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Hydropower for Safe Energy, Environment & Sustainable Development in India - A Perspective

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Abstract: *Energy is the spine of any country's domestic lifeline, progress and security. The vital force behind all development and urbanization across the globe in all sectors is essentially dependent on energy which may be renewable or non renewable. There is wide option of power generation available, ranging as per the nation need, as immediate, short term and long term. It is pertinent for any country to meet its instantaneous and interim growing power obligation through technologies utilizing non-renewable natural resources like fossil fuel, with a clear perception that it is a major source of pollution, has direct impact on environment, human and animal life and that the nature reserve is going to be exhausted some time in future. Hence it is prudent and imperative to tread the path of development by utilizing renewable resource of energy produced from the force of water, wind, tide, sun's rays and biomass. Solar, wind, tidal, biomass and geothermal energy are excellent source to be tapped but each has its own limitation that is alleviated by hydropower generated electricity which is stable, reliable, scalable and endurable. The author through the paper present an outlook on the past and current trend on global hydropower and are of standpoint that, due importance should be given to this sector by ensuring that all hydro power projects, irrespective of their capacity should be termed as renewable by the government, as generation of electricity is a function of motion of water and in this process there is no any change in the quantity, quality or property of water which flows through the intake, head race tunnel, turbine and is released through the tail race back to the river. Hydro power project is environmental friendly, plays a significant dependable role in sustainable development of remote mountainous rural India and generates safe electricity.*

Keywords: *Renewable, Hydroelectric, Hydropower, Sustainable, Environmental, Clean energy*

I. Introduction

Hydro power has a proven track record of generating clean, affordable, reliable, renewable and endurable electricity across the world and India for more than a century. In addition to generating electricity, it provides flood control, domestic water supply, irrigation and prospect of remote rural area development, recreation and tourism. Hydropower is scalable and offers significant operational flexibility to maintain grid reliability, low cost, low emission renewable energy and brings environmental benefits like reduced greenhouse gas emission, reduced air pollutants and optimized water consumption and it also facilitates the integration of increased levels of variable generation such as of wind and solar. Hydropower has been the cornerstone of the U.S. electric grid for more than a century [1]. The reason need no explanation as it is a stable, renewable and environmental friendly resource with long lived infrastructure and has the potential to provide a hedge against the future volatility of electricity prices in a changing market. Hydro power is the only answer and way forward of becoming independent of fossil energy and enduring energy and water security of the country. Unlike the other renewable such as wind, solar, biomass and small hydro that are more admired and receive additional praise in India, large hydropower is not given the support that it deserves even though, it is renewable, environmental friendly, long lasting infrastructures, cost effective, stable and has flexibility of being able to adjust output quickly to adapt to changing energy demands over period of requirement in comparison with other renewable energy like solar and wind. Secretary General, United Nations, reiterates that many renewable projects are large-scale with renewable technologies suited to rural and remote areas of developing countries where energy is often crucial in human development and has the ability to lift the poorest nations to new level of prosperity [2]. Hydropower has been endorsed as renewable energy in most of the developing and developed countries justifying it as pollution free, clean source of power utilizing the force of water, which is dependent on the nature's water cycle bestowed by sun and moon on the earth. Revival of the hydropower sector in India will give the nation safe, secure, reliable, stable and endurable electricity from domestic available resources of river, streams and ocean tides apart from sustainable and equitable development in the rural, mountainous, remote and inaccessible region.

II. Hydro Power is Renewable

In the nature, energy can neither be created nor destroyed, but it can be changed from one form to another. In hydropower generation for electricity, no new energy is created; only one form of energy is converted to another form. The moving water has kinetic energy and it forces the blades of turbine to rotate, the form is changed to mechanical energy. The turbine is coupled with a generator rotor which converts this mechanical energy to electrical energy. It is called hydropower because water is the force behind the process. The authors are of the view that all the hydro power projects irrespective of their capacity should be termed as renewable, as generation of electricity is a function of motion of water and in this process there is no any change in the quantity, quality or property of water which is taken in through the intake and released through the tail race back to the river. Hydroelectric power is generated from the force of water in motion. Water is in a constant state of motion as depicted in the hydrologic cycle in Figure: 1.0. In this system of nature powered by sun's energy, the atmospheric water condenses and falls on the earth in the form of rain, snow, hail, sleet and some other forms. Once on the earth's surface, water flows, into streams, lakes, oceans or percolates through the soil into aquifers that eventually discharge into surface waters. Further, through evaporation from surface waters or by evapo-transpiration from forest trees and plants, the water molecules return to the atmosphere to repeat the cycle. [3]

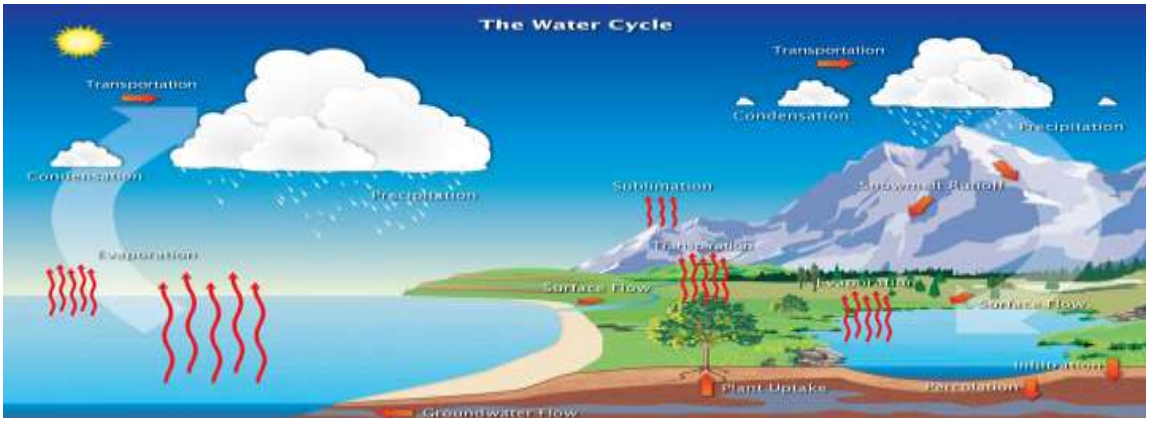


Figure1: Water Cycle [Source: earthobservatory.nasa.gov, NOAA National Weather Service, Jet Stream]

Studies have revealed that 90% of evaporation takes place from oceans, seas and other water bodies like lake, river and streams. The forest plants contribute 10% through the process of transpiration. The plants absorb water through their roots and release through their leaves and bark. Further, through the process of sublimation, water in the form of ice or snow changes directly to gaseous form. Therefore, evaporation, transpiration, sublimation and volcanic emission account for total water vapour in the atmosphere across the globe. The evaporated water is initially warm but starts cooling as it rises upward in to the atmosphere where it meets cool air. The rising water vapour condenses from gas to water droplets in presence of cool air beginning to form moisture laden cloud. These clouds grow and precipitate in the form of rain, snow, sleet and hail over the earth surface, bringing the water back and completing one cycle, thus nature ensures that water is a renewable resource.

III. Global Hydropower Trend

Hydropower is produced in 150 countries with the Asia Pacific region generating 33 percent of global hydro power in 2013. As per 2015 report, China with a population of 1,35,600,0000 has installed hydropower capacity of 319,370 MW which includes pumped storage of 23060 MW and hydropower generation of 1,126,000 GWh. The country remains the world's leading producer of hydropower as renewable energy [4]. China is a rising power that has lifted 500 million people out of extreme poverty over the last three decade, is largely dependent on hydro power generation with 1126 terra watt hours of production in 2013 which is 20 percent of countries power production. It has shown its positive intent by remarkably developing the rural remote mountainous region through contribution to local economy and increasing generation by 5% in hydroelectricity with a decrease in 3% of fossil fuel consumption, even though remaining still the largest consumer of fossil fuel. [5]

In the United States of America, hydroelectric power stations are currently the largest renewable source of electricity. Hydropower produced 51% of total renewable electricity in 2013 and 6.8 % of the total U.S. electricity. [6] As per 2015 report, United States of America with a population of 318,857,000 and has installed hydropower capacity of 101,755 MW which includes 22,241 MW of pumped storage and a hydropower generation of 250,148 GWh [4]**.** United States of America, Brazil, Canada, New Zealand, Norway, Paraguay,

Austria, Switzerland and Venezuela meet major part of their energy requirement from hydro electricity. Paraguay produces 100 % of its electricity from hydro power and exports 90% of them to Brazil and Argentina. Norway and New Zealand produces 99% and 75% of its electricity from hydro power respectively [7]**.** Hydropower has been the primary source of renewable energy generation in the United States, delivering 48% of total renewable electricity sector generation in 2015, and roughly 62% of total renewable electricity sector generation over the past decade, 2006-2015 **[8]**. Reliable generation and grid support services from hydro power help meet the nation's requirements for the electrical bulk power system and hydro power provides a long term, renewable source of energy that is free of hazardous waste and is low in carbon emissions. Hydropower also supports national energy security as its fuel is largely domestic. [1]

In India, the first hydropower plant was developed in Darjeeling and Shimla in the year 1898 and 1902 respectively [9]. As per International Hydropower Association report 2014, India has a population of 1,252,000,000 and installed hydropower capacity of 49586 MW including 4786 of pumped storage and generation of 131 TWh. India position is sixth in hydropower generation globally after China, Canada, Brazil, USA and Russia in the year 2013. In India the generating installed capacity (MW) as on 31st March 2015 is thermal 70%, hydro 15%, nuclear 2% and renewable 13%. India is endowed with an enormous hydro power potential to the tune of 84044 MW at 60 % load factor which translates to 148701 MW in terms of installed capacity. In addition to above, 6782 MW of installed capacity has been assessed from small, mini and micro hydro schemes. Also, 56 potential pumped storage schemes with an aggregate installed capacity of 94000 MW have also been identified [10]. Rivers in India carry two third of their annual flow in the monsoon months and enormous amount of water flows down in vain which can be converted to energy. Despite being recognized as nature friendly and renewable source of energy, the hydro power generation contribution in the country has been progressively declining since 1963 with 44% in 1970 to about 26% in 2007 and 15% in 2015 [11]**.** This is a concern for all associated with the sector, researchers, academicians and the scientific community as the declining percentage share is detrimental to the progress of economy, clean energy and rural growth of the country. India suffers from a major shortage of electricity generation, even though it is the world's fourth major energy consumer. Power cuts are common throughout and the resulting failure to satisfy the demand for electricity has badly affected economic growth. India's electricity sector faces lot of challenges such as poor infrastructure and high cost of production to harness India's coal bed, shortage of natural gas, limited availability of nuclear resources etc. A large part of Indian coal reserve is of low calorific value and high ash content which affects the thermal power plant's potentiality [12]. The north eastern states have enormous potential of hydropower but have little or no electricity. The military installations, boarder roads, government departments, educational institutions, hospitals and public settlement colonies of these far flung remote areas are largely dependent upon diesel generator sets, candles and lanterns since independence reflecting the unaccounted survey of electricity requirement. The people residing in these areas live as citizens deprived of the basic needs of public health, infrastructure, electricity, sanitation and drinking water. Severe power shortage is one of the greatest obstacles to India's development. Over 40% of the country's population living in rural areas do not have access to electricity and one third of Indian business cites expensive and unreliable power as one of their main business constraints. The energy shortfall of 10% also works to keep the poor entrenched in poverty. Power shortage and disruptions prevent farmers from improving their agricultural income, deprive children from study opportunities and adversely affect the health of families**.** Figure: 2, reflects the world potential and hydropower potential as per World Water Assessment Programme, 2009, in the United Nations World Water Development. [13]

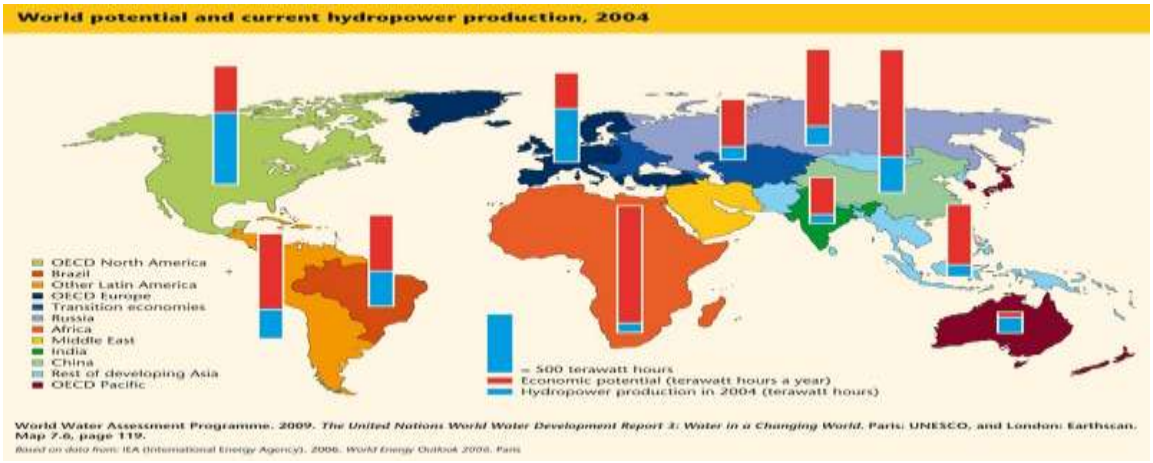


Figure 2: World Potential & Current Hydro Power Potential [Source: World Water Assessment Programme 2009, UNESCO]

India is poised for hydropower development as reflected in the hydro power policy 2008, which underlines the constraints affecting hydro power development that ranges from geological investigations and surprises in tunnelling, outdated tunnelling methods, financial, managerial, land acquisition, rehabilitation, resettlement, contracts and problems arising out of inaccessible and remote locations, power evacuation, regulatory issues, land acquisition, long clearance, and approval process [14]. It is always good to address constraints, but certainly better to provide solutions for the same, thus eliminating uncertainty or else the policy will reflect the government vision, intent and willpower, ascertaining that hydro power is not a priority. All problem mentioned in the policy are to be taken care by departmental authorities at the level of district, state and central government. The policy makers must consider before penning down that the document should spell out the hydro vision integrated with the national vision and understand that there have been innovations and non traditional approaches in the project development and applications of advanced technologies that could transform development of new hydropower projects with minimum constraints. The policy should make clear the hydro vision of nation and illustrate integrated planning methods that may allow advanced modelling, basin management, manufacturing, installation, operation and maintenance innovations to reduce cost, improve generation and environmental performance. Modern hydro turbines can convert as much as 90% of the available energy into electricity [1]**.** Development of hydropower projects opens up avenues for the economical development of remote, mountainous, rural and backward regions of the country. In recent time, hydropower is complementary to increased integration of variable other renewable generation resources like wind and solar, into the power system, as hydropower is able to reduce curtailment of excess generation by providing load management and energy storage.

Water is a State Government subject in India hence hydropower development is the responsibility of State Government. Central government advises on the hydropower matter and plays role for overall river basin planning and arbitration [15]. The authors feel that development of the hydro power sector should be equally made the subject of both, State and Central Government and the Central government should frame a hydro vision as the backbone of nation's energy security. Hydropower development is undertaken individually by each State through their hydro power generation departments and by Central Public Sector Undertakings (CPSU) like, National Hydro Power Corporation (NHPC), National Thermal Power Corporation – Hydro (NTPC-Hydro), Satluj Jal Vidyut Nigam Ltd. (SJVNL), Tehri Hydro Development Corporation (THDC), Narmada Valley Development Corporation (NVDC), North Eastern Electric Power Corporation (NEEPCO), Bhakra Beas Management Board (BBMB), Damodar Valley Corporation (DVC) and private companies. These CPSU organisations were created with the objective to take up hydro power project development on the river and rivulets, predominantly in the mountainous, remote and rural areas of the country. The Central Government's vision was farsighted and intent positive, to tap the resources by generating power and simultaneously develop these isolated areas, thus meeting the aspirations of people who are deprived of the basic amenities of food, water, sanitation and public health. Each project taken up by these organisations whether commissioned or under construction is praiseworthy as they have fulfilled the objectives for which they had been established. Dreams and aspirations of local inhabitants were met through economic betterment, infrastructure development, improved transportation, employment, work, schools, and medical facilities with hospitals, sanitation and public health thus adding up to the GDP growth. Hydropower should be a key government initiative to boost economic growth and provide reliable access to electricity to all its citizens.

India has the potential to develop 148 GW of installed hydropower capacity, with resources primarily concentrated in the Himalayan states of Arunachal Pradesh, Sikkim, Uttrakhand and Himachal Pradesh. The projects symbolize a turning point for development in the key region of north-eastern India, where 93% of hydropower potential in Brahmaputra basin is yet to be exploited. The intent of states and central government since last seventy years of independence is clearly reflected in state disputes and politics over developing hydropower potential in the north east region of country, being fully aware of China developing hydropower in the upper riparian in the interest of their nation's energy security. The Indian government is considering reviewing legislation and support schemes, including tariff regulations to promote electricity generation from renewable sources. The government has also taken efficiency measures, like streamlining of statutory clearances and high level monitoring to avoid delays in the implementation of projects. [12]

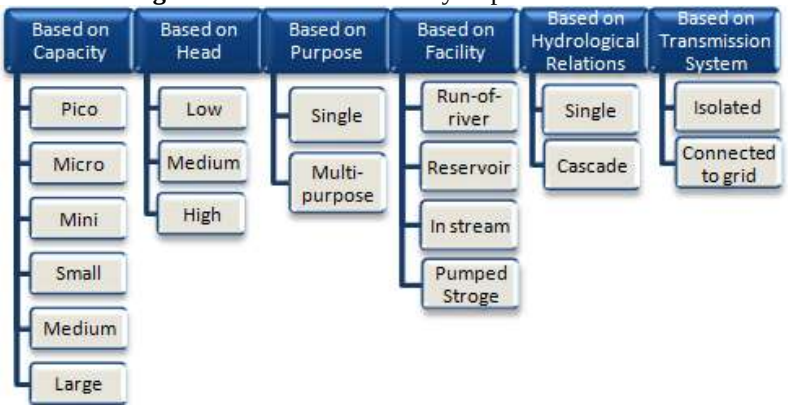
IV. Classification

Hydroelectric power schemes can be classified in under several categories according to the project capacity, head, purpose, facility, type of flow and operation as shown in Figure: 3 and Figure: 4. Hydropower has been classified based on hydrological flow and operation [16]. Run-of-river (RoR) for small and micro hydropower utilizes water that runs of a river and avoids big environmental impacts. Storage or reservoir has impact of social and environmental concern for which mitigation and management measures need to be studied and implemented. Pumped storage hydro power works as energy buffer and do not produce net energy. In-stream hydropower schemes uses rivers natural elevation drop, without to dam a river.

Run of River [ROR] is a type of hydroelectricity generation scheme as shown in Figure : 5, where no water storage is provided and hence is subject to seasonal river flow variations and thus operates as an intermittent energy source. However, it is always advisable to take a safe approach by having little or limited amount of water storage, generally termed as pondage. This can regulate water flow and serve as either base load power plant or peaking power plant. ROR is considered ideal for rivers or streams with a minimum dry weather flow and can store water for peak or base load demand especially during wet seasons. The diversion dam diverts the river flow through desilting chambers, where the silt is allowed to settle down, and clear water flows through the head race tunnel [HRT] to the turbines. The velocity of water rotates the impeller in the turbine converting water's kinetic energy into mechanical energy. The rotating turbine also rotates the generator developing a electromagnetic field to convert mechanical energy into electrical energy. The water thereafter returns to the river through the tail race tunnel [TRT]. ROR projects are different from conventional hydroelectric projects which store a large quantity of water in their reservoir and have a large land area submerged. The ROR projects do not require a large impoundment of water and hence environmental friendly. The Bureau of Indian Standard [BIS] describes run-of-river hydroelectricity as a power station utilizing the river flow from its pondage for meeting diurnal or weekly fluctuations of demand for generation of electricity. The normal course of the river is not materially altered**.** Several run-of-river projects have been designed to a scale and their generating capacity competing traditional hydro dams. Major examples are Belo Monte Dam (11233 MW) on river Xingu of Brazil, Satluj Jal Vidyut Nigam Ltd. (1500 MW) on river Satluj, India, Ghazi-Barotha Hydropower Project (1450 MW) on river Indus, Pakistan, Carillon Generating Station (752 MW) on river Ottawa, Quebec, Canada, Baglihar hydroelectric project (900 MW) on river Chenab, Chief Joseph Dam Project (2620 MW) on river Columbia, USA and several others. Small run of river project has minimum impact on the environment and people living in the vicinity. It ensures clean power with minimum GHG emission and requires less submergence land which minimizes the relocation of project affected people, saves productive land to a greater extent. However, these types of projects are generally intermittent source of power as they have little or no capacity for energy storage and hence cannot synchronize the output of electricity generation to match consumer demand. These projects are able to produce their envisaged potential when seasonal river flows are high and least during summer and winter months.

Dams with storage reservoirs are projects with high dams that provide storage for water generation. The water is usually stored at times of high flow in the river and the reservoir is drawn with a more balanced electricity generation during the times of low flow. Most of such projects store and release the water over a year. **Pumped Storage** schemes produce electricity to supply high peak demands by moving water between reservoirs at different elevation. At times of low electrical demand, excess generation capacity is used to pump water into the higher reservoir and during times of high demand, water is released back into the lower reservoir through a turbine. This scheme provides the most commercially important means of large scale grid energy storage and improve daily capacity factor of generation system. They are perfect centralised peaking power stations for load management in the grid. India has already established nearly 6800 MW pumped storage capacity which is part of its installed hydro power plants. **High head small volume** schemes enable to generate by using relatively small volume of water dropping it down a high head from the intake through the penstock to the power house and are used to divert water some kilometres downstream or even into another river basin. **Low head large volume** is a typical run-of-river scheme where the maximum flow is diverted through the intake to the turbine over a relatively low head. **High head large volume** schemes are of large storage dams with which large quantity of electricity can be generated. Combination of renewable source of power generation is a superlative option in which, day time surplus solar generated electricity can be made available to meet the electricity demand during night time with the help of pumped storage hydropower units. [17]

Figure 3: Classification of Hydropower Schemes



Pico	•From a few hundred watts up to 5 KW
Micro	•5 KW to less than 100 KW
Mini	•100 KW to less than 1 MW
Small	•1 MW to less than 15 MW
Medium	•15 MW to less than 100 MW
Large	•100 MW and more

Figure 4: Classification based on Capacity, Source: Singh, 2009 [18]

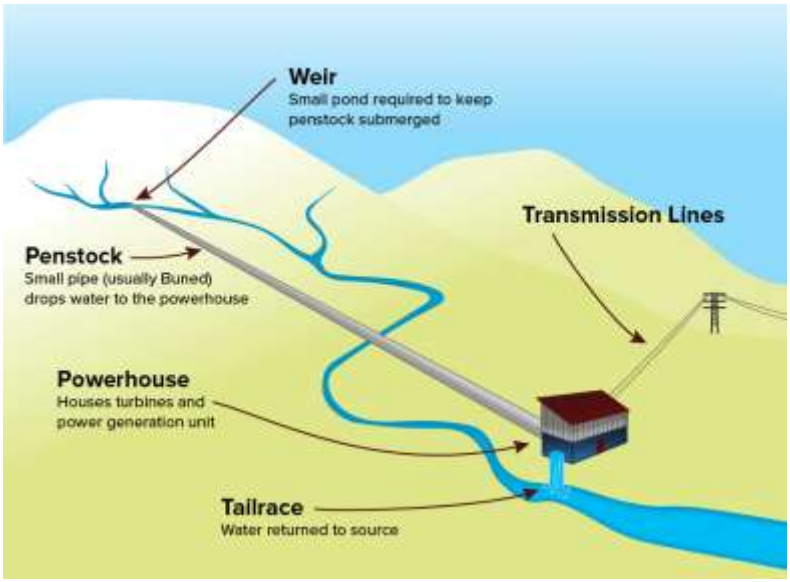


Figure 5: Typical Run of River Scheme [Source: Next Generation hydro, Canada]

V. Need And Advantages

A large part of hydropower projects are situated in mountainous region of remote rural North East India in the states of Arunachal Pradesh, Assam, Manipur, Nagaland, Tripura, Meghalaya and Mizoram which has a combined envisaged potential of 60000 MW approximately. Most of these states are inaccessible by road and population living in poverty and deprived of minimum basic amenities. People for sustenance are largely dependent on forest products and limited or no agriculture. There is lack of public health, palatable water, medical health care, public transportation, education and infrastructure facility. The hydropower projects is one of the unutilized potential which will bring sustainable development in these regions and fulfil the aspiration of local people living under adversity in these remote hilly areas which are awaiting development since independence craving for employment, business, financial, medical, electricity, social safety, township. Attention is sought of all who matter, from government to private corporate and leading banks of the world to invest and fulfil the aspirations of people and make the country have secured renewable hydropower energy.

The generation of electricity is a function of motion of water and in this process there is no any change in the quantity, quality or property of water which flows through the intake, head race tunnel, turbine and is released through the tail race back to the river. In the process of generation of electricity from hydroelectric plants there is no any emission of greenhouse gases, toxic waste, air, water, land pollution. Hydropower development being environmental friendly also helps in confronting climate change and aids in reducing carbon emission and carbon footprint. The infrastructure life is long lasting, endurable and power generation is stable, reliable and flexible. The operational and maintenance cost is minimum thus lowering the generation cost. Apart from generation, hydropower projects assist in flood moderation, irrigation, navigation and water supply. Catchment area treatment is carried out to minimise soil erosion which help in land stabilization and prevents landslides.

VI. Discussion

Increasing the amount of hydropower for meeting the nation's electricity needs will require a holistic approach to project development and incorporates sustainability principals by balancing environmental, social and economic factors associated with hydropower. The authors on their study in the North Eastern States of India have observed that the hydropower projects are predominantly situated in remote, hilly, inaccessible rural regions which lack infrastructure and communication facilities, stressing the need for development of these regions. The only lifeline in these north eastern states is the road being constructed and maintained by Border Road Organisations which gives employment opportunity to the local inhabitants and their work is outstanding. These roads are constructed from strategic point of view and are single with temporary wooden bridges which are unsuitable for heavy traffic movement that will arise due to hydropower project construction activity. Conversion of all these hilly single strategic roads to double lane heavy traffic road and all the bridges designed for Class 70R loading must be taken up on priority which will again primarily depend upon the financial plans and resources of Central and State Government.

The preliminary works like preparation of feasibility study, detailed project report, statutory clearances related to forest diversion, environment impact assessment study, environmental public hearing and land acquisition are significantly important because they are directly linked with the public and several of these states do not have land reforms and documented land records. These works should not be seen as inordinate delays but time taken to make the public aware of the project, thereby assisting them to take a decision on their own will, for parting off their land for the project, thus upholding the ethos of democracy. Environment, land acquisition, rehabilitation and resettlement are the key issues that need to be addressed with accuracy in the beginning of the project setup as they are linked to public sentiment. Further, it is very important for all private investors and proponents to stress upon precision in the preparation of detailed project report with accountability in order to ensure minimized uncertainty arising out of geological and hydrological study. The central or state public sector undertakings have trouble free access to huge debt capital requirement whereas private developers will not find easy or like to have access to enormous huge debt on their balance sheet as full recourse funding option.

Past and present practice of Environmental Impact Assessment has focussed only at the project level and the onus of getting the EIA carried out has been with the project proponent limiting the significance of EIA to the level of mere project clearance and as a report for regulatory compliance with an action plan on mitigation measure, safeguards and monitoring. Thus, overlooking the broader aspects of EIA for river basin development, regional planning and thereby denying justice to nature self regulatory system. Unlike before, now development of project should not be formulated in isolation but with a holistic approach of comprehensive river basin plan for sustainable development. Cumulative Environmental Impact Assessment (CEIA) is the answer for basin wise development in the region as the study will detail on the basin vulnerability due to multiple projects, ecosystem, effect on local weather and climate due to cumulative evaporation effect from all the poundage, adverse effect on the hydrological flow regime, base flows reduced to environmental flow or even to zero flow during season of peak demand, unpredictable flash flood and flood severity. [19]

The author have observed that water is the main source for generation of electricity and the onus of providing required amount of water lies with the state and central government. Further, river valley projects involve use of water which is also a depleting resource with time and in conditions when multiple projects start their generation in the same river basin, the capacity of any project to meet peak demand may be compromised by other peak load projects. This unplanned power generation system failure will lead to water grabbing and disputes, investment wastage on uncertainty and unsustainable development will take place justifying over use as also misuse. Further, the CEIA studies carried out for each basin must be extended to region beyond the geographical boundary of states and should be integrated in the developmental plan of the region with a clear conceptual approach from generation to evacuation in one hand and preserving the ecosystem, environmental safeguards, water management and flood control on the other. It is suggested that the CEIA and carrying capacity study for river basins must be carried out and integrated with regional developmental plan of the entire north India. [19]

VII. Conclusion

There has been remarkable scientific innovation and advancement in turbine manufacturing. Modern hydro turbines can convert as much as 90% of the available energy into electricity. Project development, operation and maintenance of new hydropower has progressed in terms of technology, environmental management, monitoring, protection and mitigation with advancement like, fish friendly turbines that reduce fish injury and mortality, fish passage structures to facilitate upstream and downstream fish movements, auto – venting turbines to ensure availability of adequate oxygen levels in outflows [1]**.** It is always in the interest that research and development, advancement on innovative technologies be continue to be applied at all the new projects to enhance generation efficiency, environmental performance and water use effectiveness. Large hydropower schemes have vigorous monitoring systems that have unique position to contribute lessons learned

and best practices in the larger interest of increased power system sophistication scheduling to blend variable generation with new or existing hydropower strengthening the grid.

India should focus in meeting its growing electricity demand through hydropower as it is reliable, scalable, flexible, safe, enduring and environmental friendly. Further, development of these projects is the only logical way to strengthen the local rural economy in the remote, hilly, inaccessible regions apart from securing the nation's economy. The declining sector needs to be revived and geared in the larger interest towards security of energy and water [20]. Development of any hydropower scheme, public facilities or infrastructure often requires the exercise of legal powers by the state under the principle of eminent domain for acquisition of private property, leading to involuntary displacement of people, depriving them of their land, livelihood and shelter, thus restricting their access to traditional resource base and uprooting them from their socio-cultural environment. These have traumatic, psychological and socio-cultural consequences on the affected population which call for protecting their rights, in particular of the weaker sections of the society including members of the scheduled castes/tribes, marginal farmers and women. The central government has framed National Rehabilitation and Resettlement Policy based on which Most of the states have formulated their own rehabilitation and resettlement policy. It is mandatory for all developers to abide as per the provision laid down in the policy. The policy details on every aspect and concerns related to project affected person's right and benefit through compensation be it financial, employment, property settlement or livelihood upholding the ethos of democracy. The author are of the view that India should develop a hydro vision integrated with the national vision, drawing inference through past analysis, with the view that hydropower development significantly brings economic, societal benefits and include cost savings in mortality, morbidity and economic damage from power sector emissions of air pollutants and avoids global damage from GHG emissions. Hydropower, a low carbon generation option, has been and should continue to be a substantial part of addressing the challenge of producing and making clean, affordable, enduring and secure energy for the nation and climate security.

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