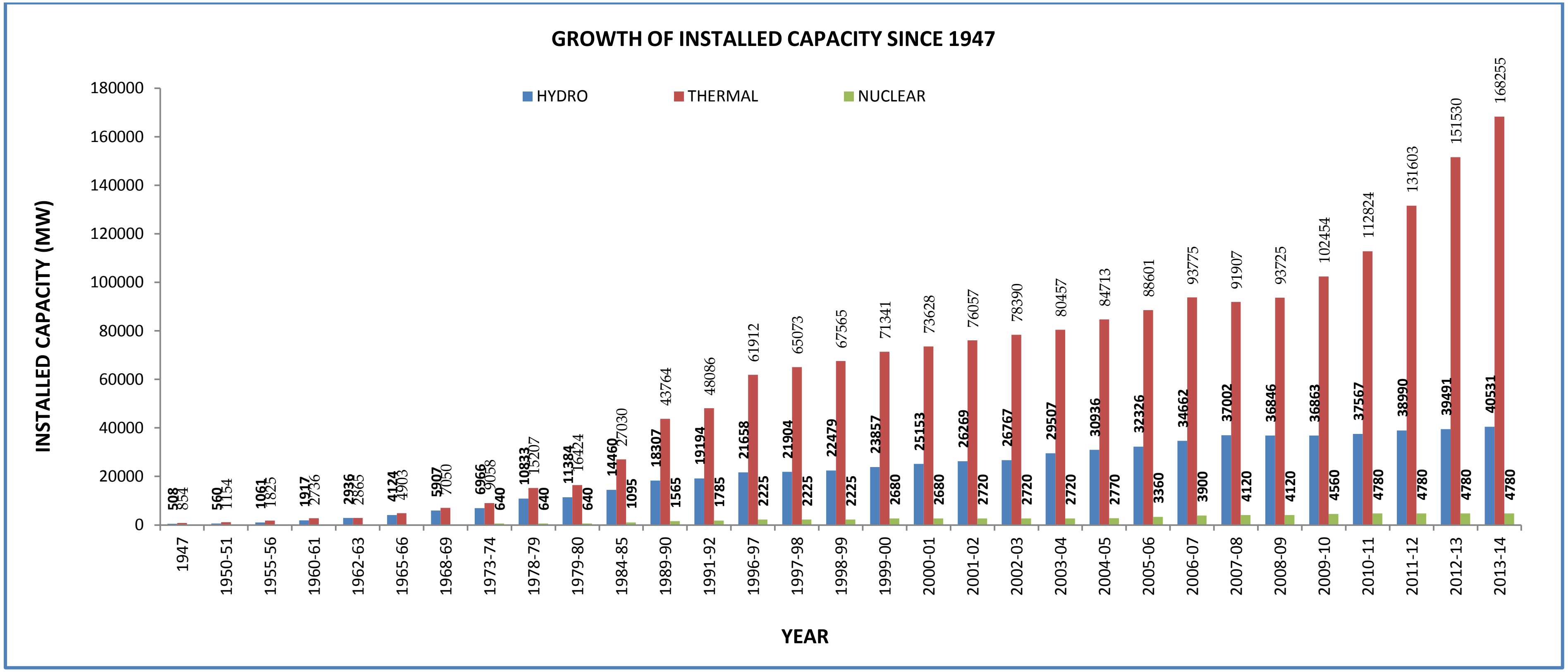

Figure 3 Growth of Installed capacity since 1947

Source: (CEA, 2014a)

Figure 3 captures the growth of installed capacity of hydropower since 1947 till date vis-à-vis that of thermal power and nuclear power. Hydropower contribution to the installed capacity as percentage of the total recorded at 37.3% in 1947, it touched a high of close to 51% in 1962-63 and has fallen down to almost 17% in 2013-14. In the context of generation of electricity from hydroelectric power stations, the share of hydropower as a total of power generated in the country was more than half at close to 54% at 2194 MU during the year of independence. It fell to 17.40% in 1996-97 and its share in total generation is 14% in 2013-14 at 134848 MU as indicated in Figure 4. The growth of hydropower generation vis-à-vis other energy sources since 1947 is indicated in Figure 5.The trend of hydro capacity and generation is captured in the graph below (Figure 6).

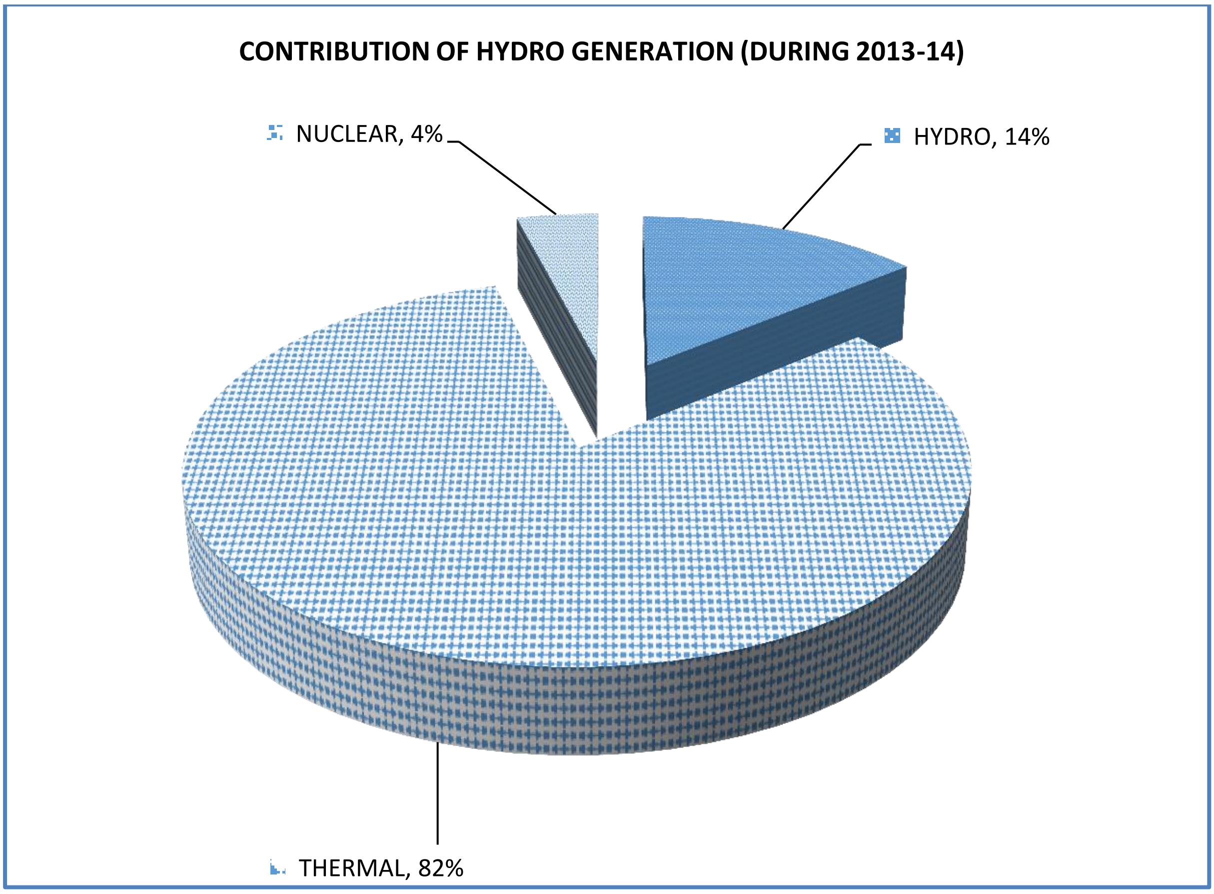

Figure 4 Share of hydropower in total generation

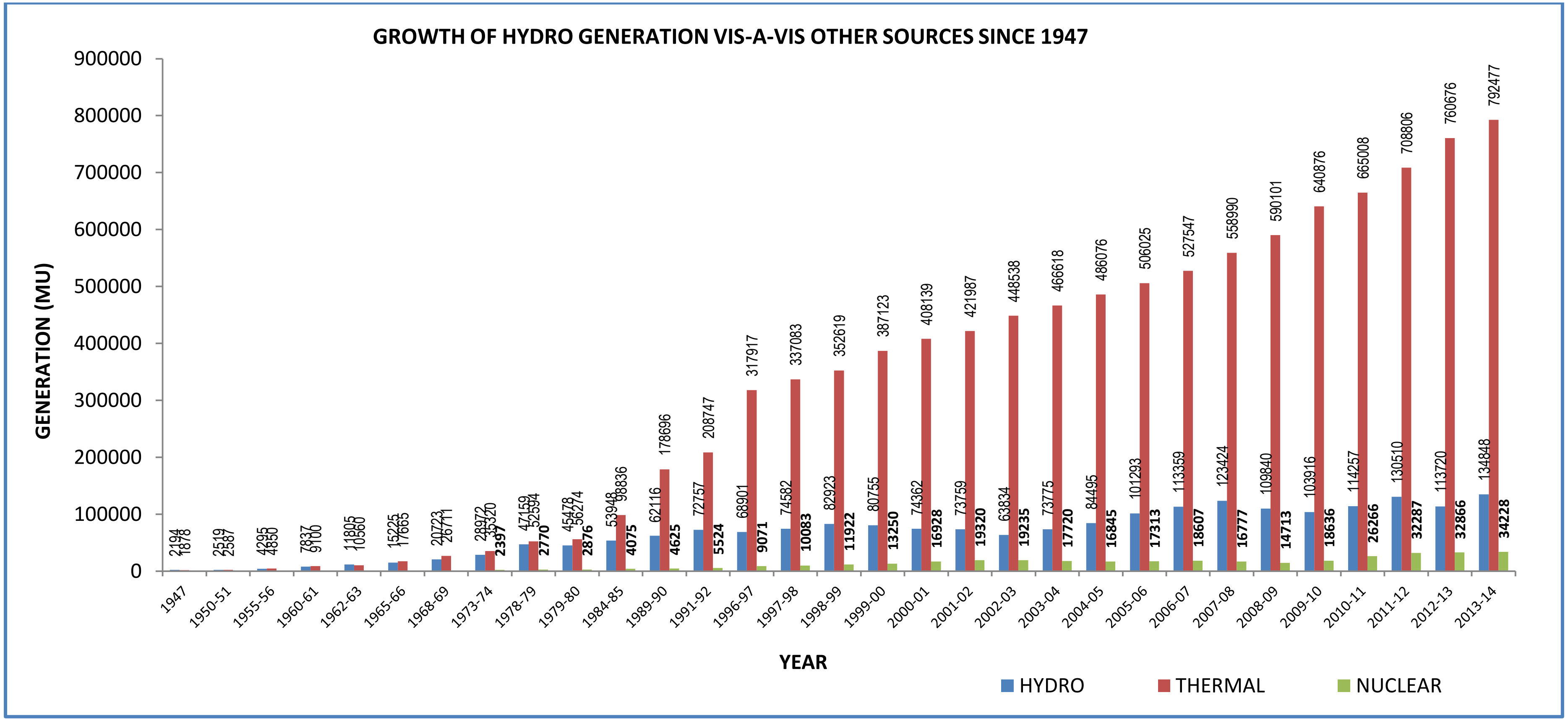

Figure 5 Growth of hydro generation vis-à-vis other sources since 1947

Source: (CEA, 2014a)

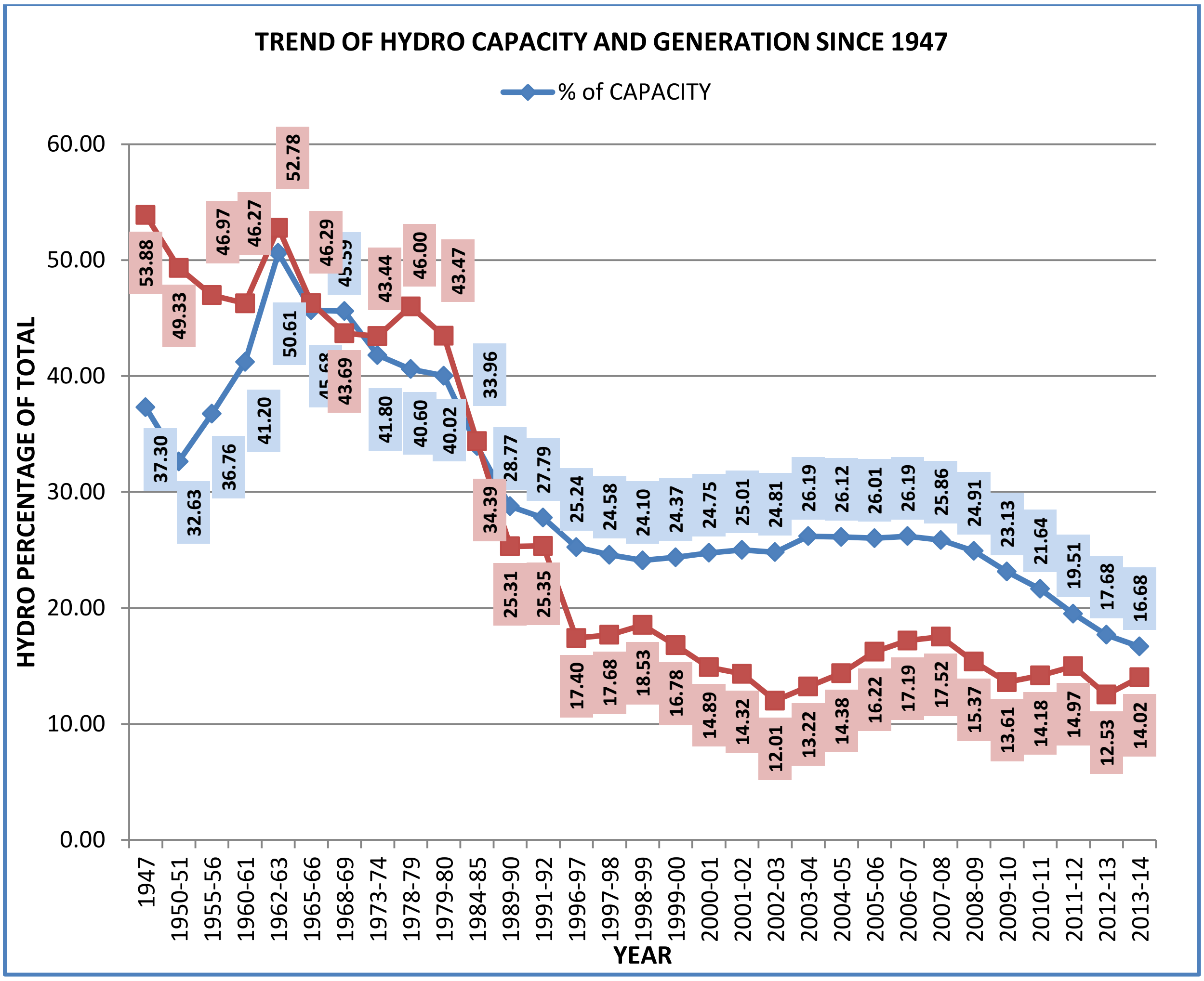

Figure 6 Trend of hydro capacity and generation since 1947

Source: (CEA, 2014a)

The State sector holds a major proportion of the sector wise installed hydropower capacity among the different actors to the tune of 61% while the share for Central sector is close to 33% with the remaining share under the private sector as on 31st March, 2014 as indicated below in Figure 7. Similarly in the case of hydro generation by different actors, the state sector contributes to more than half at 55% while the central and private sector's share are 38% and 7% respectively. This is described below in the pie chart (Figure 8).

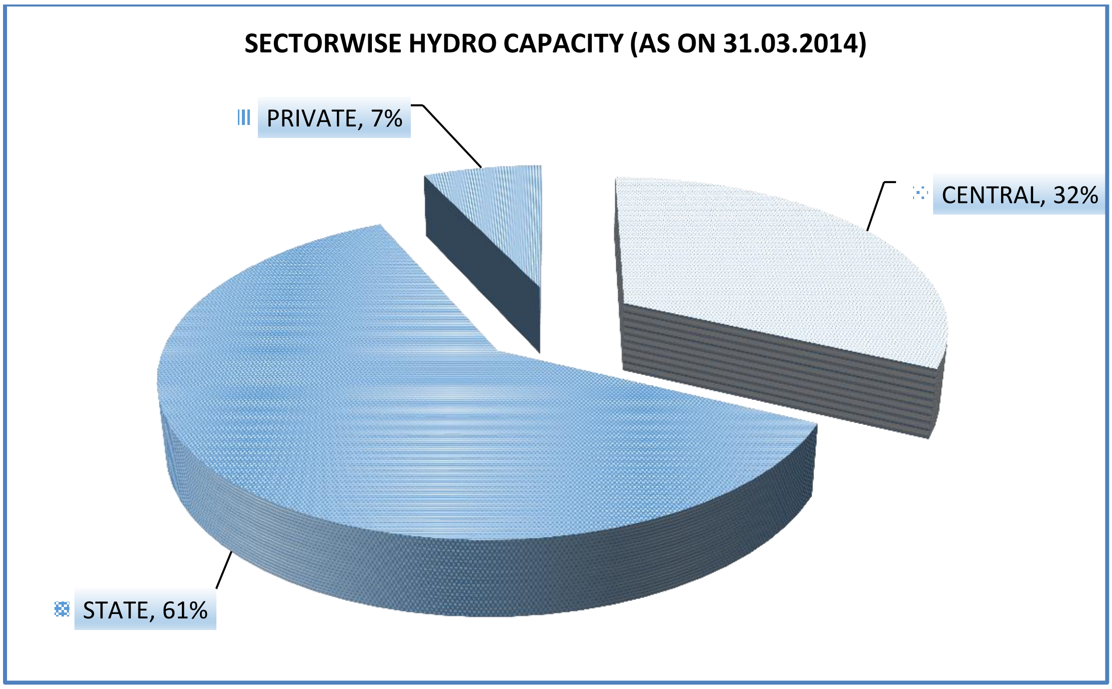

Figure 7 Hydropower capacity by sector

Source: (CEA, 2014a)

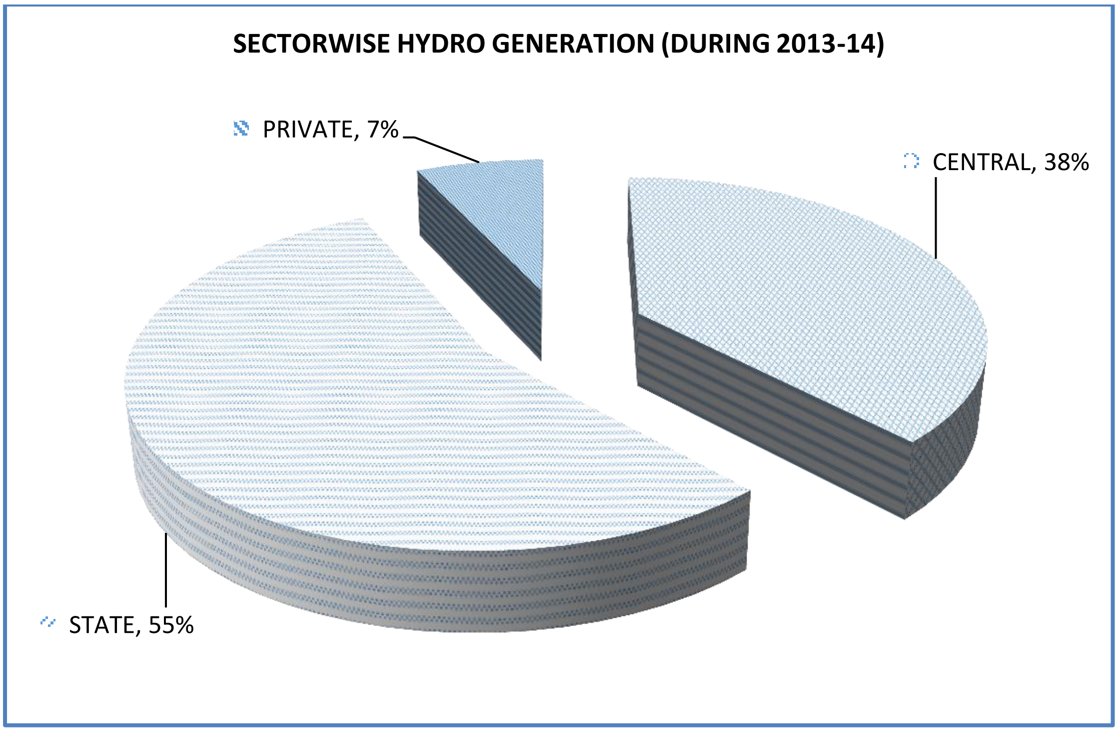

Figure 8 Sector wise hydropower generation

Source: (CEA, 2014a)

2. Interventions for Green Growth

The major advantage in hydro power is the lack of emissions to the atmosphere during its fuel cycle as compared to other fossil fuels. But there are other negative externalities emanating from hydro projects which are related to the social, environmental, economic and cultural aspects of the local communities where the projects are located. Hydro power projects cause serious impact on the aquatic and riparian eco-systems through modifications and habitat destruction. They alter the bio-physical quality of ecosystems resulting in the loss of biodiversity, and other ecological functions, impacting the livelihood of people dependent on the ecosystems. (Rajashekariah, Kaushal, & Bhowmik, 2012). However, governments – both the state as well as the centre - in India have been cognizant of these problems and initiated several initiatives to limit the impact of these negative externalities which could be classified as good practices or 'green' initiatives. The following section explores some such initiatives undertaken by hydro project developers as well as the state governments.

2.1 Clean Development Mechanism

The Clean Development Mechanism (CDM) was developed as part of the Kyoto protocol and aimed as a means of allowing countries not part of the Annex I to achieve sustainable development and contribute to the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCC) (Slariya, 2012). This was a means to abate the monetary costs of curbing emissions. This mechanism enables Annex I countries to substitute their own emissions by purchasing carbon credits from climate protection projects in Non-Annex I countries. Developers of these projects must show that their projects will only be realised through the additional income generated from the sale of carbon credits. In keeping with this goal a number of hydroelectric projects in India aim to seek carbon credit under this mechanism as carbon-offsetting projects. There are 57 projects in Himachal Pradesh that have applied for CDM status as on June 29, 2011 (Yumnan, 2013). For example, the 192 MW Allain Duhangan project in the district of Kullu is expected to generate almost 500,000 certified emission reductions (CER) per annum (approximately revenue of $7 mn) which will be sold to the Italian Carbon Fund. Similarly the 1000 MW Karcham Wangtoo dam on the Sutlej river in the Kinnaur district will generate 3.5 mn carbon credits (approximate revenue of up to $ 50 mn) which will be sold to various buyers in Annex I countries (Erlewein & Nusser, 2011).

2.2 Compensatory Afforestation Fund Management and Planning Authority

As per the provisions of the Forests (Conservation) Act, 1980, the hydro developer has to strictly comply with the statutory regulations of the act. Hydropower developers have to bear the cost of raising the compensatory afforestation (CA) including payment of the Net Present Value (NPV) of the forests land being diverted for non-forest purpose under the relevant Forests (Conservation) Act, 1980 and Environmental Protection Act, 1986 which are to be deposited with the Compensatory Afforestation Fund Management and Planning Authority (CAMPA). CAMPA works as the National Advisory Council under the chairmanship of the Union Minister of Environment & Forests for monitoring, technical assistance and evaluation of compensatory afforestation activities. The primary purpose of compensatory afforestation is to make up for the diversion of forest land proposed to be utilized for construction of the proposed hydroelectric projects. CA will also help in maintaining and improving the ecological and environmental balance and promote afforestation and prevent soil erosion. Moreover, if forest land has been used then, compensatory plantation has to be established on a degraded forest land which must be twice the size of the forest land used for the construction of the project. Compensatory afforestation also includes activities such as soil conservation, fencing, protection, monitoring and evaluation along with maintenance for a 5-year period along with protection of surrounding forests. For the year 2012-13, Himachal Pradesh had an approved Annual Plan of Operation (APO) of Rs. 62.16 crores against which it received Rs. 52.40 crores against which an annual expenditure Rs. 47. 23 crores was reported. For the year 2013-14, the Adhoc CAMPA had agreed to release Rs. 53.50 crores (HP State CAMPA, 2013).

2.3 Catchment Area Treatment & Sedimentation Removal

Hydro power projects cause large-scale changes in the catchment area altering the ecosystem. Thus Environment Impact Assessment (EIA) report along with a set of plans which form the Environment Management Plan (EMP) includes the catchment area treatment plan in addition to other components such as biodiversity conservation plan, fisheries management plan, R&R plan, economic rehabilitation plan among others. The stated objective of the Catchment Area Treatment (CAT) plan is to reduce the inflow of silt into the reservoir, conserve soil and minimise run-off. For example, the Ganga-Brahmaputra river system carries a billion tonnes of sediment annually, which is 8% of the total sediment load reaching the global oceans and the highest sediment load of any river system in the world. Moreover, studies have shown that the siltation rates in 21 Indian river valley projects were 182% higher than originally estimated (Thadani, 2006). Reservoirs are subjected to sedimentation which embodies the sequential process of erosion, entrainment, transportation, deposition and compaction of sediment. (Government of Uttarakhand, n.a.). The deposition of sediment not only reduces the capacity and the lifespan of a reservoir but also impacts water availability. It is generally believed that sediment coarser than 0.20 mm in size is harmful for turbine blades and will thus have to be eliminated from power channels (Raju & Kothyari, 2004). The annual loss of storage in reservoirs due to sedimentation is about 1% corresponding to about 50km worldwide (Boroujeni, n.a.). Moreover, erosion of the sediment on the banks of streambeds and banks causes braiding of the river.

Various measures are put in place to manage sedimentation. Chief among them is watershed rehabilitation, sediment flushing, sediment routing and sediment removal and disposal. Watershed rehabilitation which essentially looks at soil conservation strategies including structural measures such as terraced farmlands, flood interceptions and diversion works, bank protection works, gully head protection, silt trapping dams; vegetative measures such as afforestation, rotation cropping, no-tillage farming among others. Sediment flushing essentially involves opening up the dam’s bottom outlets and allowing the accumulated sediment to be re-suspended and flushed out (Pande, 2015). However, apart from consuming lot of water, flushing is ideally not recommended due to its environmental impacts on fish gill clogging, changes in riverine habitats, clogging of agriculture fields, and reduced dissolved oxygen, among others. Sediment routing can be done in two ways. One is channelling sediment-heavy flows into a tunnel to avoid serious damage to the reservoirs and then using diversion methods (warping) to fill low lands and improve the quality of salinized land (Boroujeni, n.a.).

Typically, CAT plan accounts for 60% or more of the total EMP budget and 0.5-2.55% of the total project cost. CAT plans are project-specific and use different approaches to curb soil erosion and implement eco-restoration plans. Developers also use the Silt Yield Index (SYI) developed by the All India Soil and Land Use Survey (AISLUS) as part of the plan, since it provides a comparative erodibility criteria of the catchment but not the absolute silt yield. Once the CAT plan has been approved by the Impact Assessment Department of the MOEFCC, funds are released by the Adhoc authority to the state CAMPA depending on the APO provided by the Forest Division of that particular state. Table 3 and Table 4 is an example of the break-up of the cost – both biological as well as engineering - required for CAT for the Vishnu Pipalkoti Hydroelectric project.

Table 3 Cost estimate for CAT- Biological Measures (Vishnu Pipalkoti HEP)

Item	**Rate (Rs.)**	**Target**	
		Physical	Financial (Rs. Mn)
Plantation (800ha.)	25000/ ha.	364ha.	9.10
Pasture Development	10000/ ha.	280ha.	2.80
Social Forestry	25000/ ha.	60ha.	1.50
Fuel wood and fodder	10000/ ha	60ha.	0.60
Nursery Development	200000/ no.	5	1.00
Maintenance of Nursery	100000/ no.	5	0.50
Barbed wire fencing	100000/ km	5 km.	0.50
Watch and ward for 3 years for 10 persons	5000/ man/ month	360 man month	1.80
		Total	**17.80**

Table 4 Cost estimate for CAT - Engineering Measures (Vishnu Pipalkoti HEP)

Item	**Rate (Rs.)**	**Unit**	**Quantity**	**Target**	
				Physical	Financial (Rs. Mn)
Step Drain	2500 RMT	25 RMT	20	500 RMT	1.25
Check Dams	20000	-	20	20	4.00
Contour Bunding	25000/ ha.	Ha.	15	15	0.38
				Total	5.63
Total Cost (Biological + Engineering measures)					**23.43**

A typical CAT plan will include compensatory afforestation for the loss of forest land to cover denuded slopes, biodiversity and wildlife conservation, managing environmental damage during construction, maintaining the quality of water, sustaining and enhancing the potential for fisheries and developing tourism as a means of providing alternate livelihood. A report by R. Thadani (2006) has found discrepancies in the manner CAT plans are implemented. For example, he states that a number of CAT plans are not based on ground reality, focus excessively on engineering solutions, do not implement biological solutions adequately, do not consider the impact on local communities and have weak monitoring mechanisms. Some of these points stand corrected while some others were corroborated when the authors of this paper went on a few field visits to Himachal Pradesh. For example, at the Kashang Hydroelectric project, regular public hearings with the Sub-divisional magistrate had been held such that the villagers were aware of the CAT Plan, but stated that their suggestions had not been incorporated in the plan. Moreover, since the project is still in the construction stage, muck continued to be deposited alongside the road or by the bank of the river. But other recent reports (Rajashekariah, Kaushal, & Bhowmik, 2012) suggest that a few hydroelectric developers are providing a number of benefits to the local community including subsidised electricity (Baira Sual HEP) and employment generation (Allain Duhangan HEP), planting 4.58 million saplings on a 2000 ha. in lieu of 982.5 ha of forest land lost for project construction as well as a fish farm, (Chemera HEP), among others.

2.3.1 Muck Management Plan

Constructing different components of the hydropower projects includes both surface as well as underground excavation and tunnelling leading to huge quantities of overburden and rock i.e. muck. Muck disposal has to be planned scientifically to designated areas so that it doesn't interfere with either the environment or the ecology, nor does it impair the river flow regime or the quality of the water. The designated sites must be planned keeping in mind the nearness of the generating component and interference with either surface river flows or impact on ground water aquifers. A lot of hydro developers utilize a portion of this muck during construction activities itself. In fact state hydro policies, both in Himachal Pradesh (Hydro Power policy, 2006) as well as in Arunachal Pradesh have stipulated that the muck generated from the construction of a hydro power plant shall be used by the company for project activities and the remaining material can be used by other development departments like the state PWD. For example, at Parbati II about 40% of the muck generated was used by the project for the construction of dam, power house, roads, retaining walls and other infrastructures resulting in the optimal utilisation of muck. Moreover local species were planted in the disposal site after suitable treatment (Rajashekariah, Kaushal, & Bhowmik, 2012). Similarly, NTPC during the construction of Tapovan Vishnugad stated that since they were able to dispose the muck generated in lesser dumping sites than allocated to them, they had decided to return one of the designated muck disposal sites, which was located within the reserve forest (Rajashekariah, Kaushal, & Bhowmik, 2012). However not all companies manage muck so effectively. For example, at the Srinagar Hydroelectric Power project, the developer i.e. the Alaknanda Hydro Power Company (AHPCL) did not adhere to the muck management plan of creating terraces with suitable retaining walls or that dumping should be done after creating terraces. Instead, the disposal sites were adjacent to the river and had the appearance of large hills of dust. The retaining walls at the base of the site were also inadequate in terms of height to prevent the muck from being washed into the adjacent river (Lahiri, 2011). Despite repeated warning, the developer had not managed this problem and further no action had been taken either.

2.3.2 Fisheries Management

Large scale construction of hydropower dams in India has impacted marine life, in particular movement by riverine fishes. Indian rivers hold close to 700 fish species and the highest fish endemism in Asia. The physical impact of dams like hydrological modification, loss of connectivity, drying up of downstream rivers, submergence, blocking migration paths, reduced nutrients, concentrated pollutants, changes in salinity etc have impacted fishing livelihood, and the diversity of fish species to a great extent (Dandekar & Thakkar, 2015). Reduced or absence of freshwater in the Krishna Estuary or the Ganga River system has impacted fish production on a large scale. Moreover, loss in hydrological connectivity has resulted in habitat fragmentation, thus obstructing migratory species by limiting their territory along the length of the river. For instance, in case of migratory fish species, floods sweep fish eggs into floodplain backwaters and lakes where they hatch and grow before joining the river at a later stage, but because dams reduce normal flooding, they fragment ecosystems by isolating the river from its floodplains, turning what fish biologists term as 'floodplain river' into a 'reservoir river', leading to isolation of fishes, running the risk of future extinction. (Rajashekariah, Kaushal, & Bhowmik, 2012). For example, in the Ganga system, the Farakka Barrage resulted in zero Hilsa yield in upstream Allahabad down from 91kg/km in the 1960s (Dandekar & Thakkar, 2015). Moreover, a lot of EIA reports list lower number of fish species as compared to the actual number. For example, the EIA for the 2000 MW Lower Subansiri lists 55 fish species in a river which has at least 156 (Vagholikar, 2011). EIA reports though do speak about fishery management by construction of fish ladders wherever possible to enable migration of fishes promote reservoir fisheries, but in practice it is rarely implemented. There are some examples of a fish farm at Chemera, the Pong reservoir which is the only reservoir to provide for Masheer angling, a trout farm at Parabati II but such examples are few and far between and more initiative needs to be taken on this front.

2.3.3 Environmental flow requirement

Of all the environmental changes wrought by dam construction and operation, the alteration of natural water flow regimes has had the most pervasive and damaging effects on river ecosystems and species (Richter & Thomas, 2007). When large dams block the flow of a river, they also trap sediments and nutrients vital for fertilizing downstream plains. They alter the natural flow regimes which drive the ecological processes in downstream areas. Quite literally they disrupt the connections between the upstream and the downstream, between a river and its floodplain (Vagholikar, 2011). In order to meet the requirement of downstream life forms and amenities like drinking water, fisheries and riparian right obligations etc, a minimum flow requirement is guaranteed. The Himachal Hydropower policy of 2006 also states that in case of RoR schemes, a minimum flow of 15% water immediately downstream has to be maintained including guaranteed provisions of water requirement during the lean season. For example, the Karcham Wangtoo project has built into its design, provisions for ensuring the mandatory 15% flows; provisions also exists for accessing real-time flows data through the project website (Rajashekariah, Kaushal, & Bhowmik, 2012). But Himachal Pradesh is only state to introduce general terms for minimum environmental flows. In Uttarakhand, it is a generally held belief among the state authorities that about 10% of the lean flow should be left at any given point in time in the natural river system while in Karnataka there is no specific mention of mandating ecological flows in Karnataka (Bhushan, Hamberg, & Goyal, 2013). Moreover, there is no regulation in place to monitor these flow patterns thus making it impossible to gauge if the developer is following the EMP report or not.

3. Ways Forward

India has a basin-wise potential of 148,701MW of which large (>25MW) hydropower generation capacity comprises 145,320MW (MoP, 2013). Of this, India has exploited around 25% of its potential with another 9% under construction as per the latest available CEA data as on 30th November, 2014. This is because the development of hydropower projects has been hampered by a number of factors including longer gestation period (8-12 years to complete from survey to commissioning); land acquisition problems; R&R troubles, inaccessible potential sites; environment and forest clearances, law & order and geological surprises. Moreover, a large number of these dams are not multi-purpose in nature, unlike the dams constructed in the initial phases of hydropower development. Despite these constraints, many states in India are focussing on hydropower development since it is relatively cleaner as compared to thermal power as well as to monetize this resource. Considering the cleaner aspects of hydropower, a TERI analysis[1] shows that in a Business As Usual Scenario (BAU), hydropower generation is expected to touch 142GW by 2051 (TERI, 2015) (Figure 9). Moreover, in an alternate scenario – Energy Security Moderate (ESM) - where the focus is on increasing efficiency, as well as the third alternate scenario – Energy Security Ambitious (ESA) – which focuses on rampant capacity addition of renewables - hydropower capacity is expected to rise to 163GW by 2051, well beyond the basin potential (TERI, 2015).

[1] Energy Security Outlook, 2015

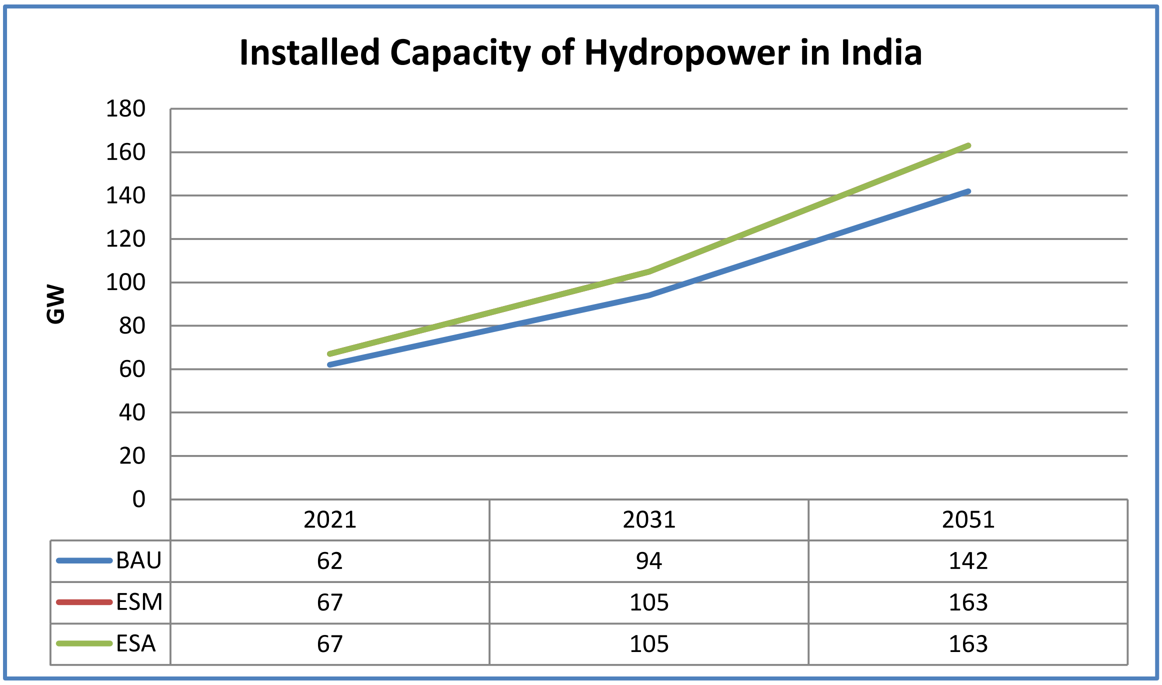

Figure 9 Projection of Installed capacity of Hydropower in India

Source: (TERI, 2015)

Taking into account this increase in the development of hydropower would imply intensive usage of land and water which have other competing demands. For example, according to Mitavachan and Srinivasan (2012), taking a sample of nine dams in India that are used for power generation, their assessment was that for every MW and GWh of electricity produced for a typical dam, the area required is 222,698 and 1374 m^2 respectively. Considering the externalities of hydropower on land, water, ecology, biodiversity and livelihood, it becomes imperative that focus must be on an overarching policy that will aid in removing the bottlenecks. On a national level, the sector is governed by the National Hydropower policy of 2008. But since water is a state subject, policies of different states are based on the national framework, but tailor-made according to their individual needs. The stipulations in these policies effectively protect the interests of the vulnerable groups such as project affected families (PAFs), tribals etc, at least on paper. However, based on our conversation[2] with various affected parties, state government officials, local NGOs and secondary sources, it is seen that the implementation of the stipulations remain faulty. Thus it becomes imperative to frame policies that are overarching in nature and transfer the benefit of these projects not just to the PAFs, but also help in the socio-development of the entire state. This section therefore deals with policy measures that can be taken in the short, medium and the long term to balance the negative externalities that emanate from hydropower projects in India.

Short-term

The current installed capacity in the country is about 41.3 GW (CEA, 2015) with about 13.2 GW under construction. Assuming that these projects that are under construction do get commissioned by the 2021, the extent of installed hydropower capacity in the country will

[2] Based on field visit to the Kashang HEP

be about 54 GW. However, the causalities of commissioning these projects is reflected on the land, livelihood sources, and the ecology of the region. Various state governments have put in place policies such as the Hydro Power Policy, 2006 of Himachal Pradesh; Policy for Harnessing Renewable Sources in Uttrakhand with Private Sector/Community Participation, 2008; the Hydro Electric Power Policy of Arunachal Pradesh, among others. These policies have framed laws that govern land acquisition, law & order, impact on the environment via EIAs and impact on the people via SIAs. Instances of non-compliance of such policies on the part of the state government and other agencies have been observed. Thus in the **short term**, one must look at measures to iron out the issues in the current policy framework. Local Area Development Fund (LADF) is deposited by the hydro developer in the accounts of the District Magistrate (DM)/Sub-divisional Magistrate (SDM)/relevant authority. This process has led to a number of discrepancies in the management of these funds. Often funds that must be used for the benefit of the PAFs is directed towards projects mandated by the District Magistrate (DM)/relevant authority, without taking into account the immediate requirements or demands of the PAFs, and even when village requirements have been approved by the *gram sabha,* processing of these funds by the relevant authority is not done on an immediate basis. Field visits and FGDs across India helped the team document many such instances. For example, at Karcham Wangtoo HEP, the developer reported that while they had transferred the money to the LADA, the villagers complained of not receiving any funds to undertake village development. Moreover, in the case of Bhakra Nangal HEP, or Pong HEP the funds never reached the beneficiaries. To avoid such misuse/diversion of the LADF, the state government can make amendments to the act such that the decision to manage these funds lies with *gram panchayat* instead of the district authority. At least in this way, it will be easier to account for the money given for this fund. Moreover, regular auditing of these funds by an independent body (constituted by the state government) will help in creating transparency and accountability of the funds.

Another issue that must be resolved is the diversion of funds allocated under CAMPA. Funds under CAMPA are allocated by the national *ad-hoc* CAMPA to the state *ad-hoc* CAMPA depending on state requirements for compensatory afforestation as well as under payment of the NPV for the forests land which have been diverted for non-forest purpose. However there have been instances where these funds have been diverted by the state governments for other expenditures (Goswami, 2015). Moreover, a Comptroller and Auditor General Report (2013) revealed that against the receivable non-forest land of 1,03,381.91 ha, between 2006 and 2012, only 28,086 ha was received by the state governments, constituting about 27% of the total receivable non-forest land. The compensatory afforestation done over the non-forest land received was an abysmal 7,280.84 hectare constituting seven per cent of the land which ought to have been received. Moreover, absence of an MIS/consolidated database allowed irregularities, especially in individual cases to go unchecked. Thus neither the MOEFCC nor the state forest department officials discharged their responsibility of monitoring compliance of the conditions of the Forest (Conservation) Act, 1980. Also, non-recovery/under assessment of the NPV and funds for CA/Addl CA/Penal Compensatory Afforestation/CAT Plan on the basis of a test check in audit was Rs. 5,311.16 cr which constituted about 23% of the total principal amount with Ad-hoc CAMPA as on 31 March 2012 (CAG, 2013). And despite all these irregularities and non-compliance issues, the MOEFCC evoked penal provision in just three cases and that too was limited to show-cause notices. Such problems highlight the need for amending the composition of the law under CAMPA. The union cabinet has given its approval for the Compensatory Afforestation Fund Bill, 2015 which will create an institutionalised structure at both the Centre and in each State and Union Territory, to ensure expeditious utilization in efficient and transparent manner of amounts realised in lieu of forest land diverted for non-forest purpose (PIB, 2015). The details of this bill have still not been made public, but even in the past questions have been raised in the parliament over the CAMPA arrangement and the necessity of this bill.

In fact, a report by the Parliamentary Standing Committee on Science, Technology, Environment & Forests (2008) on the Compensatory Afforestation Fund Bill, 2008 had made scathing observations on various aspects of this bill. The report stated that the MOEFCC had not presented a real and complete picture in respect to the diversion of funds between 1980 and 2002, especially when fund utilization in most states with the exception of Karnataka, Andhra Pradesh, Maharashtra, Tamil Nadu and Gujarat had been done reasonably well. Neither had the MOEFCC contested the interim order of the Supreme Court in 2002 in the *TN Godavarman Thirumalpad vs. Union of India* case which subsequently led the court to mandate an *ad-hoc* CAMPA and the framing of rules by the Government of India for the creation of a body to manage the funds. The Committee also noted that the proposed new authority mandated to be set up under the bill would just prolong the process of Compensatory Afforestation as the States/UT would have to deposit the money with the central government and then only a portion would be sent back to the states, depending on an allocation formula. This concern by the Committee has proven to be valid in recent years, as policy paralysis at the centre delayed funds to the states. Moreover, not only is this process time consuming, it also takes away the federal character on which our constitution is based, especially since funds are granted as per an allocation formula thus allowing the Central government to play a major role utilization of the funds and even allowing the central *ad-hoc* CAMPA body to withhold or suspend release of funds unless it is completely satisfied. Also, the original issue of fund diversion which was the genesis of the bill was not addressed adequately. Moreover, the bill was prepared without involvement of either the states or the local bodies such as *Gram Panchayat/ Gram Sabhas* and as such it could violate the interests of both parties. Moreover, it raised the issue of the present method of forest diversion (which continues), is undemocratic and non-transparent and levying higher monetary charges via the NPV has not really protected forest cover in the country, rather the pace of diversion of forest land for non-forest purposes increased from 30,997.32 ha per year between 2002 and 2008 from 20,639.99 ha per year between 1980 and 2002.

Many of the observations of the committee still hold true. In fact, during our conversation with various stakeholders within state government, it was felt that the management of the CAMPA fund should remain under the aegis of the state government, with the MOEFCC acting as an overseeing body. State governments must also look at creating a centralised database of well-investigated projects along with the amount for the NPV and compensatory afforestation funds by each user agency. This will then aid in monitoring the under-recoveries by these agencies. Moreover, a stricter penal provision and its implementation (for under-recoveries of NPV and CA and for non-compliance), within a specified deadline must be added to the clauses such that it will help the governments recover the losses. The central government could create a portal that will allow the states to file information regarding the utilization of these funds. This will effectively make the process of fund allocation, plantation work estimates; land management, work-in-progress reports more transparent and accessible to the communities. The policy must take into account the natural biodiversity mix of the region which would vary according to topography, geography and location etc. For instance, the upper Himalayas would require a tail-made policy conducive to the climate and location to enrich biodiversity and enhance flora and faunal habitat vis-à-vis that of regions along the Western Ghats.

Hydro project developers must conduct EIAs and SIAs while acquiring land for the construction of the dam. The EIAs are supposed to measure the impact of the dam on the surrounding topography, soil, ecology and the biodiversity of the catchment area. The SIAs must conduct an assessment on the impact of the dams on the livelihood of the people in the catchment area. EIA reports often under-estimate the ecological risks associated with building the dam as well as specifying the social impacts of displacement. The EIA for Teesta V HEP in Sikkim states that since it is a run-of-the-river project, the area that will be submerged will be small as compared to other large dams and there will be lesser regulation of water compared to a 'storage dam'. However, the EIA ignored that there will be extensive tunnelling done for the project in a geologically fragile landscape (since Sikkim comes under the seismic zone V). Moreover, environment and forest clearances were granted by the Expert Committee on River Valley Projects of the MoEFCC, before the completion of detailed studies on the impact to the ethnography, biodiversity and on the local communities. The SIA did not cover several pertinent questions regarding the problems due to influx of labour, employment for locals and loss of agricultural land and neither were the concerns of the PAFs addressed (Kalpavriksh, 2004).

Construction of large dams could also lead to violation of the principle of social justice. While compensation clauses in hydropower policies tend to favour the oustees, in reality, the compensation received by many is insufficient or the benefits of the compensation are awarded just one member of the family, principally the oldest sibling and his descendants. This policy is unfavourable to other members of the family who also earn subsistence from the same land. Moreover, R&R policies discount landless labourers or those who earn a living by depending on the land in the area and are similarly affected by loss of livelihood. State governments woo project developers in the hope of bringing in development to a certain region of the state but often this proves to benefit only a section of the population. Until this attitude remains, it will be hard to win social acceptance of large-scale hydro power projects. These negative externalities must be pre-empted via explicit policy, legislation, social planning and targeted financing. Creation of a comprehensive database of land banks and the specimens of the flora and fauna in each area will help the government agencies ensure compliance during the process of EIA. Moreover, advocating and overseeing benefit sharing contracts between project developers and the PAFs will guarantee greater social acceptance for hydro-power projects. A few hydro-projects in Himachal Pradesh (Baira Siul, Parabati 2, Punatsangchhu) are following a similar model where electricity to the PAFs is provided at subsidised rates for a particular slab (Rajashekariah, Kaushal, & Bhowmik, 2012).

Medium-term

In the medium term (2031), as per TERI projections, in a BAU scenario, hydropower capacity is expected to rise to 94 GW from 54 GW in 2021. This would imply development of hydro projects which have so far only been in the pipeline which would necessitate additional land and water resources. In such cases, unlike the prior projects which were already under progress, the government could take pre-emptive measures against the potential causes of concern (discussed in the short term outlook) and the unfolding mechanisms of new impoverishment, thereby tackling 'new poverty' as compared with 'old poverty' (Cernea, 2004). Creation of an authority (on the lines of the Bhakra Beas Management Board that looks at regulation of supply of water and power from Bhakra Nangal and Beas Projects to the states of Punjab, Haryana, Rajasthan and Himachal Pradesh among other responsibilities) (Asian Development Bank, 2011) based on river basins would also help management of all the dams within that particular basin and provide for seamless co-ordination between different states. Such authorities would look into setting up appropriate targets and achievement as per the EMP; look at alternatives for efficient silt management; oversee implementation of CAT plans; oversee water discharge from the dams to facilitate downstream activities; settle inter-state water disputes within that particular basin; collect data and conduct forecast modelling exercises that will aid in estimating run-offs and rainfall pattern that will help in predicting flash floods.

Moreover, the governments could look at a more integrated approach towards benefit-sharing of resources from hydropower generation as well as CDM as compared to the earlier approach that sought 'reimbursement' for project-specific participants. The revenue could be used to foster local industries such as tourism, fisheries that would benefit the state as a whole. This will in turn have a positive impact on women and children through the access to modern energy services. Moreover, these new projects must be in the form of multi-purpose dams, such that it will enhance irrigation facility in the country.

A lot of the states are already looking at facilitating small and mini hydro power capacity. In comparison to large dam, small and mini hydel power stations are much more environmentally benign. Moreover, various state policies look at different subsidies in a bid to attract private participation in small and mini hydel power station. However, this part of the hydro power policy needs work especially in the area of tariff regulation and grid integration.

Long term

In the approach to the long term goal (2050), it would be worth conducting feasibility studies to delay decommissioning of older dams. Both Bhakra Nangal and Koyna dams would be nearing the end of their life cycle, yet by this point, the ecology and the people in the area would have adjusted to the idea of having a dam in the region. Hence creating policy and institutional mechanisms to favour alternative designs to increase the dam life as also to reduce the divergence the designed and actual dam life must be taken into account.

Timeline	Issue	Recommendation
Short term	Misuse/ diversion of funds under LADF Ratio of non-forest land demarcated for CA lesser than deemed by law Non-recovery/ under assessment of NPV and CA funds Skewed EIA reports which under-estimate ecological and social risks Violation of principles of social justice	Fund management under the *gram panchayat* along with regular auditing conducted by an independent body 9stat eor central) Monitoring authority for compliance and stricter laws for non-compliance Centralised database of well-investigated projects with the amount of NPV and CA to be deposited by the user agency as mentioned in the EIA Stricter penal provision Creating a portal for states to file information on fund utilization NPV and CA funds to be distributed as per geography, topography and location Catalogue greenfield and brownfield land banks along with the accompanied flora and fauna specimens to use as a reference for project-based EIA reports Advocating and overseeing benefit-sharing contracts between project developers and PAFs
Medium term	Ratio of non-forest land demarcated for CA lesser than deemed by law Skewed EIA reports which under-estimate ecological and social risks More efficient use of land and water resources in the face of competing demands which may also involve trade-offs.	Monitoring authority for compliance and stricter laws for non-compliance Catalogue greenfield and brownfield land banks along with the accompanied flora and fauna specimens to use as a reference for project-based EIA reports Pre-emptive measures including creation of a river basin-based authority for dams management within the basin Integrated approach towards benefit-sharing of resources instead of reimbursement on project-specific basis Integrated approach includes fostering local industries like tourism (around the dam area) and fisheries Building multi-purpose dams to enhance irrigation facility in the country
Long term	Decommissioning of dams	Delay the decommissioning of dams via retrofitting the infrastructure as also, alternative designs to increase the shelf life Also look to create policy and institutional mechanisms to reduce the divergence between the designed and the actual dam life

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