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Scenario And Risk Of Hydro Power Projects In India

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Abstract: Hydropower plays an important role in the development of the country as it provides power at cheaper rate being perpetual and renewable sources of energy. In hydroelectric power plant, the energy of water is utilized for generating electricity. It is a well known fact that the rain falling upon earth's surface has a potential energy relative to oceans toward it flows. The hydropower generation affects ecology of the surroundings. It affects the land use flora and fauna of the particular field. The objective of this paper is to analyse and assess the potential of hydropower generation in India. The risk associated with hydropower plants is also discussed.
Key Words: Hydropower potential, basin, risk asssement, consumption.

Introduction

One of the oldest technologies for electricity production is hydrogenation. It has many advantages as compared to other technologies, and only 17% of world energy is supplied by hydroelectric plants. India is very rich with hydropower potential and considered as one of the pioneering countries in establishing hydroelectric power plants. In terms of usable potential India stands fifth in world but only 19.9% has been developed or used for development[1]. Researchers evaluated that hydropower can meet the growing demand of energy of the country for the generation of electricity. It is the largest renewable energy resource. Presently only 150000 MW of energy which is about 17% of the potential has been tapped so far in India whereas countries like Brazil, Canada and Norway have been extracted 30% or more of their hydro potential[3]. Hydropower combined with other purpose not only provides power, but it controls flooding, store irrigation water. The water reservoir can be a important source of CH2 and CH4. The first hydropower power plant in Asia was developed at Darjeeling and Shimla in 1898 and 1902 and yet only 19.9% has been developed in our country. The hydropower development depends on various factors which include technical difficulties and political opposition, dearth of adequately investigated projects, land acquition problem, environmental concern, regulatory issue, power evacuation problems, long clearance and approval procedure, the dearth of good contractor, and sometime law and order problem and inter-state issue are the cause for the slow development of hydropower. Government has adopted various measures to address the issues for the hydropower development and is very keen to accelerate the development. In the present paper, risk involvement and the major challenges in hydropower generation and steps to overcome challenges has been discussed. This paper also deals with the factor to increase the hydropower resources of the country, and scenario of hydropower generation and electric consumption of the India.

Hydropower Scenario of India

India is blessed with immense amount of hydro-electric potential and ranks 5th in terms of exploitable hydro-potential on global scenario[9]. The present installed capacity of India as on 30-06-2011 is approximately 37,367.4 MW which is 21.53% of total Electricity generation of India[5]. Few public sector companies which are engaged in development of hydropower in India are National Hydroelectric Power Corporation (NHPC), Northeast Electric Power Company (NEEPCO), NTPC-Hydro, Sutlej Jal Vidyut Nigam Limited (SJVNL), Tehri Hydro Development Corporation. These public sectors has a predominant share of 97%. The North-Eastern part of India: Arunachal Pradesh, Nagaland, Manipur and Mizoram and also the area of between Mumbai and Mahe on the west coast has dominant annual rainfall. The major hydroelectric power plants are located in Bihar, Punjab, Uttaranchal, Karnataka, Uttar Pradesh, Sikkim, Jammu & Kashmir, Gujarat and Andhra Pradesh. Hydropower projects with a capacity of up to 25 MW comes under a category of small hydropower (SHP) in India. Estimated SHP potential of India is about 15,000 MW, of which 11% has been tapped so far. The Ministry of New and Renewable Energy (MNRE) supports SHP project development throughout the country. So, far, 523 SHP projects with an installed capacity of 1705 MW have been installed. Besides this, 205 SHP projects with an aggregate capacity of 479 MW are under implementation. With this capacity addition, on an average of 100 MW per year and gradual decrease in gestation periods and capital costs, the SHP sector is becoming increasingly competitive with other alternatives. Presently, the following forms of hydro power projects are existing in the India:

• Storage Schemes
• Run-of-River (ROR) Schemes without Poundage.
• Run-of-River Schemes with Poundage.
• Pumped Storage Schemes.

Table 1: Major Hydropower Generating Units Of India[1,14]

S.No	Year of completion	Name of Dam	State	Capacity (MW)	Type	Length of Dam(m)
1.	1963	Bhakra Dam	Punjab	1100	PG	518
2.	2005	Tehri Dam	Uttrakhand	1000	TE/ER	592.7
3.	1977/83	Dehar	Himachal Pradesh	990	TE/ER	255
4.	1960	Nagarjuna Sagar	Andhra Pradesh	960	TE/PG	4865
5.	1964	Koyna	Maharashtra	920	PG	805

(National register of large dams-2009)

Abbrevation: - Earth: TE, Rock fill: ER, Gravity/Masonry: PG

Table 2: Region Wise Hydropower Potential Of India[15]

Region	Principal Hydro			Pumped Storage feasible Installed Capacity in MW	Small Hydro (up to 15 MW) potential in MW
	Potential at 60% Load Factor	Feasible Installed Capacity in MW	Potential in billion KWh per year		
Northern	30155	53405	225	13065	3180
Western	5679	8928	31.4	39684	661
Southern	10768	16446	61.8	17750	801
Eastern	5590	10965	42.5	9125	530
North Eastern	31857	58965	239.3	16900	1610
Total	84044	148700	600	95524	6782

(Region wise break up based on CEA estimates)

A. River Basins and Their Power potential

In basins, the water converges to a single point inside the basin, known as a sink, which may be a permanent lake, dry lake, or a point where surface water is lost underground. The basin includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels, and is separated from adjacent basins by a drainage divide. The basin acts as a funnel by collecting all the water within the area covered by the basin and channeling it to a single point. Each basin is separated topographically from adjacent basins by a geographical barrier such as a ridge, hill or mountain.

Table 3: Basin-Wise Hydroelectric Potential Of Indian River System[3]

Name of River	Number of Schemes	Firm Potential (MW)	Potential (MW) at 60% Load factor		Needed installed Capacity
			Economic Potential	Theoretical Potential	
Great Indus	190 (including 23 storage)	11992.8	19988	50172	33832
Great Brahmaputra	226 (including 76 storage)	23951.9	34920	146170	66065
Ganga	142 (including 35 storage)	3409.0	10715	_	20711
West flowing river of South India	94	3689.4	6149	9437	9430
East flowing rivers of South India	140	5719.0	9532	26972	14511
Central Indian system	53	1664.2	2740	14888	4152
Total	845	50426.3	84044	301117	148701

Godavari basin*:* Godavari basin extends over an area of 312812 sq. km which is about 9.5% of the total geographic area of the country. It is surrounded by Satmala Hills, the Ajanta Range and the Mahadeo Hills on the north, on the west by Western Ghats, and on east and south by Eastern Ghats. The basin lies in the states of Maharashtra, Andhra Pradesh, Madhya Pradesh, Orissa and Karnataka. The total State-wise distribution of the drainage area is 312812 sq .km. The black soils, red soils, laterites and lateritic soils, alluvium, mixed soils and saline and alkaline soils are the important types of soils found in this basin. About 18.93 M ha is the culturable area in the basin which is about 9.7% of the total culturable area of the country. As per latest assessment, the hydroelectric power potential of the basin is 5091 MW at 60% load factor and a large part of the potential yet to be harnessed.

Krishna basin: Krishna basin extends over an area of 258948 sq. Km which is about 8% of the total geographical area of the country. It is surrounded by the Eastern Ghats on the south east and by Western Ghats on the west and on the north it is bounded by the range separating it from Godavari basin. The basin lies in the state of Karnataka, Andhra Pradesh and Maharashtra. The total State-wise distribution of the drainage area is 258948 sq.km. The black soils, red soils, laterite and lateritic soils mixed soils alluvium soils are the important types of soils found in this basin. About 20.3 M ha is the culturable area in the basin which is about 9.7% of the total culturable area of the country at 60% load factor. As per the latest assessment, the hydroelectric potential of the basin is 2997 MW at 60% load factor.

Brahmaputra basin: This basin extends over an area of 580000 sq.km lies in Tibet (China), Bhutan, India, Bangladesh. It is surrounded by the Himalayas on the north, on the east by the Patkari range of hills running along the Assam-Burma border, by the Assam range of hills on the south, on the west by the Himalayas and the ridge separating it from Ganga sub-basin. This basin lies in the state of Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and West Bengal. The drainage area lying in India is 194413 which is about 5.9% of the total geographical area of the country. The type of soil found in this sub-basin is the red loamy soil and alluvial soil, sandy, clayey soils and laterite soils. About 12.15 m ha is the culturable area of the sub-basin which is about 6.2% of the total culturable area of the country. This sub-basin has a abundant hydropower potential. As per the latest assessment the hydropower potential of the sub-basin is 31012 MW at 60% load factor, which is almost 37% of the country's hydropower potential.

Narmada basin: The 3% of the total geographical of the country is covered by the Narmada basin which has an area of 98796 sq. km. It is surrounded by the Vindhyas on the North, the Maikala range on the East, Satpura on the South, and by the Arabian Sea on the West. The basin lies in the state of Madhya Pradesh, Gujarat, and Maharashtra. The black soils are predominant in the basin. About 5.9 M ha is the culturable area of the basin which is 3% of the total culturable area of the basin. The hydroelectric power potential of the basin is 1321 MW at 60% load factor as per latest assessment.

Mahanadi basin: The area covered by the Mahanadi basin is 141589 sq. km, so nearly 4.3% of total geographical area of the country. It is bounded by the Central India Hills on the north, on the south and east by the Eastern Ghats and on the west by Maikala range. The state which comes under this basin is Madhya Pradesh, Orissa, Bihar, and Maharashtra. The types of soil found in this basin are red and yellow soils, mixed red and black soils, lateritess soils and deltaic soils. About 7.99 M ha is the culturable area of this basin which is about 4% of the total culturable area of the country. The hydro power potential of the basin is 627 MW at 60% load factor.

Electricity Consumption

A. India Electricity Consumption

India accounts for 17% of the world's population but only 4% of the world's primary energy consumption. Due to increase in appliance ownership in residential sector and floor space development in the commercial sector and increase in equipment penetration the primary electricity consumption is expected to grow at 6.4% annually over the period 2005 to 2020. In 2009 the per capita average annual domestic electricity consumption was 96 KWh in rural areas and 288 KWh in urban areas. In one report released by government recently, it has been found that average per capita total consumption of national as of January 2012 was 778 KWh. Electricity consumption in India, currently at some 600TWh annually, is set to double by next decade (2020), and by then it would surpass Russian levels in the process[6]. The total per capita consumption of electricity of different region are shown in table 4,5,6,7& 8.

Table 4: Total Electric Energy Consumption Of Northern Region[11]

S.No.	Name of States	Per Capita Consumption of Electricity (KWh)
1.	Haryana	1491.37
2.	Himachal Pradesh	1144.94
3.	Jammu & Kashmir	968.47
4.	Punjab	1663.01
5.	Rajasthan	811.12
6.	Uttar Pradesh	886.93
7.	Uttarakhand	930.41
8.	Chandigarh	1238.51
9.	Delhi	1447.72

Table 5: Total Electric Energy Consumption Of Western Region[11]

S.No.	Name of States	Per Capita Consumption of Electricity (KWh)
1.	Gujarat	1558.58
2.	Madhya Pradesh	618.1
3.	Chhattisgarh	921.14
4.	Maharashtra	1054.1
5.	Goa	2004.77

Table 6: Total Electric Energy Consumption Of Southern Region[11]

S.No.	Name of States	Per Capita Consumption of Electricity (KWh)
1.	Andhra Pradesh	1013.74
2.	Karnataka	873.05
3.	Kerala	536.78
4.	Tamil Nadu	1210.81
5.	Lakshadweep	428.81
6.	Pondicherry	1864.5

Table 7: Total Electric Energy Consumption Of Eastern Region[11]

S.No.	Name of States	Per Capita Consumption of Electricity (KWH)
1.	Bihar	117.48
2.	Jharkhand	750.46
3.	Orissa	837.55
4.	West Bengal	515.08
5.	A&N Islands	506.13
6.	Sikkim	845.4

Table 8: Total Electric Energy Consumption Of North Eastern Region[11]

S.No	Name of States	Per Capita Consumption of Electricity (KWH)
1.	Assam	209.20
2.	Manipur	207.15
3.	Meghalaya	613.36
4.	Nagaland	242.39
5.	Tripura	223.78
6.	Arunachal Pradesh	503.27
7.	Mizoram	429.31

From the above tables it is found that the Goa (2004.77 KWh) and Pondicherry (1864.5 KWh) accounts for maximum per capita consumption of electricity, while Bihar (117.48 KWh), Manipur (207.15 KWh) & Assam (209.20 KWh) shows the lowest per capita consumption. National average per capita consumption of electricity is 778.63, fifteen states of India shows lower annual per capita electricity consumption as compare to national average[1]. Dadra and Nagar Haveli, Daman and Diu, both are ports and industrial places, the electricity consumption in both places is ten times that of national average. The states like Bihar live on fraction of electricity as compared to world. On national level, India's energy consumption is one of the lowest in the world.

Risk Involvement

Risk management in Hydropower generation is based on the principal that all business activities are an integral part of risk evaluation. Hydro faces many uncertainties and risk factor in worldwide business market and global marketplace. Conditions of market and economic changes are highly exposed to us, and have a significant impact on risk management including price volatility. In order to reduce credit risk the proactive measure to improve its financial position and to further increase or adjust the cost of operations should be adopted. The basic and main risk management of hydropower is related to volatility in cash flow i.e. to maintain a solid financial position and strong credit worthiness.

Certain risks that may adversely affect the result of operations, financial condition and business are mentioned below:

Additional Costs and Lost Operating Revenues: Risk of failure or delays in the execution of major project is mainly due to many complications which include cost increases, availability of inadequate funding and some other factor. The cost position of the Hydro can be enhanced by focusing on the strategy on business opportunities.

Development in the Market Demand and Global Economic Conditions: Our country suffers a substantial and continue increase in uncertainty and volatility in global economic and market conditions which could have an adverse effect on liquidity and results of operation. Market demand and prices declined rapidly in past few years due to the recession time period.

Negative Effect by Legal proceedings or Investigations: Commercial disputes, anti-corruption practices and issues, health and safety, criminal or civil proceedings, alleged breaches of anti-competitive, and other integrity legislation has a negative effect on Hydropower projects. There is substantial damage to the company's reputation if there is violation in rules and regulation and could result in fines or penalties, the suspension or shutdown of ongoing operations.

Risk of Counterparty Default: Deteriorating and weak economic conditions on a global, regional or industry sector level increases the risk of defaulting counterparties and may reduce or make prohibitively expensive credit insurance to cover such risk.

Failure in Developing Technologies for Growth Strategies: Technology development is important to remain in competition. Failing in developing technologies on a timely basis or not commercially feasible technology result in negative impact on our competitive position which in turn affect our operating results and also effects the future acquisitions, mergers, strategic alliances and business portfolio management.

Risk of Unforeseen Damage : There are number of damage which can affect and increases the number of risks and hazards i.e. personal injury, possible legal liability, power failures, and major military conflicts.

Risk of Environmental Damages: Natural disaster which include earthquake, flood and other calamities effect the development of hydropower projects and effect the operating results and make an negative impact on the economy and market price of project.

Risk Subjected to Range of Laws and Regulation: Laws and Regulations impose stiff standards and requirement and potentials liabilities regarding accidents and injuries, pollutant emissions, storage, treatment and discharge of waste material, handling of toxic materials, facilities, and construction and operation of our plants.

Market and Commercial Risks: For managing risk and coordinating overall risk of enterprise the corporate staff units establishes different policies and procedure. Market and commercial risk includes:

a) Financial position.
b) Liquidity risk.
c) Prices and Currency.

At the end of 2011 hydro's liquidity risk was satisfactory and further no new long term funding is required in 2012. Hydro continues to focus on cash flow and credit risk throughout the organization.

Major Up Coming Challenges

The immediate challenges facing the hydropower industry are:

Pollution

Greenhouse Gases
Oxygen Depletion
Methyl Mercury Contamination

Water Quality
Reservoir Induced Seismicity

Sedimentation

Too Much Sediment
Hungry Water
Loss of Farmland
Aquatic Life Protection

Land use issue

Involuntary Resettlement
Inter-State Issues
Law and Order Problem

Measures to Mitigate Challenges:

The major steps to meet challenges are:

- Advance and latest technology be the primary focus to be adopted by all new plants.
- Technology mission to make hydro power economically attractive (private sector involvement) and technically strong.
- Develop planned infrastructure for the proper use of resources.
- Raise the level of Diplomacy to overcome law and order issue and inter-state issues.
- Under take Research & Development to harness maximum power.
- Under take Research & Development to minimize gas emission & other geological surprises.
- Improve quality of planning and investigation and reduce construction delays.
- Under take Research & Development to improve the life and performance of the metallurgical equipment and all other equipment both from mechanical and electrical sides.
- Governing of project commissioning and construction monitoring activities should be properly validated.
- Focus on to reduce the slippages of projects.
- Refining regulatory and policy framework at country/transboundary levels, building capacity among builders as well as government and electricity companies, and enhancing transparancey for stakeholders.
- Engineering studies completed years ago need to be updated with new knowledge (hydrology) as well as sophisticated consideration of environmental and social values.

To maximize the hydropower resources of the countries, the country should have a good practice in energy planning and development, as well as multiple dimensions of water management and environmental and social protection. Some major factors which are helpful to assist country for maximizing the value of their hydropower resources are:

Scale up Financing: This task is important in the financial crisis and similar financial challenges. This task can be accomplished by improving the environment for private sector development and encouraging new combination of financing instruments. The private sector plays a critical role in providing the required financial management and technical skills.

Strengthen Planning: This can be done by supporting government in understanding the strategic value of hydropower through cross-sectoral planning, improvement of hydrological data and analysis.

Promote Good Practice of skill: This element focus on the design and development of projects, with particular attention to environment, social, economic benefits, application of operational policies, and a range of technical assistance activities.

Leverage Regional Development: By exploring synergies among complementary projects, development opportunities, multipurpose projects, revenue management, and benefits- sharing, can benefit the local communities and contribute to the expansion of hydropower resources.

Build Partnerships: For the continuous improvement in sustainable hydropower, for planning, financing, and promoting good practice.

Conclusion

The ever increasing world energy demand cannot be fulfilled much longer with fossil fuels alternatives are required to limit the chance of the climate collapse and the spreading of wars for natural resources. The 21st century will be largely defined by the way India faces and resolves the energy crisis. This is an intricate and fascinating scientific challenge, in which hydropower will play a fundamental role, and also an unprecedented opportunity to shape a more peaceful and ecofriendly world.

In the portfolio of energy, a judicial mix of hydropower can also contribute to reduction in greenhouse gas emission, increased flexibility in the grid operation, energy security, meeting the peak demand. Hydropower projects not only contribute to power but also to irrigation, navigation, and flood control. Thus hydropower is one of the potential sources for meeting the growing energy needs of the country. The Indian government has recently developed a policy to promote development of hydroelectric power and therefore giving special emphasis to accelerate hydropower development in its power development plans, a tariff subsidy to support the development of hydroelectric power is an effort to improve the nation's energy mix.

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