



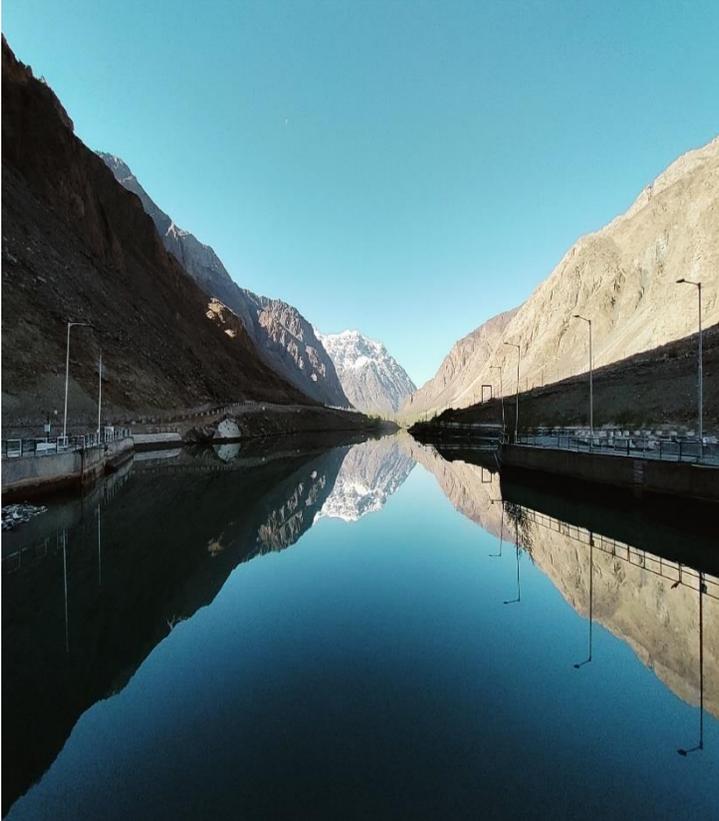
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Role and Potential of Hydro-Electrical Projects in Development in Union Territory of Ladakh

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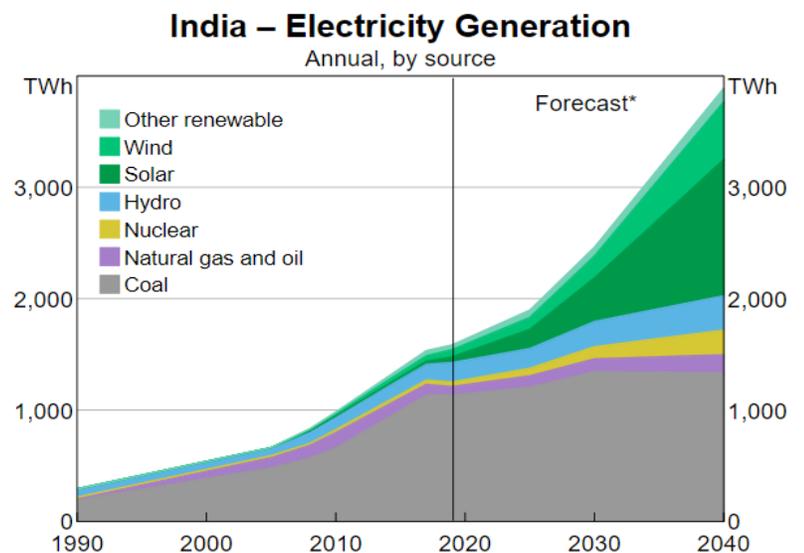
Role and Potential of Hydro-Electrical Projects in Development in Union Territory of Ladakh

Dr. Ashutosh Mishra* & Dr. Prakash Tripathi#

Introduction:

Energy plays crucial role in development of any nation. India with its aspirations to be a developed nation will require a lot of energy to achieve this goal. India has to increase the energy output which is a prerequisite to accomplish the economic target and implement the development policies and programmes. There are several regions in the country where infrastructure is not that robust, but government of India has taken up many flagship schemes for strengthening the infrastructural network in the remotest parts of India so that these parts are not left behind in the race of development and their skills can be utilised for the growth of the Nation. India's National Electricity Policy, 2021 is one such of such programs and it emphasises on the clean and sustainable energy to provide electricity to the 1.3 billion people of India. As of now, India largely depends on fossil fuels for its energy needs and 74% of its energy demand is met through the fossil fuels. Fossil fuels such as oil, coal and natural gas have contributed to one third of global green-house gas emission. The World Energy Council has predicted that energy demand will be on peak in 2030. Considering the climatic challenges India has to shift to alternate energy to achieve its energy requirement. To avoid climatic anomalies and achieve sustainable development goal, the country is making a swift but sustained transition to renewable energy technologies. To be aligned with the Paris Agreement 1.5⁰ limit, India must rely more on the renewable energy and phase out coal use from its power sector by 2040 which seems challenging task to achieve.

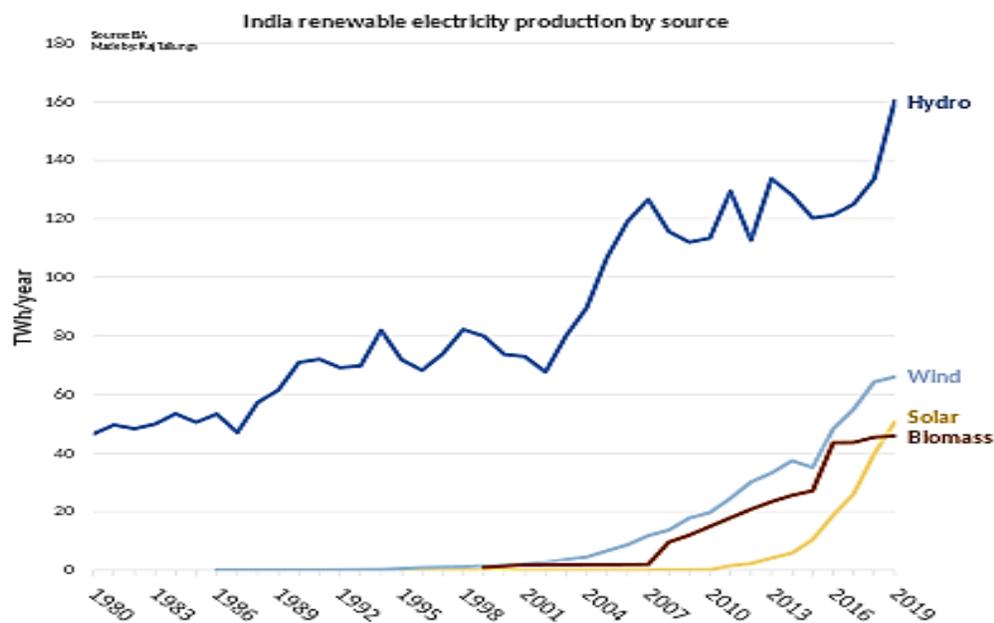
Varied landscapes and geographical conditions allow India to harness alternative energy and India has successfully accomplished it so far. However, we have to go miles. Recently, Central Electricity Authority has mentioned in its report that by 2030 India's coal capacity will increase by 64 GW above 2021 level which means more carbon emission and further delay in achieving Paris Agreement Target. The following graph shows India's commitment to reduce the coal-based power generation and moving towards the renewable energy.



Source: www.rba.gov.au/publications/bulletin/2020/dec/economic-developments-in-india.html

By 2040 the India's dependency on renewable energy for electricity generation will be more than 60% compare to today's 28%.

The country aims to attain 175 GW of renewable energy which would consists of 100 GW from Solar energy, 10 GW from Bio-power, and 5 GW from small hydro-power plants by the year 2022. By 2030 the aim is to achieve 500 GW of renewable energy. The above image shows that India is investing more and more in alternative energy especially the solar. India has committed to increase the share of renewable energy by 40% of total electricity production by 2030. Hon'ble Prime Minister's initiative to transform India's energy need from perishable fuels to renewable fuels is exemplary. In COP26 at Galsgow, PM has committed to reduce carbon emission to 0 level by 2070. This new initiative to opt renewable energy has also open new jobs and livelihood opportunities which will provide employment to the youth. The technology and mechanism used in the renewable energy are cost-effective and environmental friendly. The carbon emission from these projects are zero and they also earn carbon credits which can be further used in the development of the sector. The following image shows the production of renewable energy in India since 1980. The following image shows that the hydro-electric projects has contributed maximum in the renewable energy.

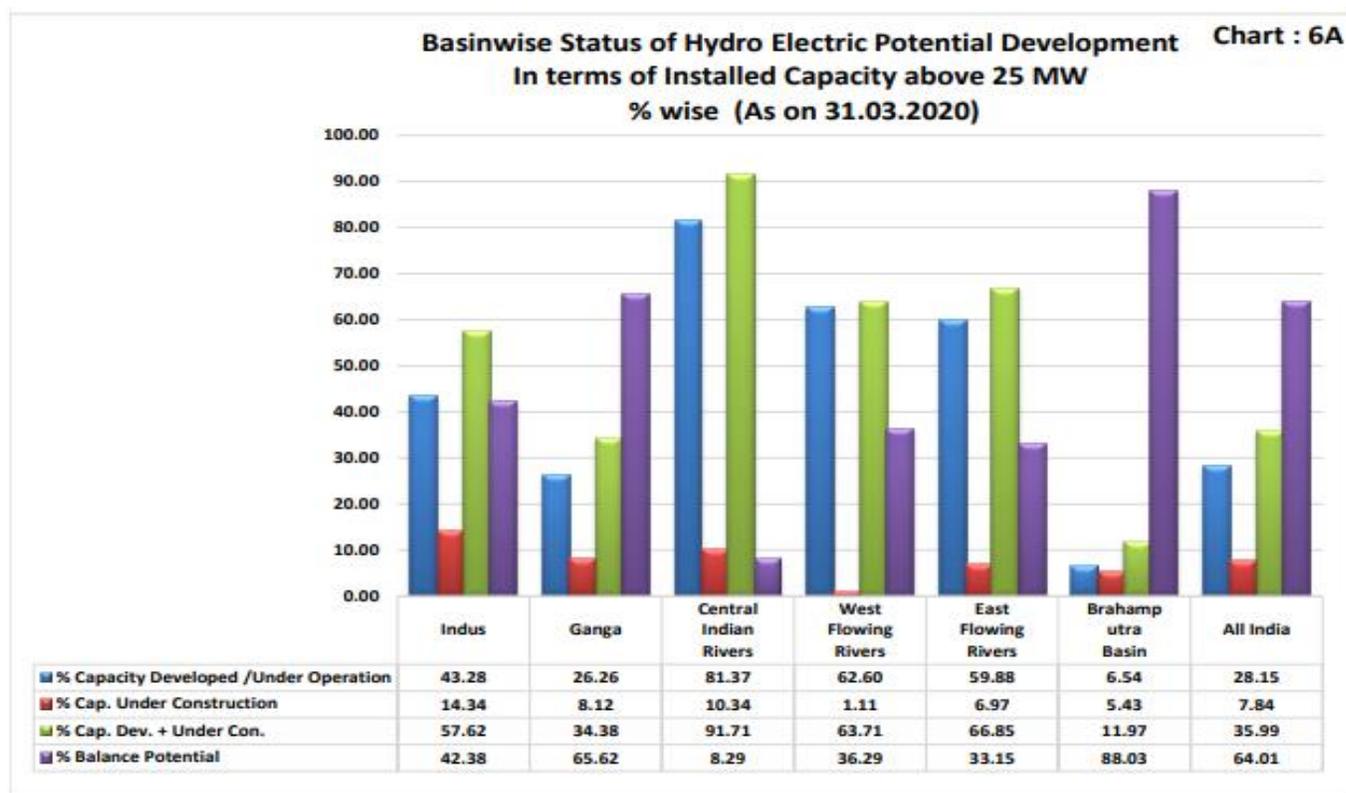


Trend of India's Renewable Energy Production

Government's initiatives like the 'Atmanirbhar Bharat' and 'Vocal for Local' can be linked with developing technology and machineries which can help in enhancing renewable energy (RE). RE also has ample scope for the business and investment. To accelerate development of the sector, India needs to ensure transparency, standardization & Uniformity of Procurement process and risk sharing framework between shareholders. These measures will encourage investments from foreign and Indian Investors. Short term

training and skill development programmes, investment in research and development will certainly help in boosting this sector.

Hydro-electrical potential in India has not been harnessed to the available extent. At the eve of Independence the hydroelectric power was contributing 37% of total power capacity and 53% of total power generation in India. Later, India's urge to Industrial growth that required large power generation to run industries forced India to rely on the coal-based power generation. The share of Hydro-electric declined sharply both in capacity and generation. Presently, India has estimated hydropower capacity of 1,45,320 MW, excluding the Small Hydro projects. At the end of February 2020, installed capacity was approximately 45,500 MW. India has targeted to achieve a capacity of 70,000 MW of Hydropower production by 2030. Growth in hydro-power generation was not very promising. In the initial decades since Independence shows higher growth rate (capacity by 13% and generation by $\simeq 12\%$) in hydro-power sector while it declined gradually in coming decades. In 2007-2019 hydro-power capacity grew by 1 percent only. In the last ten year only 10,000 MW of HEP could be added. Contractual conflicts, environmental litigations, financial stresses, and local challenges have restricted the production of Hydro-electric Power (HEP). NHPC is the major and leading PSU which owns and manages around 15% of the installed capacity in India. HEP projects are majorly located in the Himalayan Belt. However, The North-east region and Trans Himalayan regions are still have enough potential for HEP projects. Ganga Basin is also not harnessed adequately. Following graph shows the basin-wise potential for the HEP in India.

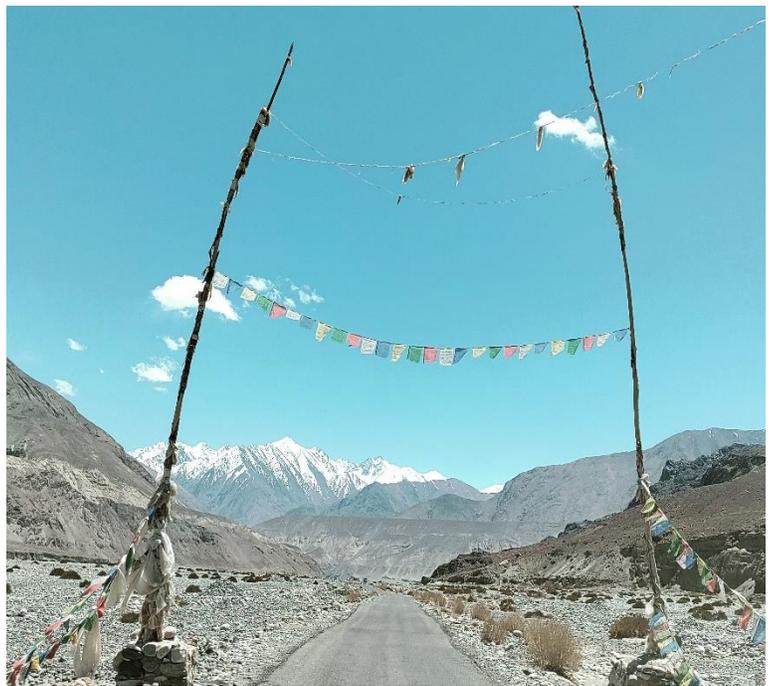


Source: https://www.cea.nic.in/wp-content/uploads/pdm/2020/12/growth_2020.pdf

Himachal Pradesh is the leading state which produces maximum HEP in India. Hydropower Projects are more than just engineering endeavours. They have far-reaching socioeconomic and environmental consequences. During the construction of HEPs, geological challenges are common. The land acquisition procedure is another challenge and requires public hearings and Gram Sabha clearance. When gram Sabha gives the approval the Resettlement and rehabilitation (R&R) become another sensitive issue and also requires a lot of money. Budget is another challenge that has not been adequately factored in when project proposal are made and this causes budgetary implications at the later stages. The initial construction and machinery costs are also very high but the good thing is that as the time passes the net profit of the project turns in the positive. Following texts talks about the potential of HEP in transforming the socio-economic life in Ladakh Union Territory.

Ladakh:

Ladakh (La (pass) + Dakh (Country)), the place of Mountain Passes, is an union territory of India which was carved out from erstwhile Himalayan states of Jammu and Kashmir state on October 2019. Ladakh make its territory with Jammu and Kashmir in North and West; Tibet in east; Lahul and Spiti in South. It lies between Karakoram Range, Zaskar range, Ladakh range, of Trans-Himalaya in the North and Great Himalaya range in the South. This highly strategic landscape is inhabited by 2.74 lakh people who spread in 59,146 KM² with a density of 4.6/ KM². The Union Territory is divided into two regions Drass-Kargil and Leh-Ladakh. The latter is majorly inhabited by the Buddhists and the former region is populated by the Muslim Communities.



A view from Ladakh

The region has several name such 'Ladwags' in Tibetan, 'Ladax' in Persian, 'Ladakh' in English, Great Tibet in Medieval period. The area was inhabited in the Neolithic period and the earliest inhabitants consists of mixed Indo-Aryan population of Mons and Dards Aryan. The last border village Thang has ample scope for the tourism. The area has suitable weather for horticulture and agricultural activities which will generate livelihood options and improve the economy of the region. Goba Ali, a veteran of the Thang village explained how he undertook the responsibility to aware villagers and tourists regarding the horticulture and other traditional

knowledge which can be beneficial for people. In the tune of Atmnirbhar Bharat and vocal for local these knowledge system should be promoted.

Ladakh's high-altitude cold desert area is characterised by rugged, desolate cliffs and plateaus, picturesque snow-clad mountains, green patches in the valleys and barren mountains and river beds. The region has several small rivulets which fed the Indus, Zaskar, Shyok and Nubra rivers, the major rivers of the area. Ladakh is a popular adventure destination where tourists can do mountaineering, rafting, trekking, etc. The area has one of the highest motorable roads Khardungla and Changla which are snow covered even in the summer. One can experience the snow-fall in these areas in summer. Area is rich in cultural and ethnic diversity and have number of Gompas (Buddhist Monasteries). Thanga Art and Cham dance are another cultural features of the Ladhak region.



A landscape view of Ladakh

Hydro-electric Potential of Ladakh region:

The Ladakh region is drain by several small and large rivers. These rivers are tributaries of Indus. The Indus River originates in Tibet at the junction of the rivers Sengge Zangbo and Gar Tsangpo, then flows into Ladakh through Demchok village which used to connect Ladakh and Tibet via the Indus River. Demchok is part of LAC, and China controls parts of Demchok. India owns the left bank of the Indus at Demchok. After Demchok it flows towards Leh via Dungti. The river is lifeline



Confluence of Indus and Zaskar Rivers

of Ladakh region and play instrumental role in the sustenance of the Ladakh.

Indus River basin has played a very vital role in the Ladakh region. It has provided the basis for civilization to grow and prosper around its bank. The river fills agricultural lands with new soils and irrigates the region. Indus and its tributaries are major sources of fresh water and hydro-electric power in the Ladakh region. Presently more than 150 MW of hydroelectricity is being generated from the major and small hydro-electric power projects built on the Indus and its tributaries. Ministry of Power has mapped out the potential of River Indus and suggested that only 40% of total potential of river basin has been utilised while 60% is still has potential to be utilised.

The rivers of the Ladakh are-

1. Chip Chap River (Tributary of Shyok)
2. Dras River (Tributary of Suru)
3. Galwan River (Tributary of Shyok)
4. Indus River
5. Jeong River (Tributary of Shyok)
6. Markha River (Tributary of Zaskar)
7. Nubra River (Tributary of Shyok)
8. Prarang River (Tributary of Suture River)
9. Shingo River (Tributary of Dras River)
10. Shyok River (Tributary of Indus River)
11. Suru River (Tributary of Indus River)
12. Tsarap River (Tributary of Zaskar River)
13. Zaskar River (Tributary of Indus River)

Two major hydropower projects have already been constructed and in operation in Ladakh on the Indus river.

1. Chutak project of 44 MW on Suru, a tributary of the Indus,
2. Nimoo Bazgo or Alchi project of 45 MW on the Indus

Eight more hydropower projects are underway to be developed on the Indus River and its tributaries in Ladakh.

A. Hydropower projects to be developed on the Indus River in the Leh district of Ladakh:

1. Durbuk Shyok (19 MW),
2. Sankoo (18.5 MW),

3. Nimu Chilling (24 MW),
4. Rungdo (12 MW),
5. Ratan Nag (10.5 MW)

B. Hydropower projects to be developed on the Indus in the Kargil district of Ladakh:

6. Mangdum Sangra (19 MW),
7. Kargil Hunderman (25 MW)
8. Tamasha (12 MW)

To understand the role and scope of the Hydropower project in the development in the Ladakh region a team consisting Dr. Ashutosh Mishra, OSD, Delhi School of Public Policy and Governance, University of Delhi and Dr. Prakash Tripathi, MKPDF, Delhi School of Public Policy and Governance, University of Delhi had visited two power projects run by NHPC namely Chutak and Nimoo-Bazgo. It would be prudent to provide a brief about the activities of NHPC.

National Hydro-Power Corporation (NHPC) Limited :

NHPC Limited is an Indian hydropower producing corporation founded on November 7, 1975 with a Rs. 2000 million authorised capital with the mission of planning, promoting, and organising an integrated and efficient development and growth of hydroelectric power in all aspects. The company was incorporated under the Companies Act as a private limited company under the name of National Hydro Electric Power Corporation Private Limited. The Government of India acquired the company and converted to a public sector company with effect from April 2 1986. The company works under the Ministry of Power, Government of India.



NHPC Head Quarter Building

NHPC Limited currently has an installation base of 7071.2 MW from 24 power plants, including two projects in Joint Venture mode. Given the difficulties faced in implementation of these projects, such as adverse geological conditions, difficult legal and order issues, and inaccessible remote areas, the performance so far is admirable. Its power plants and hydroelectric projects are primarily located in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Arunachal Pradesh, Assam, Manipur, Sikkim, and West Bengal in India's north and north-east.

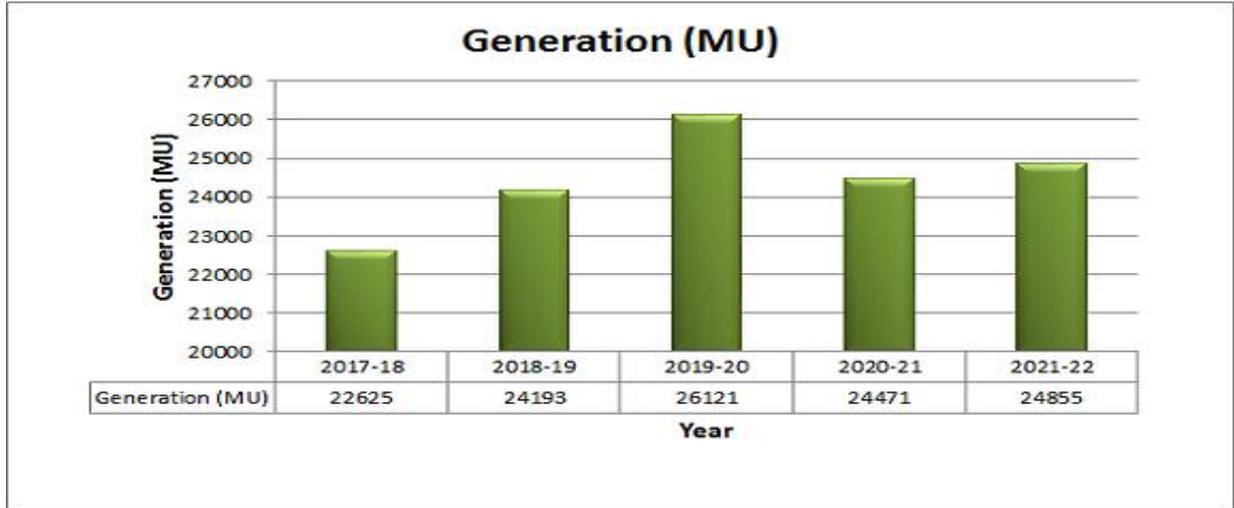
The Mission of the NHPC:

- To achieve excellence in development of clean power at international standards.
- To execute & operate projects through efficient and competent contract management and innovative R&D in environment friendly and socio-economically responsive manner.
- To develop, nurture and empower the human capital to leverage its full potential.
- To practice the best corporate governance and competent value based management for a strong corporate identity and showing concern for employees, customer, environment and society.
- To adopt & innovate state-of-the-art technologies and optimize use of natural resources through effective management.

The company has experience in hydroelectric project design, development, construction, and operation. From front-end engineering design to commissioning and project operation and maintenance, it performs and controls all aspects of projects. It has also been hired as a project developer for a few projects, with the goal of designing, developing, and delivering a hydroelectric power station on an agency basis to a client. It also offers contract-based technical, management advising, and consultancy services to domestic and international clients. Now, NHPC has broadened its scope to cover other energy sources such as solar, geothermal, tidal, and wind.

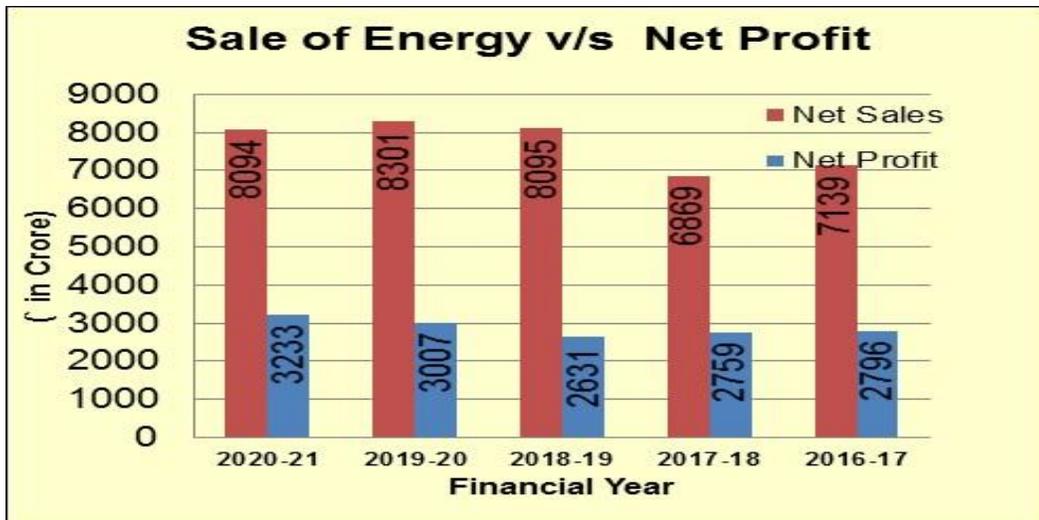
The company obtained the Loktak hydropower project with a capacity of 105 MW from the Government of India in 1976-77, and the Baira Siul hydroelectric project with a capacity of 180 MW the following year. The Baira Siul power station in Himachal Pradesh was commissioned by the firm in 1981-82. During the 1983-84 fiscal year, the company completed the construction of the Devighat power station in Nepal and the Loktak power station (105 MW) in Manipur. They established a Hydro Power Training Institute at the Baira Siul hydropower facility the next year to teach and upskill operators and supervisory personnel. In 1987-88, the company set up a satellite telecommunication network to connect numerous projects. The company was elevated from the Schedule B to the Schedule A corporation by the Indian government in 1989-90. With effect from April 28, 2008, the Ministry of Power granted the company Mini-Ratna (Category I) status.

Power generation of NHPC in last five years are given in the following image. Company has continuously provided electricity to the Nation. Maximum power generation was in 2019-20 which was 26121 MU and in the year 2021-22 it has slightly declined to 24855 MU.



Source: NHPC Website

From the sale of power, the enterprise has earned an income of Rs. 8094 Crore with net profit of Rs 3233 Crore in the year 2020-21. Following graph shows that company is continuously earning profit from last five years and in the last three year the profit is increasing gradually.



Source: NHPC website

The Chutak Hydro-power Project is a run-of-the-river scheme with an installed capacity of 44 MW (4X11 MW) that harnesses the hydropower potential of the river Suru (a tributary of the Indus river) in the Kargil region of the Union Territory of Ladakh. The project includes a 15-meter-high and 45.60-meter-long barrage, a 5.9-meter-diameter and 4.767-kilometer-long horseshoe-shaped HRT, orifice type surge shaft, and two reinforced concrete lined pressure shafts with four 21-meter-long and 2.3-meter-diameter penstocks each. The barrage is located at



A view of Chutak Power Project

Sarze village. The underground power plant located in the Chutak village, has 44 MW installed capacity, housing four 11 MW units, each designed to operate at a net rated head of 52 m and generate 212.93 MU in a 90 percent reliable year with 95 percent machine availability. The three units of the project were launched on 29th November 2012 while the last unit was launched on 1st February 2013. The project was dedicated to nation in 2014.

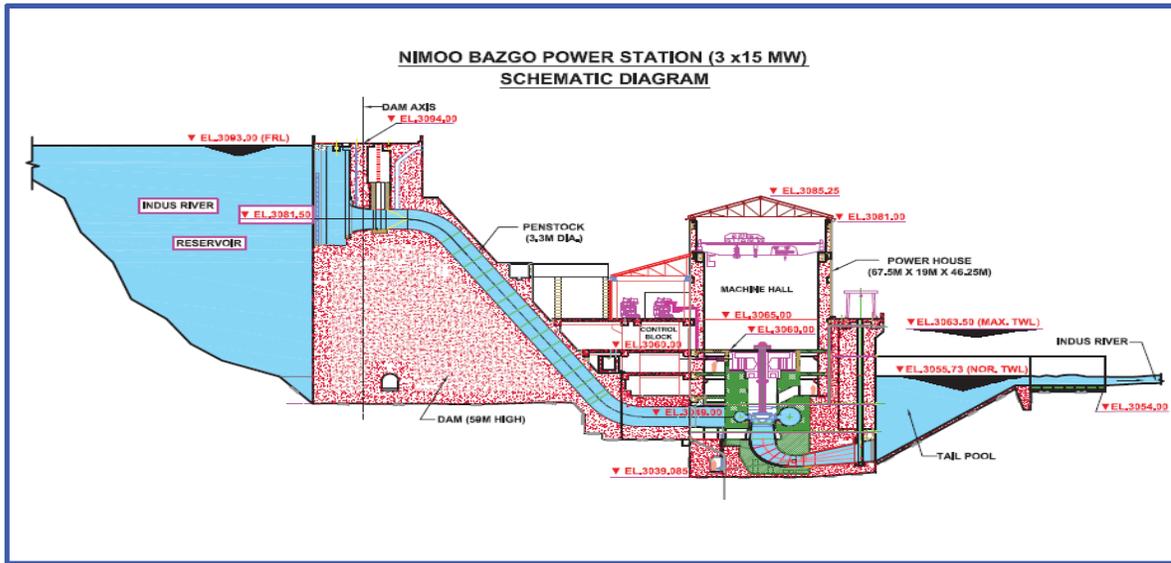
Nimoo-Bazgo Project is another achievement of the NHPC. The power station has installed capacity of 45 MW. Located on the Indus river at Alchi village, this project has three machines of 15MW each. The project was approved in 2005, commissioned in the year 2013 and dedicated to nation in 2014. The project includes a 57 m high concrete dam with 5 slipways blocks of 13 m each having S shaped profile. This run of the river scheme with small pondage harness the hydropower potential of river Indus. Jammu & Kashmir was the only beneficiary state of the project before Ladakh become UT. Now both UTs share the generated power. The type of



Nimoo-Bazgo Power station gate

turbine used is Francis. The manufacture of both Turbine and Generator of the power plant is Bharat Heavy Electricals Limited. There are 3 units in operation and all the three units are commissioned. The first, second

and third units are commissioned in the month of June 2013, January 2013 and October 2012 respectively with an installed capacity of 15 MW for each units.



Schematic Diagram of Nimoo-Bazgo Power Station

Before, commissioning of the Chutak hydro-power Plant, the Kargil region was deprived of the regular electricity. Ladakh was part of the Jammu & Kashmir and as per the MoU signed between the Jammu & Kashmir government and NHPC, these projects supplied power to J&K only. Ladakh was ignored and therefore people face electricity problems. The officials of NHPC told that the electricity supply was very limited in the Ladakh region.

State power division did not have enough power supply and they cut supply from Ladakh region to fulfil in Kashmir region. Ladakhis got power supply for merely two hrs in a day. **After the commissioning of the NHPCs Projects the electricity problem in these regions have been addressed. Now, when electricity is enough. Their daily struggle to collect fuel has come to an end and they dedicate time for other activities such as education, agriculture.**

“Electricity is primary need for development in any region, if one do not have access to the electricity then s/he cannot think of any other development. Whether it is road, hospital, school, or household you need electricity to construct and run them”, says Sh. Bikram Singh, Head of Project Nimoo-Bazgo Project. He continued, “Electricity has generated opportunities of livelihood options. People can harness the electrical energy to run their small business. **This**



A view of the Nimoo-Bazgo Power Project

region has enough potential for micro and small enterprises. In the lack of electricity the natives could not think of that. Now they are looking forward to these options.” Sh. Sanjeev Tiwari, Project Manager, Nimoo-Bazgo Project explained the benefit of the projects on tourism. He said, “Ladakh has beautiful landscape, a lot of tourists come here from different parts of India. Electricity was required to run hotel and restaurant. If tourists will not get facilities they will not enjoy their stay and this certainly affect the tourism and livelihood of the Ladakhis”.

Hydro-power projects also provide job opportunities to natives, the Grade-IV employees and contractual staffs are majorly from Ladakh. These projects play pivotal role in the development of the region. Being a high conversion and cost effective renewable energy source, the Hydro-projects can be boon for the region. After being a Union Territory, Ladakh is under the central administration with no role of J&K state and therefore the production of the electricity can be channelized in a very effective and efficient manner to bring development in the region. A Hydro-electric project requires high initial investment, say for example the Chutak power project required around Rs. 1000 Cr. This 4 storey powerhouse receive water from a reservoir located 7 km away through a tunnel. The construction cost of this project was very high but the advantage of the project is the low operation cost and long lifespan which ultimately result into a profitable enterprise. Another attractive feature is that it is gentle in operation, with quick start and stop capabilities and the ability to respond to changes in load more quickly, particularly during load shedding and brownouts, as opposed to thermal plants, which are slow and sluggish.

Power sector is the backbone of the economy and necessary for other sectors to function. Hydropower is the cleanest electricity technology with no or minimum carbon footprint. In this time, when environmental

challenges and climate change are growing more stringent. India has promised to reduce its carbon footprint and Hydro-projects can be useful method to achieve this target. Natives of the region accepted that after implementation of the Hydro-projects in the area, their life have become better and comfortable. Hydro projects have opened new vistas to utilise their time and energy in right direction and make it beneficial for their daily-life.

However these projects also have certain challenges such as unavailability of reliable data, availability of water in the reservoir, precipitation, technological challenges, contractual delay, limited skilled man-power, accessibility of machinery, transportation cost, lack of infrastructural facilities and management, administrative challenges in granting clearance, local opposition, international treaty with Pakistan are several challenges which needs to be address during the commissioning of a hydro-project. But, for a long time, the people of Leh and Kargil have lived in disadvantaged conditions with little or no access to electricity. The previous governments (state and federal) ignored the region for a long time. Now primary role of the UT administration is to take mature and visionary steps to comprehend these people and their concerns by providing an environment in which various trade-offs can be discussed and highlighted, thereby addressing the aforementioned challenges.

Conclusion:

Ladakh is blessed with number of rivulets and rivers which runs through its difficult terrains. The sloppy and steep mountain reliefs of the region provide adequate potential and kinetic energy in the water that can be harnessed through the hydro-electric projects. There is ample scope to develop hydro-projects on different rivers of the region which can light the region and also flourish it by regulating and channelizing water for required purposes. Hydro-electric projects have been criticised for their high initial cost and displacement caused by the projects. Hydro-projects are also considered to be sensitive as they lie in highly seismic zones and having potential for devastating result after any natural calamities. Located in the difficult and inaccessible sites, these projects require high initial cost for developing road, bridges and other infrastructures for its implementation. But, **Hydro-projects have been proved as a blessing for the Ladakh region. The overall positive impact of these projects have been far more significant in the region. Earlier nearly all the power was through Diesel Generator sets which apart from producing costly electricity (approx. Rs. 20 per unit) was destroying the fragile ecosystem because of the high level of air pollution. Ladakh in the year 2012 (Before Nimmoo Bazgo Project was commissioned) was tourists nightmare with high level of noise and air pollution in the local habitat areas. Now the things have changed completely with a flourishing all year around tourism industry. As told by the locals, the impact of these two projects cannot be assessed in simple numbers, it is beautiful experience which they have lived.**

These projects have not only provided electricity in the region but also generated livelihood options. Hydro-projects have no carbon foot-prints and earn carbon credits which is used for the development of the region. NHPC also promotes fisheries and horticulture in the region and finance them with its CSR fund. Overall, hydro-electric projects should be given priority which can develop this region rapidly without disturbing its ecological pristineness. Ladakh has ample potential for the horticulture and organic farming, Region is not explored much in terms of the renewable energy. The speedy winds can also be used for generating the wind energy.

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