OPPORTUNITIES AND RISKS FOR HYDROPOWER DEVELOPMENT IN UTTARAKHAND

A thesis submitted to the
University of Petroleum and Energy Studies

For the Award of
Doctor of Philosophy
in
Management

BY

B.C.K. MISHRA

July 2019

GUIDE

Dr. Anil Kumar
Dr. Mohammed Yaqoot
Dr. A.K. Jha

UNIVERSITY WITH A PURPOSE

Department of Energy Management
School of Business
University of Petroleum & Energy Studies
Dehradun – 248 007: Uttarakhand

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DECLARATION

I declare that the thesis entitled Opportunities and risks for hydropower development in Uttarakhand has been prepared by me under the guidance of Dr. Anil Kumar, Professor of Energy Management, University of Petroleum and Energy Studies, Dehradun. No part of this thesis has formed the basis for the award of any degree or fellowship previously.

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CERTIFICATE

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ABSTRACT

Uttarakhand is a hilly State situated in the north of the Union of India with its north borders deep inside the Himalayan region. With a splendid bio-diversity, the state has been blessed with rich water resources from which the Indo-Gangetic rivers originate. The state was carved out from the state of Uttar Pradesh in November, 2000, after separation of the western hilly region. In an attempt towards regional development of the new state, an industrial package was announced to welcome industries in the region. As a result, there was nearly a fourfold increase in the demand of electricity from 3611MU in 2002-03 to nearly 13574MU in 2016-17. The power generators, which were primarily hydro based, could not match the rapid pace of industrialization. As a result the state, which was envisioned to be a ‘grid exporter’ has since year 2006 turned into a net ‘grid importer’ of power. The hydropower projects did not timely come up to alleviate the power scenario. Major hydropower projects either were stopped due to various reasons or were indefinitely delayed. The hydropower sector could not grow and mature despite availability of abundant water resources and support of Government for making the State an energy hub.

A study was required to focus on this particular aspect of the problem. This thesis is an effort in this direction. This study is not only to identify the barriers that caused the slowdown of hydropower development, but is also aimed at identifying the opportunities that can be harnessed to reverse the energy trend in this region with surplus hydropower generation capacity.

In this study, carried out with application of case study method, a comprehensive review has been done on the current status of hydropower development in Uttarakhand, with respect to the national and global trends, its potential and installed capacity, technological status, policy and regulatory support to hydropower and issues in the whole process of developing a hydropower plant. The objective was to identify and rank, according to their significance, the major barriers and opportunities for the growth of the hydropower development in Uttarakhand. The study was conducted based on vast literature review, interviews and case studies on hydropower plants in Uttarakhand. The opinion of various stakeholders, like developers, financers, government, local administration, local population, NGOs and project affected people, has been incorporated to make it an elaborate and comprehensive study. The respondents have been chosen such that the

responses of all the stakeholders are incorporated and an authentic quantification of various barriers and opportunities for hydropower projects in Uttarakhand are derived.

The results of the study indicate that 77.62% responses point to some kind of risks involved as compared to only 22.38% responses that highlight opportunities in hydropower development in this hilly state. Further, *improved socio-economic condition, tourism & area development, clean source of energy, revenue generation and employment generation* have been identified as the top five opportunities for hydropower development in the state, *with* each of them individually accounting for *17.27%, 15.00%, 14.09%, 9.77%, 8.86%* respectively of the total significance from among the opportunities identified. Similarly, *Rehabilitation & Resettlement, Law & Order, Financial Constraints, uncertainty in policies, Ecological and Environmental Impact*, have been found to be the top five barriers that together have 50% significance in restraining the growth of hydropower in Uttarakhand.

The study indicates the weights of various risk factors and opportunities that the hydropower developers should take into account while making decisions for investment in hydropower development in Uttarakhand. This distribution of opportunities and risk factors provide the investors a holistic overview to invest judiciously in hydropower development in Uttarakhand. Also the authorities interested in development of hydropower in the state should take note of the barriers and take action to find ways and remedial measures to mitigate them so as to expeditiously harness the existing hydropower potential for the benefit of the state.

Acknowledgement

This study is the result of my lifetime of experience as a power sector professional closely associated with hydropower project development and power distribution in the region. This effort would not have seen the light of the day without the support of many other professionals and academicians who were not only excellent management gurus but also were equally humble gentlemen.

I take this opportunity to express my profound gratitude to my major **Prof. Anil Kumar,** who very kindly consented to provide his all out support, encouragement, guidance and valuable input for this study. His scholarship and long years of academic experience came handy to my research work. He deserves my sincere admiration all my life.I owe my gratitude to my co-guide **Dr. Mohammed Yaqoot**, philosopher and a critical thinker. His academic prowess combined with his zeal to explore and experiment new approach, has helped me structure my divergent thoughts into a presentable framework. With his excellent streak of being frugal in words and fathomless in meaning, he has been very kind in accepting my shortcomings and guiding me to overcome them.I gratefully acknowledge the help and guidance I have received from my external guide**Dr. A.K Jha**. His industry oriented approach has added new dimensions to my study.

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I truly acknowledge the abiding affection from my spouse **Jyotsana**, my daughters **Tanya, Navya,** and my son **Hrishit**, who have been a constant source of inspiration and support at all times. I acknowledge the help extended by my brother **Mani** for driving me through all the odds that came in my way in pursuit of my objective. Without their endurance, this undertaking could not have been possible.

I dedicate this work to my beloved mother and my late father, for their love and blessings that strengthened my belief in myself.I thank the ALMIGHTY for giving me the strength and patience to work through all these years and follow HIS guiding light towards the journey of life.

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Chapter 1

1.0 Introduction

1.1 Global Sustainability Shift and Opportunities for Hydropower

Globally, sustainable development has become the guiding principle for achieving socio-economic progress. Sustainable development is a progressive and inclusive business maturity framework that meets the needs of the present without compromising the ability of future generations to meet their own requirements. To achieve sustainable development, it is imperative to have a synergy between economic growth, social inclusion and environmental protection. On 25th September 2015, the United Nations adopted 17 sustainable development goals aimed at ending poverty, protecting the planet, and ensuring prosperity for all by 2030.

To combat climate change, 'Affordable and clean energy' and 'Climate action' are two of the 17 sustainable development goals that are focused on, for accelerated integration of affordable and clean renewable power to the electric grid (UN, n.d.). The utilization of renewable energy sources was also promoted under various mechanisms of the Kyoto Protocol that ended in 2012. Subsequently, to combat climate change, the Paris Agreement was adopted in 2016. About 160 countries have signed the Paris Agreement aimed to reduce their greenhouse gas emissions through renewable energy utilization, energy efficiency improvement and aforestation. Hence, sustainable development goals and the Paris Agreement have shifted the focus on enhanced renewable energy utilization (UNFCCC, n.d.). As a result, several countries have already added sizeable renewable power capacities to their grid. The power generated from inexhaustible energy sources namely hydro, wind, solar, biomass, geothermal and ocean is considered renewable power. In many studies, hydropower has been considered separate from renewable energy as the former constitutes a significant component of renewable power capacity and its inclusion can mask developments in other renewable energy technologies as well (REN21, 2017). Similarly, in this study, hydropower has been treated separately from renewable power. China, USA, Germany, Japan, India and Italy are global leaders in renewable energy with 258, 145, 98, 51,46 and 33 GW installed capacity respectively by the end of the year 2016 (REN21, 2017).

In 2016, renewable power generating capacity experienced its most significant annual growth with capacity addition of 161 GW that constituted 62% of net global power capacity addition. Wind power and solar PV are the main constituents of the renewable power capacity installed globally. Fall in prices of renewable energy technologies (especially solar PV and wind) and targeted renewable energy support mechanisms have been the main drivers behind increased renewable power capacity addition and the trend is expected to continue (IRENA, 2017; IEA, 2015; REN21, 2017; Sahu, In Press). A projection by International Renewable Energy Agency suggests that by the year 2050, the share of solar PV and wind power would be about 52% of the global electricity generation (IRENA, 2017).

Hydropower is a clean and renewable source of energy that can be harnessed for large-scale power generation (Tahseen and Karney, 2017; Li et al., 2015). Greenhouse gas emissions during the construction and operation of hydropower plants are quite low compared to that from fossil fuel-fired power plants. On life-cycle basis, a typical hydropower plant emits 2-18 kt CO_2 equivalent per TWh in comparison to 389-1272 kt CO_2 equivalent per TWh released by fossil fuel-fired power plants (Gagnon et al., 2001; IEA, 1998; Zhang et al., 2007; Tahseen and Karney, 2017). Assessment studies suggest that by utilizing 50% of global hydropower potential, greenhouse gas emissions could be reduced by 13% along with the added benefit of substantially reduced SO_2 and NO_x emissions (Bates et al., 2008; Swingland, 2003). With significantly higher useful lives that can be further extended up to 100 years through appropriate renovation and modernization, and zero fuel cost, electricity generated by hydropower plants is generally cheaper (WB, 2017; NG, n.d.; PwC, 2016). The multi-faceted hydropower projects are often used for power generation, water supply, flood control, and recreational benefits (Capik et al., 2012; Evans et al., 2009; Kaygusuz, 2009).

Storage dams of hydropower projects have a substantial energy storage capacity that enables flexible operation of electric grids (Rehman et al., 2015; Maxim, 2014; Zhang et al., 2015). The energy storage capacity of hydropower plants can be utilized to address intermittency issues associated with renewable power from wind or solar (Ayodele and Ogunjuyigbe, 2015; Caralis et al., 2012; Steffen, 2012; Kusakana, 2015). Thus, reliable, clean, and cheap hydropower can facilitate the integration of more renewable power (wind or solar) to the grid.

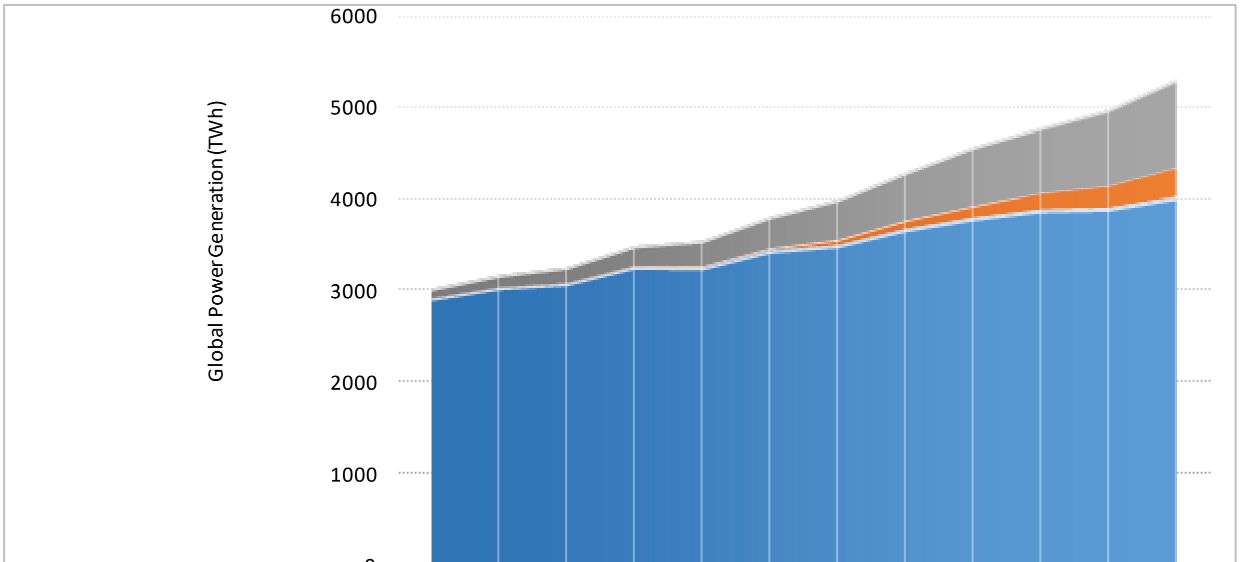
Hydropower projects often bring investments in roads, dams, canals, schools, hospitals, and communications to remote locations leading to the economic development of the area. However, these projects involve dislocation of project-affected people along with the irreversible impact on the environment that often hinders their development (Tahseen and Karney, 2017). In light of the universal adoption of sustainable development goals, the Paris Agreement, and the consequent commitment to enhancing the integration of renewable power to the grid, it is imperative to assess opportunities and threats for hydropower. In this study, an attempt has been made to assess the opportunities and risks for hydropower as a facilitator to sustainable development.

1.2 Global Trends in Hydropower

Globally, during 2005-2016, hydropower generation grew at a compound annual growth rate of 2.7% per annum whereas wind and solar power generation registered compound annual growth rates of 17.35% and 38.31% respectively (Figure 1). With an addition of 25 GW during 2016, global hydropower capacity reached 1,096 GW by the end of the year 2016 that contributed 16.6% to global electricity generation (Table 1). In terms of installed hydropower capacity, China, Brazil, USA, Canada, the Russian Federation and India are leaders with a total share of about 60% of global capacity (Table 1).

During 2016, global pumped storage capacity (counted separately) also increased to 150 GW with an addition of 6.4 GW during the year (REN21, 2017). In the year 2016, China commissioned about 33% of the new global hydropower capacity followed by substantial capacity additions in Brazil, Ecuador, Ethiopia, Vietnam and Peru (Table 1). In pumped storage capacity addition during the year, China once again emerged as the leader followed by South Africa, Switzerland, Portugal and Russian Federation. With an addition of 8.9 GW of hydropower capacity and 3.7 GW of pumped storage capacity in

2016, China achieved cumulative capacities of 305 GW and 27 GW respectively. The hot spots of growth in hydropower generation were China and Brazil with 6% and 7.4% annual increase during 2016 (REN21, 2017).



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Global Wind Power Generation (TWh)	104	133	171	219	278	341	437	527	644	709	828	960
Global Solar Power Generation (TWh)	4	6	8	13	21	34	65	100	138	196	256	333
Global Hydropower Generation (TWh)	2920	3038	3084	3267	3256	3441	3502	3677	3797	3886	3903	4023

Figure 1: Growth of hydro, solar and wind power generation during 2005-2016 (BP, 2017)

In addition to new hydropower capacity addition, modernization and retrofitting have been an integral part of the hydropower industry. Generally, modernization and retrofitting ~~extends~~ the useful life of the hydropower plant along with significant improvement in its performance. In 2016, modernization and retrofitting of Kamskaya Plant in the Russian Federation increased the plant's capacity by 14% along with improved reliability and safety (REN21, 2017). Apart from technological improvements in mechanical equipment of hydropower plants, integration of advanced control systems to the plant and data analytics are optimizing plant operations resulting in enhanced reliability, improved efficiency and smoother integration to the grid.

Table 1:Top countries by hydropower capacity and capacity addition in 2018(REN, 2019)

	Capacity added in 2018 (GW)	*Cumulative Capacity (GW)*
Top countries by total capacity		
China	7.0	322
Brazil	3.8	104
Canada	0.4	81
United States	0.1	80
Russian Federation	0.1	47
India	0.5	45
World	20.0	1132
Top countries by capacity addition during 2018		
China	7.0	322.0
Brazil	3.8	104.0
Pakistan	2.5	9.8
Turkey	1.1	28.0
Angola	0.7	3.1
Tajikistan	0.6	5.8
Ecuador	0.6	5.1
India	0.5	45.0

Adoption of Sustainable Development Goals by the United Nations in 2015 along with endorsement of the Paris Agreement in 2016 has resulted in a global shift towards sustainability. The sustainability shift has created enormous opportunities for renewable energy options as they are clean and sustainable. Worldwide, nations have fixed renewable power targets intending to achieve large-scale integration of renewable power to the grid. Table 2 presents the renewable energy targets in some countries. The same trend of enhanced renewable power addition to the grid is visible globally.

Few countries such as Canada and the USA have no national renewable power targets although several of their states have adopted renewable power targets (REN21, 2017). Thus, the global shift towards sustainability will lead to substantial renewable power capacity addition to the grid.

Increased shares of variable renewable energy for power generation have stimulated the growth in electricity storage capacities as they help to keep the grid stable. Pumped hydro storage, battery, flywheel, compressed air and thermal storage (molten salt) are the various electricity storage options. Of the total global power storage capacity of 176 GW installed until mid-2017, pumped hydro storage accounts for 96% followed by thermal storage (1.9%), battery (1.1%) and mechanical storage (0.9%) (IRENA, 2017). Pumped hydro storage is the most matured large-scale electricity storage technology that can keep the grid stable while integrating variable renewable power to it (Foley et al., 2014; Kocaman and Modi, 2017; Steffen, 2012; Rehman et al., 2015).

As depicted in Figure 2, a pumped hydro storage system stores the potential energy of water that is pumped from a lower reservoir to a higher reservoir. Surplus and cheap electricity available during the off-peak period is used to run the pumps to raise water from a lower reservoir to an upper one. During high power demand, the stored water is released through hydro turbines to generate electricity. In the pumped hydro system, a reversible turbine-generator can act as a pump or turbine as per need (Rehman et al., 2015).

Table 2: Renewable energy targets of some countries (REN21, 2017)

Country	*Targeted share of electricity generation from renewable sources*	*Targeted renewable power installed capacity*
Algeria	27% by 2030	1 GW from bio-power; 15 MW from geothermal power; 13.5 GW from solar PV; 2 GW by concentrated solar power; 5 GW from wind power by 2030
Bhutan	100% by 2050	5 MW from bio-power; 5 MW from solar PV; 5 MW from wind power by 2025
Brazil	23% by 2030	18 GW from bio-power; 125 GW from hydropower; 24 GW from wind power; 7 GW from solar by 2024
China	No declared target	340 GW from hydropower; 110 GW from solar power; 210 GW from wind power by 2020
Denmark	50% by 2020 100 % by 2050	No declared target
Finland	33% by 2020	13.2 GW from bio-power; 14.6 GW from hydropower; 884 MW from wind power by 2020
Germany	40-45% by 2025 55-60% by 2035 80% by 2050	100 MW addition per year from bio-power; 2.5 GW addition per year from solar PV; 2.5 GW addition per year from wind power (onshore); and 6.5 GW from wind power (offshore) by 2020
India	40% by 2030	100 GW from solar power; 60 GW from wind power; 10 GW from bio-power and 5 GW from

Country	*Targeted share of electricity generation from renewable sources*	*Targeted renewable power installed capacity*
		hydropower (small-scale) by 2022
Japan	24% by 2030	1.5 GW from ocean power (wave and tidal) by 2030
Mexico	35% by 2024 50% by 2050	20 GW from renewable power by 2030, of which 10 GW from wind power
South Africa	9% by 2030	17.8 GW from renewable power by 2030
Turkey	30% by 2023	1 GW from bio-power; 1 GW from geothermal power; 34 GW from hydropower; 5 GW from solar PV; 20 GW from wind power by 2023
United Kingdom	No declared target	39 GW from wind power (offshore) by 2030
Yemen	15% by 2025 100% by 2050	6 MW from bio-power; 200 MW from geothermal power; 4 MW from solar PV; 100 MW from concentrated solar power; 400 MW from wind power by 2025

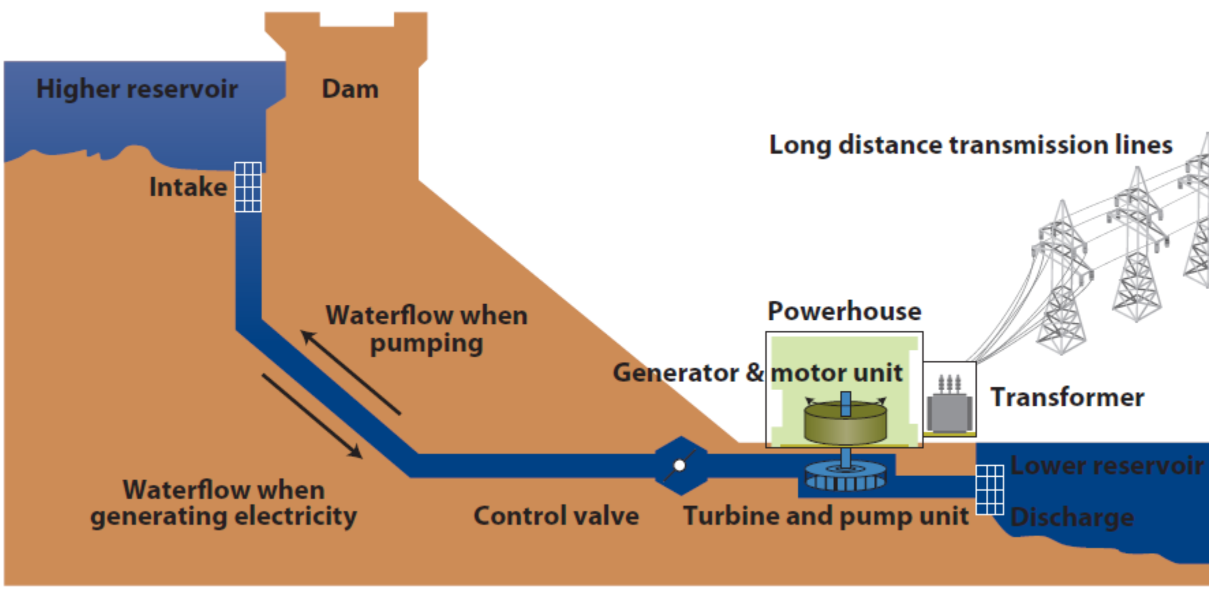


Figure 2: Schematic of pumped hydro storage system (Luo et al., 2015)

During 2016, global pumped hydro storage capacity increased by 6.4 GW that was double of the previous year capacity addition (IHA, 2017). These capacities were primarily added in China, South Africa and Europe (REN21, 2017). Currently, China, Japan and the United States are the global leaders in pumped hydro storage installed capacity with 32.0 GW, 28.3 GW and 22.6 GW respectively (IRENA, 2017). Additionally, 20 GW of pumped hydro capacity is under various stages of construction globally (IHA, 2017).

As many countries are striving to substantially increase the share of intermittent renewable energy in their electricity mix, significant growth in multi-purpose hydropower plants especially pumped hydro storage is expected. Reflecting the trend, data presented in Figure 1 show a strong correlation between expansion in solar/wind power generation and hydropower generation. The correlation coefficient between global expansions in hydropower versus solar power generation is estimated at 0.91; whereas this correlation is 0.98 between global hydropower and wind power generation growth. Thus, several countries have declared their plans for enhanced hydropower capacity addition. For example, in its 13th five-year plan, China aims to achieve 40 GW pumped storage capacity by 2020 to balance the large volume of solar and wind power that is getting integrated to the grid (IHA, 2017). For the last five years, annual investment in new renewable power capacity (including hydropower) has been about two times that in new fossil fuel power plants. During 2016, solar power received the maximum investment followed by wind power and hydropower. Overall, renewable energy accounted for 63.5% of the total investments in new capacity during 2016 (REN21, 2017).

Widespread development of pumped hydropower storage capacities is leading to its evolution as storage systems with improved operational flexibility to balance fluctuations in the grid. Traditionally, in pumped hydropower systems, power regulation was only available during generation. However, contemporary variable speed pumped hydropower systems increase plant efficiency and flexibility with power regulation option in both pumping and generation mode (IHA, 2017). Ternary systems having a motor-generator and distinct pump and turbine set can allow for simultaneous generation and pumping that provides improved frequency control (IHA, 2017). Some of the hydropower plants are experimenting with floating PV panels on the reservoir surface that increases electricity generation with reduced evaporation and no additional land requirement (IHA, 2017).

In addition to directly fulfilling two sustainable development goals of 'affordable and clean energy' and 'climate action' through the supply of affordable, reliable, flexible and renewable hydropower and facilitating the integration of other renewable energy sources to the grid, hydropower projects help achieve many other sustainable development goals. Irrigation, flood control, water supply and tourism are some of the multiple purposes of reservoir-based hydropower projects that directly or indirectly help to achieve sustainable development goals of clean water and sanitation, good health and well-being, employment opportunities and economic growth, healthier marine ecosystem and sustainable living. As hydropower helps to achieve many sustainable development goals, the global sustainability shift will lead to enhanced hydropower capacity addition throughout the world.

1.3 Hydropower for Electricity Generation

Worldwide, for large scale capacity additions, coal, nuclear, gas and hydropower stations have been installed extensively [7]. As hydropower stations have emission/radiation free operation, these are considered as clean sources of energy. Also, hydropower stations allow us to reap the benefits of economy of scale and thus the largest power stations in the world are hydropower plants with capacities up to 22,500 MW (Three Gorges Dam, China) [7]. Due to its large scale (economy of scale) and zero fuel-cost based operation, hydropower is the cheapest source to generate electricity [17]. Once a dam has been constructed and the hydropower equipment is installed, the energy source (i.e. water) is free that is renewed yearly by snow and rainfall [17]. **A comprehensive snapshot of the advantages of hydro powered electricity is as follows:**

a. It is a clean source of energy [1]–[4]

b. In many cases development of hydropower is associated with irrigation, drinking water, flood control and tourism benefits [5][6][7].

c. Ideally, suits for meeting the peak demand as it has the inherent capability of a quick start, stop, load variations etc. [5][6][8][9][7][10]

d. The cost of generation is not only inflation free, but it also reduces with time [5][7][11][12][13][14].

e. Once the hydropower project is constructed, it can generate power at a predictable constant rate [8][15][7]

f. Hydropower projects emit very less greenhouse gases when compared with other large scale energy options [6][8][7][16][4][2][17].

g. Dams are designed and constructed to last several decades which further contribute to the generation of power for decades [8][6][18].

h. Run-of-River (ROR) projects have comparatively low environmental damage [7][17].

i. Hydropower provides quality power and a high level of service to the power system (reliability, flexibility, efficiency) [7][19][20]

j. Operating costs are very meagre and only fewer personnel are required on site during regular operation which further reduces the operating cost [18][21][22][1][23][24][6][25][26].

k. As remote areas develop, the rural people benefit can be benefitted with from better connectivity, job opportunities, education, health care facilities and infrastructure [17].

l. Hydroelectricity makes it feasible to utilize other renewable sources as well [23]. They can be modified at very low costs to allow pumped storage[11][13]. Most of the existing hydropower plants can be used as a storage for wind and solar power which are intermittent in nature [18].

The advantages of hydropower makes it a desirable constituent in the fuel-mix capacity and reflects the countries commitment towards clean energy development.

1.4 *Power Sector in India*

India has recorded a remarkable economic growth in the last decade and the credit goes to access to reliable and affordable electricity [28][29][30][31]. Accessible, reliable and affordable electricity is the most significant factor that contributed to the economic development of the country [32].

As the economy grows the demand for quality, reliable and affordable energy also increases [33]. Thus, supporting the upward economic development, India's power sector has also experienced stimulated growth trajectory during the phase[34]. Capacity-wise, India has the 5th largest electricity generating capacity in the world with a reported installed capacity of 356.81 GW as on 25th June 2019[35].

Fuel-wise, thermal (coal, gas, and diesel) and hydropower contribute 63.42 % and 12.72% to India's power generation capacity respectively. The remaining contribution comes from energy sources namely solar, wind, small hydro, biomass and nuclear (Table 3). As evident in Table 1, the fuel-mix indicates the dominance of coal in India's power. This pattern of the energy mix is highly problematic for the country[36]. As a responsible nation with concern for sustainable development, India has to focus mainly on Green Energy which generates electricity through renewable sources[37][27][1].

Table:3 ALL India Installed Capacity (In MW) of Power Stations[35]

Source	Installed Capacity	Percentage in Energy Mix
Thermal(Coal, Gas, Diesel)	226279	63.42
Nuclear	6780	1.90
Hydro	45399	12.72
Renewable Energy Sources	78359	21.96

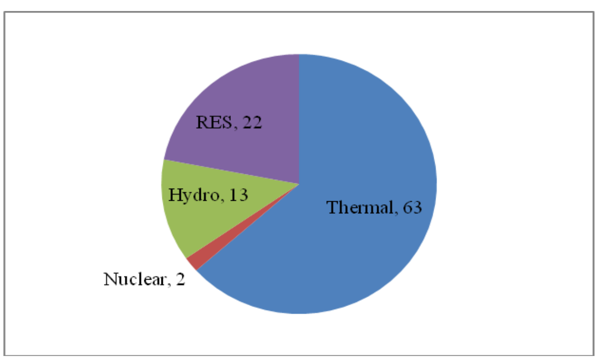


Figure:3 India's primary energy mix- fuel type [35]

The total installed capacity also includes captive power generation capacity of 40 GW [38]. From April 2000 to March 2015, the Indian power sector has attracted USD 9.56 billion that is 4% of the total FDI inflows during the period. India's accelerated economic growth coupled with rapid industrialization and infrastructure growth has fuelled the energy demand of India [39]. Expansion in industrial activities, growing population, 'Power for All' households, increasing per-capita electricity consumption to international standards and ambitious projects such as 'Make in India' to boost manufacturing and 'Smart Cities' for improved infrastructure in cities are expected to increase India's electricity demand significantly[40].In addition to power generation from conventional energy sources, Government of India has also outlined an ambitious plan to have 175 GW capacity addition through renewable energy sources (solar, wind, biomass, small hydro) by 2022 [41]. As per the International Energy Agency (IEA) estimates, India needs to add 600 to 1200 GW of additional power generation capacity before 2050 [41].

Increased capacity addition at a rapid pace will need significant investments. It will also have an impact on the environment that needs serious attention. Dependency on private and foreign institutions for funds and global focus on mitigation of greenhouse gas emissions and sustainable development puts the onus on policymakers of India to adopt cheaper and clean energy sources for power generation.

1.5 History of Hydropower in India

As per contemporary definition, Hydropower or hydroelectricity refers to the conversion of energy from flowing water into electricity. However, historically, one of the first uses of hydropower was for mechanical millings, such as grinding grains colloquially known as ***'Gharats' or 'Water Wheels'***. These Water Wheels have traditionally been used in the Himalayan regions for rice hulling, milling of grain and other mechanical applications and have undoubtedly proven to be the precursor of the development of Hydropower technology. Today, modern hydro plants produce electricity using turbines and generators, where mechanical energy created from moving water spins rotors on a turbine to generate electricity.

The first Hydro Power Station implemented in India was Sidrapong in Darjeeling (West Bengal) completed in 1897 and is still in operation. At the time of Independence, a total installed Hydropower capacity was meagre 508 MW and today it stands at 49.98 GW (Incl. Small Hydro of less than 25 MW) making India the 6th largest country in terms of Hydropower capacity (**Source: CEA/Renewables 2019 Global Status Report**). The table below shows the trend of Hydro-Electric power in India from 1947 to 2017 **(above 25 MW):**

Table: 4 Installed Capacity of hydro power in India since Independence (CEA)

Year	Installed Capacity in MW	Share in Total Installed capacity
1947	508	37%
1950-51	560	32%
1960-61	1917	41%
1970-71	5907	45%
1980-81	11384	40%
1990-91	19194	28%
2000-01	23,816	24.3%
2001-02	25,120	24.7%
2002-03	26,261	25.4%
2006-07	34654	26.1%
2011-12	38990	19.5%
2012-13	39491	17.6%
2013-14	40532	16.5%
2014-15	41267	15.1%
2015-16	42,783	14.1%
2016-17	44,594	13.5%
2017-18	45,293	13.2%
2018-19	45,399	12.7%

Ministry of Power in the Government of India is responsible for the development of large hydropower projects in India. To maintain the balance between hydropower and thermal power, Ministry of Power has announced a Policy for accelerated growth/ expansion of Hydropower in the country. Development of small hydro at an accelerated pace is one of the tasks in the Policy which is under the purview of Ministry on New & Renewable Energy.

Presently, the following forms of hydropower projects exist in the India:

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

As per the Central Electricity Authority Assessment (CEA), the economically exploitable hydropower potential in terms of installed capacity is 148,701 MW, out of which 145,320 MW is from schemes having a capacity above 25 MW. All over India, the hydro-electric schemes in operation and construction accounts for only 35% and thus, the bulk of the potential (65% including the projects that are under development) are yet to be developed.

Hydropower projects are strongly site-specific which is reflected by the fact that the three major Himalayan river basins of country viz., Brahmaputra Basin, Indus basin and Ganga basin accounts for more than 80% of the total identified hydro potential of the country with a capacity of 120, 608 MW out of 148,701 MW based on region-wise assessment of CEA. Northeast region accounts for the maximum potential of commercially exploitable hydropower.

All over India, the Brahmaputra basin accounts for highest potential with 66065 MW followed by Indus Basin (33832 MW) and Ganga Basin (20711 MW). However the Brahmaputra basin is the least developed in terms of its assessed potential, with only 15% of its potential being tapped. Compared to that, the Indus basin is the most developed basin producing 52% of its potential followed by the Ganga Basin (34%). **(Source: CEA).**

The R&D efforts have developed new and improved designs of water mills for mechanical and electricity generation of 3 to 5 kW. After testing at AHEC, IIT Roorkee, these designs have been replicated by 12 very small scale manufacturers.

Local organizations such as the Water Mill Associations, cooperative societies, registered NGOs, local bodies, and State Nodal Agencies are being encouraged to install watermills in their areas. The state of Uttarakhand has taken the lead in setting up electricity generation watermills and over 500 such watermills were installed in remote and isolated regions of the state.

The advantages of hydropower make it a desirable constituent of the fuel-mix of a country's installed power capacity. As per CEA, the hydropower potential in India is about 1,48,701 MW of which only 36,482 MW capacity has been developed, 12,738 MW is under construction and 96,100 MW (about 66% of potential capacity) is yet to be developed (Table 1). Such immense/ vast unutilized potential indicates a huge opportunity for India to generate cheap and clean electricity through large scale hydropower development.

Hydropower potential-wise, Uttarakhand, Himachal Pradesh and Arunachal Pradesh are the top three states in India with hydropower potential of 18,175 MW, 18, 820 MW and 50,328 MW respectively (Table 5). However, as presented in Table 5, Himachal Pradesh has 37.84% of its hydropower potential remaining unutilized whereas Uttarakhand and Arunachal Pradesh have 71.85% and 93.40% potentials lying unutilized respectively. Arunachal Pradesh is in the north-eastern part of India that faces law and order issues and thus a significant scale hydropower development in that state may not be feasible. The average unutilized hydropower potential of 92.81% for north-eastern states is indicative of the law and order challenges and subsequent feasibility issues for hydropower development in the region (Table 5). After Arunachal Pradesh, Uttarakhand ranks next with vast/ immense unutilized hydropower potential of about 12,932 MW (Table 5). As Uttarakhand is a peaceful state with negligible law and order problem compared to the north-eastern part of India, the probability of development of unutilized hydropower potential is higher. Thus, the study focuses on hydropower development in the state of Uttarakhand.

1.6 Utilization of Hydropower Potential in Uttarakhand

The State of Uttarakhand is situated in the Central Himalayan Region, where the Himalayan glaciers feed its perennial rivers making it suitable for the development of hydropower projects.

In Uttarakhand, out of the total hydropower potential of 18,175 MW, only 3,988 MW capacity has been developed while 1,640 MW capacity is under construction phase [41]. However, due to urbanization and economic growth, the demand for electricity has been steadily growing in the state.

During 2015-16, against the energy demand of 12,889 MU, the state faced a shortage of 214 MU (deficit of 1.7%) [41]. In year 2016-17, Uttarakhand faced an increased energy demand of 13,574 MU with a deficit of 336 MU (2.5%) [41].

Table 5: State-wise status of hydroelectric potential and development [5], [40], [42]

Region/State	*Identified capacity (MW)*		*Capacity Developed*		*Capacity under construction*		*Capacity yet to be developed*	
	Total	*Above 25 MW*	*MW*	*%*	*MW*	*%*	*MW*	*%*
Northern								
Jammu and Kashmir	14146	13543	2669	19.71	1630	12.04	9244	68.26
Himachal Pradesh	18820	18540	8908	48.05	2616	14.11	7016	37.84
Punjab	971	971	1206	100.00	206	21.22	0	0.00
Haryana	64	64	0	0.00	0	0	64	100.00
Rajasthan	496	483	411	85.00	0	0.00	72	14.91
Uttarakhand	18175	17998	3988	19.04	1640	9.11	12932	71.85
Uttar Pradesh	723	664	502	75.54	0	0.00	162.40	24.46
Sub Total (Northern)	*53395*	*52263*	*17122*	*32.76*	*6092*	*11.66*	*29049*	*55.58*
Western								
Madhya Pradesh	2243	1970	2395	100.00	400	20.30	0	0.00
Chattisgarh	2242	2202	120	5.45	0	0.00	2082	94.55
Gujarat	619	590	550	93.22	0	0.00	40	6.78
Maharashtra	3769	3314	2487	75.05	0	0.00	827	24.95
Goa	55	55	0	0.00	0	0.00	55	100.00
Sub Total (Western)	*8928*	*8131*	*5552*	*68.28*	*400*	*4.92*	*2179*	*26.80*
Southern								
Andhra Pradesh	2366	2341	1747	74.62	50	2.14	544	23.25
Telengana	2058	2019	431	21.35	360	17.83	1228	60.82
Karnataka	6602	6459	3585	55.51	0	0.00	2874	44.49
Kerala	3514	3378	1882	55.70	100	2.96	1397	41.34
Tamil Nadu	1918	1693	1782	100.00	0	0.00	0.00	0.00

Region/State	Identified capacity (MW)		Capacity Developed		Capacity under construction		Capacity yet to be developed	
	Total	Above 25 MW	MW	%	MW	%	MW	%
Sub Total (Southern)	*16458*	*15890*	*9427*	*59.33*	*510*	*3.21*	*5953*	*37.46*
Eastern								
Jharkhand	753	582	170	29.21	0	0.00	412	70.79
Bihar	70	40	0	0.00	0	0.00	0	0.00
Odisha	2999	2981	2028	68.00	0	0.00	954	31.99
West Bengal	2841	2829	272	9.62	160	5.66	2397	84.72
Sikkim	4286	4248	669	15.75	2622	61.72	957	22.53
Sub Total (Eastern)	*10949*	*10680*	*3139*	*29.39*	*2782*	*26.05*	*4759*	*44.56*
North Eastern								
Meghalaya	2394	2298	282	12.27	40	1.74	1976	85.99
Tripura	15	0	0	0.00	0	0.00	0	0.00
Manipur	1784	1761	105	5.96	0	0	1656	94.04
Assam	680	65	375	57.69	0	0	275	42.31
Nagaland	1574	1452	75	5.17	0	0.00	1377	94.83
Arunachal Pradesh	50328	50064	405	0.81	2854	5.70	46805	93.49
Mizoram	2196	2131	0	0.00	60	2.82	2071	97.18
Sub Total (North Eastern)	*58971*	*58356*	*1242*	*2.13*	*2954*	*5.06*	*54160*	*92.81*
All India	*148701*	*145320*	*36481*	*25.10*	*12738.00*	*8.77*	*96100*	*66.13*

During the initial years after the formation of the State of Uttarakhand in 2001, it was an energy surplus state (Table 6). However, with its ever-increasing energy demand and slow pace of capacity addition through hydropower, the state has been facing energy shortages for the past several years (Tables 6,7). With the state facing power shortages and with significant unutilized hydropower potential, policymakers of the state need to promote hydropower development for electricity generation being an affordable and a clean source of energy which will pave the way to a sustainable development of the state.

Table 6: Demand vs Supply of power in Uttarakhand[41]

Year	*Availability of power (MU)*	*Demand of power (MU)*	*Surplus (+) / Shortage (-) of power (MU)*
2002-2003	5189	3611	1578
2003-2004	5257	4062	1195
2004-2005	5007	4537	470
2005-2006	5426	5157	269
2006-2007	5867	5997	-130
2007-2008	6648	7049	-401

Year	*Availability of power (MU)*	*Demand of power (MU)*	*Surplus (+) / Shortage (-) of power (MU)*
2008-2009	7740	7847	-107
2009-2010	7389	8936	-1547
2010-2011	8737	9854	-1117
2011-2012	8638	10460	-1822
2012-2013	9171	10571	-1400
2013-2014	8834	10987	-2153
2014-2015	12072	12445	-373
2015-2016	12675	12889	-214
2016-2017	12966	13153	-187
2017-2018	13372	13403	-31
2018-2019	13831	13923	-92

1.7 Growth of Hydropower in Uttarakhand:

It is evident from Table 3 and Figure 2 that during last few years, the growth in development of hydropower in Uttarakhand has been sluggish which is depicted by the flattening of the growth curve since 2010. (Figure 2).

Table 7: Growth of hydropower in Uttarakhand (UJVNL)

Year	*Installed capacity (MW)*	*Annual growth (%)*
2001	1112.90	-
2002	1117.00	0.37
2003	1117.00	0.00
2004	1123.50	0.58
2005	1408.50	25.36
2006	1808.85	28.43
2007	2813.85	55.56
2008	3123.85	11.02
2009	3164.35	1.30
2010	3164.35	0.00
2011	3614.50	14.23
2012	3614.50	0.00
2013	3614.50	0.00
2014	3637.90	0.65
2015	3967.90	9.07
2016	3988.00	0.53
2017	3992.00	0.10
2018	3997.00	0.13
2019	3999.25	0.06

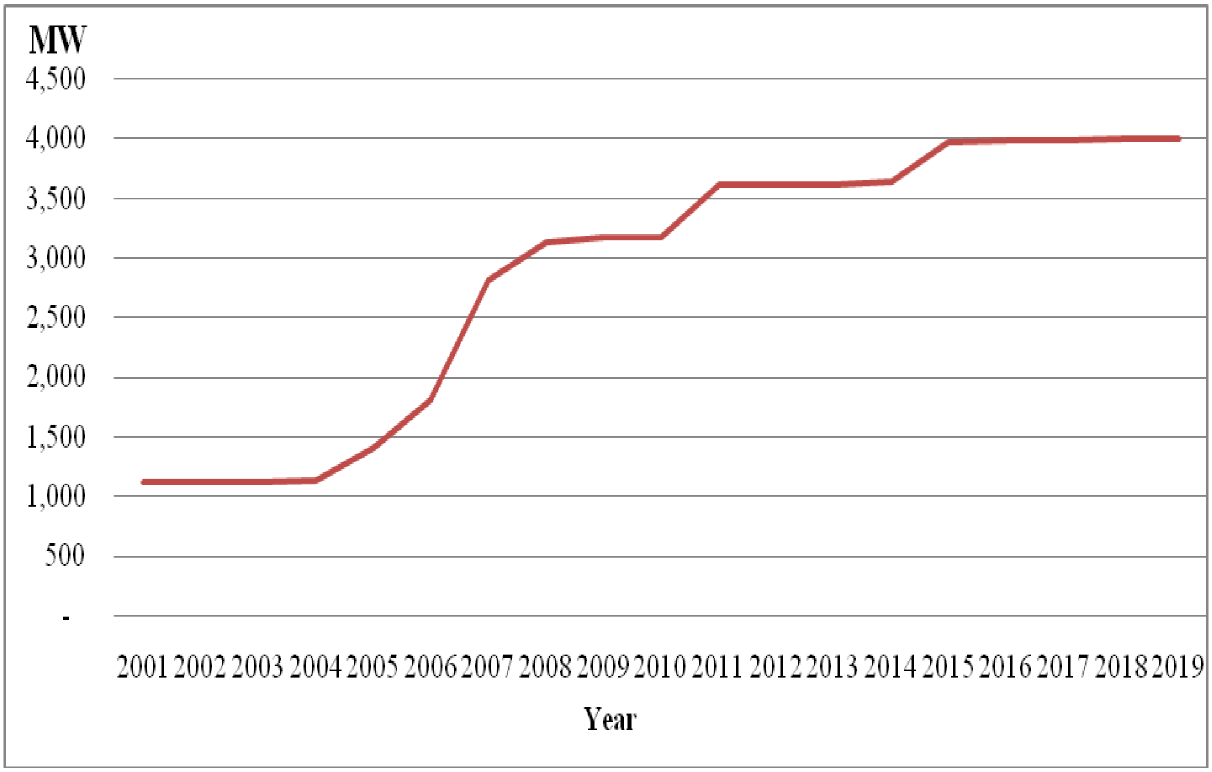


Figure 4: Growth of hydropower capacity in Uttarakhand (UJVNL)

The sluggish growth in the development of hydropower in Uttarakhand indicates presence of barriers and subsequent risks that hinder its development. Low hydropower capacity utilization in other hydropower potential rich states such as Arunachal Pradesh point that they may also be facing similar barriers. This research aims at studying the barriers and risks associated with hydropower development in India, with special focus on Uttarakhand.

The outcome of the report would suggest practical risk mitigation measures that would enable the State of Uttarakhand to reap the benefits of its hydropower potential. The results of the study may also have implications for the development of a conducive regulatory framework for the promotion of hydropower in other states in India.

1.8 Overall Opportunity Loss

The State of Uttarakhand can increase its stream of revenue through the development of unutilized hydropower potential. By under-utilizing its hydropower potential, the State is losing a significant amount of revenue. The following estimations present a calculation of the foregone revenue and subsequent tangible and intangible opportunity losses

Tangible Opportunity Losses:

Tangible Opportunity Loss

= {(Potential – Installed Capacity) x Cost per MW x Equity x (ROE-Treasury bill rate)}

- Potential = 18175 MW [8]
- Installed Capacity = 3999.25 MW [16]
- Equity = 30%
- ROE = 16%
- Avg. Treasury bill rate = 7.55% (Avg. 1993-2016)
- Cost per MW = Rs. 10 Cr. Per MW

Tangible Opportunity Loss = {(18175-3999.25) x 10^8 x 0.30 x (0.16-0.0755)}
= Rs. 35,93,55,26,250/- per annum

Intangible Opportunity Losses:

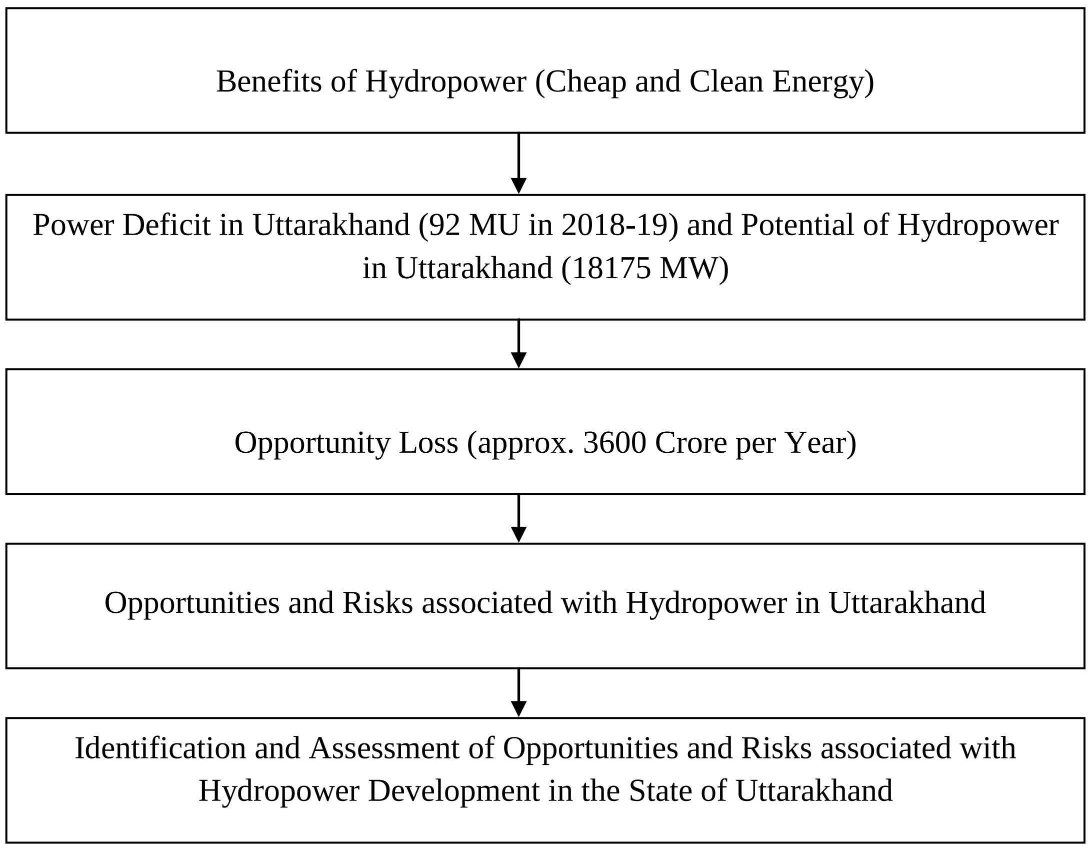
- Self-sustenance of the state in terms of electricity
- Development of a competitive energy market
- Sustainable development
- Local area development

The above estimations indicate that the state of Uttarakhand is foregoing an annual revenue of approximately Rs 3600 crore per annum by not developing its unutilized hydropower potential.

1.9 Business Problem

The sluggish growth of Hydropower in Uttarakhand results in tangible losses to the tune of Rs. 3600 Crore per annum and various intangible opportunity losses which is due to the presence of barriers and consequent risks.

1.9.1 Justification of Topic



Chapter 2

2.0 Hydropower Law, Policy and Regulation

2.1 Background: The Indian power sector has made significant progress over the years. The installed capacity of the industry grew manifold from 1,361 MW in 1947 to 356.81 GW in June, 2019. The sector has also undergone substantial structural changes. Regulatory policies have played a predominant role in changing the landscape of the Indian power sector. Though the sector has come a long way from its humble beginnings, it is still lagging on several fronts, such as power shortages, T&D losses, among others, and has a long way to go. A host of legal and regulatory as well as policy initiatives has been taken from time to time to promote renewable energy in the last 20 years. However, since the Electricity Act 2003, there has been a spurt in new regulations that have led to a growth in the renewable energy sector.

2.2 Environment for Renewable Energy

Renewable energy growth in India encounters enormous challenges with inconsistent and varying implementation by the states, varying or absence of any renewable portfolio standards, inadequate enforcement measures, complex clearance mechanisms, land allocation systems and lack of civil society participation. More pressing issues such as building Renewable Energy (RE) equipment manufacturing capacity within the country, creating a facilitative, market-oriented, pro-poor yet competitive environment that can sustain the energy contribution from renewable resources are some of the other significant/ pressing concerns that need immediate and streamlined initiatives and probably through a legal instrument.

From the international experience where RE has been a success, for smooth and consistent RE growth, a consistent legal and regulatory framework is quintessential and has a more certain status than a collection of policies, mission and programs which is the case in India.

The positive attributes of generating electricity from renewable energy sources are widely accepted, although some of these technologies may not be currently competitive commercially with conventional fuels. Renewable energy technologies can help solve energy issues related to electricity generation, namely, environmental concern, energy security, rural electrification and applications in niche markets where conventional electricity supply is not feasible. In the case of India, all the above mentioned issues are important; however, the most critical issue is that of energy shortages. Renewable energy sources can supplement the present power generation and at the same time address the environmental and energy security issues. Renewable energy technologies have good potential in India and considerable progress has been achieved.

The renewable energy technologies are being promoted through various policies and programmes of the Ministry of Non-Conventional Energy Sources (MNES) and the above mentioned achievements are a result of such promotional policies. However, it has been observed that in the overall power generation scenario, the utilization of renewable energy for electricity generation has remained marginal. The present installed capacity of renewable energy based electricity systems is about 79371 MW whereas the total installed capacity in India is about 3,57,875 MW. Some of the other limitations and barriers that have been faced for promoting renewable energy based electricity generation are:

1. Pricing of power generated from the renewable energy sources,
2. Intermittent nature of electricity from wind, solar and small hydropower,
3. Barriers such as restrictions on getting access to the grid and
4. Market barriers such as the lack of access to credit.

Out of these issues, the pricing of power generated from renewable energy sources remains the most critical issue and various policies have been implemented to overcome this issue in India.

These policies are generally related to the stage of development of the technology, e.g. capital subsidies in the early stages of development.

2.3 Evolution of Policy Environment

Based on the government's regulations and policies, the evolution of the Indian power industry can be divided into two broad phases, pre-reform and post-reform phases. The pre-reform phase (up to 1991) can be divided into the pre-independence phase (before 1947) and post-independence phase (1947-1990) and post-reform phase can be broken down into three phases.

Evolution of the Indian Power Industry

Period	Pre-reform (before 1991)		Post-reform (after 1991)		
Year	Pre-Independence (Prior to 1947	Post – Independence (1947-1990)	Phase I (1991-1995)	Phase II (1996-2003)	Phase III (2003 onwards)
	Status as of 1947	Status as of 1990	Status as of 1995	Status as of 2003	Status as of 2008
Capacity (MW)	1,361	63,636	87,171	107,877	146,900
Generation (Mn KWh)	4,073	245,438	350,490	532,693	731,000

Status at the end of year

Source: D & B Industry Research Service

Exhibit 1: Regulations for the Power Sector

Laws/Policies	Objective	Impact
The Electricity Act, 1910	Infrastructural framework for supply of electricity	Attracted private capital
The Electricity Act, 1948	Mandated creation of SEBs	Ownership in the hands of SEBs
IIP Process, 1991	Private investment in power generation	Projects from private players came into generation
The Electricity (Amendment) act, 1998	Making transmission a separate activity	Central Transmission Utility & State Transmission Utilities were setup
Mega power policy, 1995	Setting up of Mega power plants	Mega power plants get benefited

Laws/Policies	Objective	Impact
The Regulatory Commission Act, 1998	Provision for setting up of Central State Electricity Regulatory Commission	Independent regulatory mechanism
Electricity Act, 2003	Providing reliable and quality power to customers at reasonable rate	Investment in capacity addition
National Electricity Policy, 2005	Competition and protection of consumer	More players influenced to invest and more efficient consumer service
National Tariff Policy, 2006 Revised Tariff Policies, 2016	Tariff Structuring	Attractive tariff for players

Source: D & B Industry Research Service

2.4 Pre-Independence Era (UPTO 1947)

The demand for electricity during this phase was driven by demand from industries, commercial enterprises (including tramways) and also domestic use. Most of the earlier private companies in the power sector cease to exist today as they were amalgamated into state-owned enterprises; however, a few of them continue to exist as private players.

The Electricity Act 1910 was the first Act (one of the earliest regulation) in the power industry, which was introduced before independence in 1910. The Act provided a basic framework for the supply of electricity in India. The sector was at a nascent stage during this time and there was a huge investment requirement for laying down basic infrastructure. The Act encouraged the growth of the industry by issuing licenses to private companies. Thus, during this phase, electricity generation was mainly in the private sector and power generation was largely based on coal and hydropower.

Box 1: Salient Features of Electricity Act 1910

1. Structural framework was set up for electricity supply
2. Envisaged growth of the electricity industry through private licenses
3. Licenses were allotted by state governments for the supply of electricity in a specified area. The legal framework was set up for laying down wires and other works
4. Ensured a fair relationship between licensee and consumer.

2.5 Post-Independence Era (1947-1990)

At the time of independence, electricity generation and supply was concentrated in the hands of private electricity suppliers, and mainly in urban areas. Electricity supply was a must across the country to promote overall growth and development; hence, the Electricity (Supply) Act 1948, based on the UK Electricity Supply Act 1926, was introduced. Under this Act, the Central Electricity Authority (CEA) was established at the central level and the State Electricity Boards (SEBs) at the state level. The objective of the CEA was to develop a sound, adequate, and uniform national power policy to coordinate the development of the power sector in India.

In the initial period, the SEBs' performance was satisfactory and they played a vital role in the development of the sector. The SEBs were able to generate the minimum returns for many years, but, eventually, their performance faltered and they had to seek financial aid from the state in the form of grants, subsidies, soft loans and the like. The early seventies were marked by incidents of power blackouts and grid collapses. Hydropower generation suffered especially, as availability of water resources was heavily dependent on the monsoon season.

The Central government amended the Electricity (Supply) Act 1948 and established the National Hydropower Corporation (NHPC) in 1975 to build hydropower plants and the National Thermal Power Corporation (NTPC) to set up coal-based power plants to supplement the generation capacities of the SEBs and private companies. Power Grid Corporation of India Ltd was formed to cater to the need of integrated transmission network.

During this phase, a lot of emphasis was laid on setting up hydropower plants, as the government planned to develop the irrigation and power sectors simultaneously. The installed capacity in the hydropower sector did witness significant growth up to 1970; however, the lesser-than-expected growth rate and longer gestation period decreased its share in total power generation capacity. In the meanwhile, coal-based power plants continued to grow and the percentage of thermal power capacity increased in the total capacity.

While the SEBs aided the growth in the Indian electricity sector, they suffered substantial financial and technical losses. These losses were due to factors such as poor revenue collection and billing, poor metering and energy accounting, electricity theft, cross-subsidies and SEB's inefficiencies. As a result, the end consumers had to bear the brunt of inadequate power supply as the state-owned corporation power plants were running at low plant load factor (PLF) and the SEBs did not have enough funds for renovation and modernization of their plants.

As a result, the demand-supply gap was increasing and many states were facing an electricity crisis. These circumstances forced the government to restructure the sector in a phased manner, and this paved the way for meting out electricity reforms in 1991.

2.6 Post–Reform Phase (After 1991)

The deteriorating health of the SEBs made it impossible for them to infuse fresh investments into the sector. Moreover, the country was facing a macroeconomic financial crisis that made it difficult for the governments, both the Central and state governments, to fund power projects through budgetary support. Due to these events, the government decided to restructure the power sector in a phased manner in 1991; consequently, it opened up the power sector (at the time of liberalisation) and invited foreign private companies to get funds and technology into the Indian power sector.

The post-reform phase can be divided into three phases:

Exhibit 2: Post Reform Framework

1991 (IPP Process)	1995 (Mega Power Policy)	1996 (Common Minimum National Action Programme	1998 (Electricity Regulatory Commission Act)	2003 (The Electricity Act)
• Amendment in the electricity (supply) act, 1948 • Opening up of private investment in power generation	• Capacity addition in generation through mega projects (1000MW) • Competitive bidding introduced	• Guidelines for establishment of regulatory commissions • Promoting private partnership	• Creation of SERC & CERC	• Replaces existing act • Focus on laws relating to generation, transmission, distribution, trading and use of electricity • Create a liberal framework for the development of power sector

Source: D & B Industry Research Service

2.6.1 First Phase (Started In 1991): Independent Power Producers (IPP)

Investments were a must in the power sector to enable it to produce electricity in line with the expected economic growth. The government liberalised the sector and opened it for foreign and private investments to increase the availability of funds for the power sector. For allowing independent power producers to operate in the sector, the government amended the Electricity Act 1910 and the Electricity (Supply) Act 1948 through the Electricity Laws (Amendment) Act of 1991. The amendment allowed private participation in thermal, hydro, wind, and solar power projects, and also allowed them to operate as IPPs. Foreign ownership of up to 100% was allowed. IPPs were to operate on a cost-plus model wherein the tariff was determined by the Central government and the IPPs were guaranteed a 16% post-tax return on equity, full repatriation of profits, among others. The operators and the SEBs entered into power purchase agreements (PPAs) as the

SEBs were responsible for transmission and distribution of power generated by private players.

The first phase of the reform failed as the objective of attracting private players did not achieve the desired results. Private players did not enter the sector, as the SEBs, who were to transmit and distribute the power generated by the private players, were still running in losses. Private players were uncertain about their returns due to the poor financial health of the SEBs. The annual commercial losses of the SEBs increased consistently from Rs 45.60 bn in 1992-93 to Rs 106.84 bn in 1997-98. The power plants continued to work at low PLF.

2.6.2 Push for Renewable Energy

Ministry of Non Conventional Energy Sources (MNES), in 1993, prepared policy guidelines for the promotion of power generation from renewable energy sources which included provisions such as accelerated depreciation, concessions regarding the banking, wheeling and third party sale, among others.

Further, the Electricity Act 2003 (EA 03) that was notified by the Ministry of Power in June 2003 along with the National Electricity Policy recognised the role of renewable energy technologies and stand-alone systems. The EA 03 has accorded significant responsibilities to the State Electricity Regulatory Commissions (SERCs) that are now key players in setting tariffs for renewable energy based electricity generation and have also been mandated to set quotas for renewable energy as a percentage of the total consumption of electricity in the area of the distribution licensee. The National Tariff Policy that was notified by the Ministry of Power in January 2006, in continuation with the EA 03 and the National Electricity Policy also emphasizes the importance of setting renewable energy quotas and preferential tariffs for renewable energy procurement by the respective SERCs. A detailed review is as follows:-

2.7. Review of Indian Legislation and Policies

Ministry of Non Conventional Energy Sources Initiatives

In India, the utilization of renewable energy technologies for electricity generation has a long history. The wind demonstration projects set up in the early 80's in Tamil Nadu, Gujarat, and Maharashtra are an example of this. This phase was followed by the development of policy measures, including financing and institutional measures to support renewable energy technologies. The Ministry of Non-Conventional Energy Sources (MNES), in 1993 prepared policy guidelines for the promotion of power generation from renewable energy sources. Some of the salient features of this policy guideline are –

- Buy back price of Rs. 2.25 per kWh with 5% annual escalation, with 1993 as base year,
- Concessions regarding the banking, wheeling and third party sale and
- Fiscal incentives like allowing 100% accelerated depreciation for renewable energy projects were also given.

The MNES guidelines were valid for a period of 10 years.

Power being a concurrent subject between the central and the state governments in India; different states adopted the MNES guidelines to a varying degree. Further, there have been modifications in the state level policies with on one hand, some states giving additional benefits to renewable while on the other hand, some states have even diluted the benefits that were proposed in the MNES guidelines.

The 1995 Mega Power Policy did not propose any fiscal concession, hence in 1998, the revised Mega Power Policy 1998 included these concessions. The Power Trading Corporation (PTC) was also set up after this revision to purchase power from identified projects and to sell to identified-SEBs. Establishing regulatory commissions and privatising electricity distribution in cities (with a population of more than 1 mn) were the pre-conditions included in the revised policy.

In December 1996 the Common Minimum National Action Programme (CMNAP) was structured in consultation with the state governments, and guidelines were established to hasten the sector's progress.

During this period, private sector investments were already being made for capacity addition in generation but the need was felt for private participation in transmission as well; consequently, the Electricity Laws (Amendment) Act was passed in 1998 to enable private participation in the power transmission sector. The central transmission utility (CTU) and the state transmission utility (STU) was set up under this Act. The maintenance and construction activity of the transmission network was supervised by CTU at the inter-state level and by the state transmission utility (STU) at the intra-state level.

The CERC issued the first Indian Electricity Grid Code (IEGC) in January 2000 to ensure grid discipline and to set operation and governance parameters for players in the transmission and distribution (T&D) sectors.

The Electricity Act 2003, which came into effect from June 10, 2003, replaced the earlier laws, acts governing the Indian power sector, namely, the Indian Electricity Act 1910, the Electricity (Supply) Act 1948 and the Electricity Regulatory Commissions Act 1998. The bill sought to provide a legal framework for enabling reforms and restructuring the power sector.

The Electricity Bill was passed by the Parliament in 2003; this Bill sought to provide a legal framework for enabling reforms and restructuring of the power sector. The Bill became an Act with effect from June 10, 2003 and replaced the earlier laws governing the power sector, namely, the Indian Electricity Act 1910, the Electricity (Supply) Act 1948, and the Electricity Regulatory Commission Act 1998.

2.8. Electricity Act 2003

The Act sought to create a liberal framework for the development of the power industry, promoting competition, protecting interests of consumers, supply of electricity to all areas, rationalization of electricity tariff and ensuring transparent policies and promotion of efficiency, among others. The Act came out with the National Electricity Policy, mandatory creation of SERCs, emphasis on rural electrification, open access in transmission and distribution and some other provisions. It mandated the regulatory commissions to regulate the tariff and issues of license. This Act focused on laws relating to generation, transmission, distribution, trading, and uses of electricity. The Act was amended on 27-01-2004 and 15-06-2007 and the Electricity Act 2003 was enacted with stronger power and clarity and with greater emphasis on assessment, fines, and legal framework to check the monetary losses due to theft and unauthorized use of electricity.

Generation: The generation segment opened up for private players in 1991. However, even over the years, the generation capacity from private players did not reach the desired level. The government introduced specific/ distinct policy measures in generation in the Electricity Act 2003 to ensure more private participation and to reduce the demand-supply gap. Generation of power was de-licensed and the requirement of techno-economic clearance for thermal power generating plants by CEA was dispensed with, which paved the way for the entry of more players in thermal generation. The Act also removed restrictions on captive power generation and simplified the procedures. Open access was allowed immediately in transmission, which gave the right to private power producers or any other generating utility to sell its power to any entity using transmission network (without any discrimination).

Box 2: Open Access

In order to introduce competition in Distribution of Electricity Open Access has been introduced in Electricity Act 2003. Open Access has been defined under section 2(7) of the EA 2003 as hereunder:

"Open Access means the non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensee or consumer or a person engaged in generation in accordance with the regulations specified by the Appropriate Commission."

Basically Open access facilitates non-discriminatory use of transmission lines or distribution system by any generating utility or consumer. Accordingly, any seller or buyer can use the transmission line owned and controlled by any utilityto sell their power at any location in any region subject to conditions laid down by appropriate Commission (which includes SERC or CERC as the case may be).In other words the generators and buyers can trade freely by using the transmission or distribution network by just paying applicable transmission, wheeling charges and other applicable charges as determined by the appropriated Commission to the owner of the network.

The section 42 of the Act mandates that a distribution licensee is required to develop and maintain an efficient, co-ordinated and economical distribution system in his area of supply so that it can supply electricity in accordance with the provisions of the Act. Open Access has been classified as detailed hereunder:-

(i) Inter-State Open Access: When purchasing and selling of power involves different states then Open Access is governed by Regulations promulgated by Central Electricity Regulatory Commission (CERC).

(ii) Intra-State Open Access: When purchasing and selling of power involves single state then Open Access is governed by Regulations promulgated by State Electricity Regulatory Commission (SERC).

Further, based on period of Access, the open access customers can have three kinds of Access namely Long-term Access, Medium-term Open Access and Short-term Open Access. Long-term Access, Medium-term Open Access and Short-term Open Access has been defined as the Open Access in the intra-State transmission system or distribution system for a period exceeding 12 years but not exceeding 25 years,for a period exceeding three months but not exceeding three years and for a period up to one month at a time respectively.

In order that Open Access is available to Customers. The Regulatory Commissions have been entrusted to frame Regulatory framework for Open Access. Accordingly, Uttarakhand Electricity Regulatory Commission has also notified UERC (Terms and Conditions of Intra-State Open Access) Regulations, 2015 for providing Open Access to Open Access Customers (i.e. licensees, generating companies, captive generating plants and consumers)who are using intra-State transmission system and distribution systems of the UttarakhandState subject to payment of transmission and other charges as determined by the Commission from time to time.

However, Hon'ble UERC has permitted Open Access to the consumers who are located within the area of the distribution licensee of the State and have a contracted load of 100 kVA and above and are connected to the distribution system of licensee at 11 kV or abovethrough an independent feeder emanating from a substation of licensee or industrial feeder subject to other terms and conditions as laid down in the aforesaid regulations.

Consumer who has a supply agreement with the distribution licensee and avails the option of drawing part or full of its demand from any other person under open access, in any one or more time slots during a day or more in any month or more during the year, without ceasing to be a consumer of the distribution licensee has been defined as **Embedded open access consumer by** Honb'le UERC.

The benefits of Open Access in Electricity sector are detailed as hereunder:

(i) Customer has a choice to explore the market and purchase cheaper power from sellers.

(ii) Customers are free to select seller from pool of competitive sellers.

(iii) Help power market to grow.

(iv) It promotes consumption of Renewable Power as Open access consumers are also required to meet their Renewable Purchase Obligations (RPOs).

(v) It may help cut power shortage since a seller can now sell power to different consumers as per requirement.

In long run this will yield to competitive pricing of electricity and accordingly electricity prices will go down.

Transmission: The Electricity Act 2003 introduced ~~a~~ non-discriminatory open access in the transmission segment, which enabled the generators to sell power to any customer and gave the buyer the option to choose the generator using the transmission network. The transmission utility was not allowed to refuse the use of its transmission network except in instances of capacity limitation.

Distribution: The measures meted out included more than one distribution licenses permitted in the same area, which increased competition among the distribution licensees, and ensured better services for the end consumer. Delhi witnessed the best case of multiple licenses after privatisation in 2001, which resulted in improved operational performance, reduction in AT&C losses, and reduction in incidences of load shedding.

NDPL, BSES, and BRPL, the three distribution companies, came into existence and took charge of power distribution in different areas of Delhi. The anti-theft provisions under the Act lowered the monetary/ financial losses of utilities as electricity losses arising from theft decreased continuously and investors started to show renewed interest.

In the distribution segment, open access was introduced, which opened up a new era of choice for consumers to choose their supplier. Many SERCs like Uttarakhand, Jharkhand, Madhya Pradesh, and Punjab have issued guidelines for open access and allowed it up to 1 MW capacity and above.

Exhibit 3: Segment-Wise Impact of Electricity Act 2003 in different Segments of Electricity

Segment	Objective	Impact
Generation	1. De-licensing of generation 2. Liberalisation in captive power policy	1. More players attracted towards generation 2. Captive generation increases
Transmission	1. Open access to transmission and distribution lines	1. Choice to choose customer/efficient transfer of power
Distribution	1. Open access in phase manner 2. Stringent penalties for power theft 3. Transparent subsidy management	1. Choice for buyer to choose Supplier 2. Reduction in losses 3. Equal benefit to all

Source: D & B Industry Research Service

2.8.1 Policy Promotion for Renewable Energy Sector

The EA 03 also had its impact on the renewable power sector and recognised the role of renewable energy technologies in the National Electricity Policy and in stand-alone systems.

Some of the essential/ crucial provisions in the Act with regard to the promotion of renewable energy are given below.

Section 3 (1)

"The Central Government shall from time to time, prepare the National Electricity Policy and tariff policy, in consultation with the State Governments

and the Authority for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or materials, hydro and renewable sources of energy."

Section 4

"The Central Government shall, after consultation with State Governments, prepare and notify a national policy, permitting stand-alone systems (including those based on renewable sources of energy and other non-conventional sources of energy) for rural areas."

The state electricity regulatory commissions (SERCs) are now crucial players in the context of state-level policies for renewable.

Section 61 (h)

"The Appropriate Commission shall, subject to the provisions of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided by the promotion of co-generation and generation of electricity from renewable sources of energy."

Further, the EA 03 has made it mandatory for SERCs –

Section 86 (1) (e)

"to promote cogeneration and generation of electricity through renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any persons, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee."

2.8.2 Changing Market Structure after Electricity Act 2003

With the enactment of the Electricity Act 2003 and the implementation of open access, the market structure in the power sector changed from the old single buyer structure to a multi-buyer model. The generator could sell power to any buyer using the open access provision in transmission and users had the choice to choose their supplier. Ever since the introduction of the Electricity Act 2003, there was increased competition among generators and suppliers, which improved the sector's performance. Currently, many states, which have unbundled the SEBs, have reported improvements in their operational efficiency and can ensure reliable power supply to consumers.

The market structure, which has taken shape after the Electricity Act 2003, looks promising as it gives the right of choice to the supplier as well as a buyer while attempting to ensure quality and regular supply of power. Under the Indian Constitution, energy is a concurrent subject and hence its development is the joint responsibility of the central and provincial state governments. The Parliament and the state legislature are both empowered to make laws.

Ministry of Power (MOP): The MOP is responsible for the development of the electrical energy sector in India. The main functions of the MOP are planning, formulating policies, administration and enactment of legislation for thermal and hydropower generation, transmission and distribution. The Ministry also looks after processing of projects for investment decision as also monitoring the implementation of power projects. It is responsible for the administration of the Electricity Act 2003 and the Energy Conservation Act 2001 and to make amendments to these Acts, to maintain accordance with the government's policy objectives.

Regulatory Bodies: The CERC and the SERC are the two primary regulatory bodies that govern the power sector. These regulatory bodies were formed in 1998 when the Electricity Regulatory Commission Act 1998 came into force; so far these bodies have an established arrangement for protection and promotion of consumer interest, fair competition, transparency, and for providing a level-playing-field for all players in the sector.

2.8.3 Contribution of Regulatory Bodies

The regulatory system was not effective in the power sector in India before 1997. The SEBs performance was not satisfactory; they were suffering from substantial financial and commercial losses; there was no regulatory body to regulate the functioning of SEBs and regulations were not addressing core issues like consumer interest, the supply of reasonable power, and its quality. The sector was facing an urgent need for regulatory bodies, which would regulate the sector efficiently. Therefore, to a competitive, transparent, and consumer-friendly environment, an independent CERC at the Centre and a separate SERC at the state level were considered as the need of the hour for regulating the power sector.

The respective commissions took over the role of a regulatory body for the sector. The regulatory authorities set up transparent procedures for tariff fixation keeping in view the interest of both the supplier and the beneficiary and carried out the tariff plans in a successful manner. Regulatory commissions passed numerous regulations and provided a legal framework for players to conduct their business in the industry.

Box3: Functions of CERC

- Regulate the tariff of generating companies owned or controlled by the Central government
- Regulate the inter-state transmission of electricity
- Determine tariff for inter-state transmission of electricity
- To issue licenses to persons to function as transmission licensee and electricity trader concerning their state operations
- To levy fees/penalty as per provisions of the Act
- Specify grid code having regard to grid standards
- To specify and enforce the standards with respect to quality, continuity and reliability of service by licensees
- Fix the trading margin in the inter-state trading of electricity

Box4: Functions of SERC

- Determine the tariff for generation, supply, transmission and wheeling of electricity, wholesale, bulk or retail, as the case may be
- Regulate electricity purchase and procurement process of distribution licensees
- Facilitate intra-state transmission and wheeling of electricity
- Issue licenses to persons seeking to act as transmission licensees, distribution licensees and electricity traders with respect to their operations within the state
- Specify state grid code
- Specify or enforce standards for quality, continuity and reliability of service by licensees
- Fix the trading margin in the intra-state trading of electricity.

System Operators: There are five different regional load dispatch centres (RLDC); NRLDC (Northern RLDC) situated at Delhi, WRLDC (Western RLDC) situated at Mumbai, SRLDC (Southern RLDC) situated at Bangalore, ERLDC (Eastern RLDC) situated at Kolkata, NERLDC (North-Eastern RLDC) situated at Shillong (Meghalaya). The primary function of these load dispatch centres is to look after the operation of the power system in their respective regions and report to the National Load Dispatch Centre (NLDC). Power Grid is the central transmission utility, which acts as the NLDC. NLDC monitors the different load dispatch centres.

2.9 Status of Reforms

Reforms have played a crucial role in each segment of the power sector. In the generation segment, de-licensing of thermal and captive power generation and generation in rural areas has allowed private players to invest in power generation.

The government made distribution a separate segment to improve the segment's performance.

After the establishment of regulatory commissions, several regulations have been passed; the most important ones being Availability–Based Tariff Order (2002), Terms and Conditions of Tariff (2004), Multi-Year Tariff (MYT) Norms (2004), Electricity Grid Code (2006), and Open Access in Inter-State Transmission (2008). Under the Availability Based Tariff (ABT) regime, the generator and the beneficiary (buyer) set up PPAs based on which generators feed power to the grid and the beneficiary draws the power. When the beneficiary overdraws power they have to pay unscheduled interchange (UI) charges, but if the generator overfeeds to the grid, it will have to pay the UI charges. The mechanism helps in maintaining grid discipline and aids the grid to operate at optimal efficiency. Many states like Gujarat, Karnataka, Delhi, Maharashtra, etc. have implemented intra-state ABT and have optimised their power purchase cost.

The terms and conditions of the tariff were introduced in 2004, as per which many norms were laid down to determine the tariff for generation, transmission, and distribution. In 2006 the Electricity Grid Codes laid down technical rules covering all the utilities connected through the grid or using inter-state transmission system. These codes ensured the efficient functioning of the power system and penalised the user for avoiding the rules. CERC is the regulatory body that monitors these codes at the central level while SERC monitors it at the state level.

The reforms in the sector have progressed well so far; however, the concern that is still prevailing in the sector is government dominance over the regulatory commission. The government has regulated the sector for more than 50 years and many times, it has been unwilling to transfer the power to regulatory commissions. Tariff setting still has a component of subsidies that are given by the government; hence, in spite of clear norms and regulations, the commercial viability of tariff remains a question mark. Accordingly, reforms have to be more intensive and come out with more measures in removing odds present in the sector.

Electricity Act 2003: The act came into force from 2^{nd} June 2003. It is a comprehensive enactment replacing the then existing Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998[79]. The objective of the Act is to introduce competition, protect consumer's interests and provide electricity to all[79][80].

The Act provides for National Electricity Policy, Rural Electrification, open access in transmission, phased open access in distribution, mandatory SERCs, license free generation and distribution, power trading, compulsory metering and stringent penalties for electricity theft [79][80]. The aim is to push the sector onto a trajectory of a healthy business growth and to enable the States and the Centre to move in agreement and coordination[79][80].

Electricity Act 2003, mandates for hydropower generators, to get concurrence from concerned authority by submitting required documents, a scheme estimated to involve a capital expenditure exceeding such sum, as may be fixed by the Central Government, from time to time, by notification and further for optimal utilization of resources such as coal, natural gas, nuclear, hydro and other renewable sources [80]. It also mandates the Central Government to prepare National Electricity Policy and Tariff Policy from time-to-time in consultation with the State governments and the authority for the development of power system[80]. The Act has also emphasized on the development of hydropower and safety of the structures including dams etc. [42][80].

National Electricity Policy: In 2005, the policy took shape with a focus on quality and reliable power supply to every household at an affordable price[81].

It encourages private participation in generation, transmission and distribution sectors keeping in view significant investments required for the development of the whole power sector[81]. The policy suggests the Central and State governments to develop workable and successful models for encouraging public-private partnership[81]. The policy also focuses on Hydropower development by considering it as a clean and renewable source of energy and addresses several points that help in the development of Hydropower in the country[81].

a) Rapidly harnessing the hydropower potential will also facilitate the economic development of states particularly, North-Eastern States, Sikkim, Uttarakhand, Himachal Pradesh and J&K[81].

b) Hydropower projects require a huge investment. Therefore, debt-financing of longer tenure would need to be available for these projects[81]. According to the NEP, the Central government is committed to policies that ensure development and financing of viable hydropower projects[81].

c) State governments should provide approvals or clearances, such as Forest/Environmental Clearances and need to review the procedures for land acquisition, for speedy implementation of Hydropower projects[81].

d) Central government to support the State governments for expeditious development of their hydropower projects by offering services of central public service undertakings like National Hydro Power Corporation (NHPC)[81].

e) Adequate safeguards for environmental protection with a suitable mechanism for monitoring implementation of Environmental Action Plan and National Policy on Rehabilitation and Resettlement (R&R) in this regard to ensure that the concerns of project-affected families are addressed[81].

Provisions for Renewable Energy

Some of the essential/crucial provisions concerning non-conventional energy generation mentioned in the National Tariff Policy are:

Section 6.4

(1) Pursuant to provisions of section 86(1)(e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from non-conventional sources, taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs as decided by the SERCs, latest by April 1, 2006. It will take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity. Therefore, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.

(2) Such procurement by Distribution Licensees for future requirements shall be done, as far as possible, through a competitive bidding process under Section 63 of the Act within suppliers offering energy from the same type of non-conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs.

(3) The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from non–conventional sources, to be followed in cases where such procurement is not through competitive bidding.

Implementation of Section 86 (1) (e) of the EA 03 and Section 6.4 (1) of the National Tariff Policy are underway and different SERCs are in the process of issuing tariff orders for renewable energy based electricity generation and specifying quota/share for power from renewable energy.

National Tariff Policy: The Central Government has notified the National Tariff Policy in continuation to the National Electricity Policy according to section-3 of the Electricity Act 2003[82][83].The Policy has set some objectives like assured electricity to consumers at reasonable and competitive rates, the financial viability of the sector, promoting transparency, consistency and predictability in regulatory approaches across jurisdictions and encouraging competition[82][83].

The Policy deals with the general approach to the determination of tariff and all the components of Tariff like Return on Equity, Working Capital, Depreciation, Operation and Maintenance expenses, Interest on debt and variable costs for the project developers[82]. On generation, the policy talks about setting up of separate capacities for meeting peak demand and introduction of differential rates for peak and non-peak power[83].

The policy has a resolution passed on 31 March 2008 for development of Hydropower sector. It is primarily focused on the determination of tariff by the appropriate commission, concurrence of CEA, financial closure, the award of work, long term PPA (35 years), free power for the State in which the project is constructed (up to 13%) and R&R issues[84]. It is also mentioned in the policy that the cost of project developers will include 10% contribution to the power reform programs like RGGVY, DDUJVY etc., in the affected area based on the project report sanctioned by Ministry of Power (MoP)[84].

The policy lays down the guidelines for attracting adequate investments to the sector and ensuring reasonable charges for the consumers. These guidelines stress on competitive procurement of power. The Central government formulated this policy in consultation with regulatory commissions and CEA. Regulatory bodies are guided by tariff policy in framing the tariff regulation.

Box5: Objectives of NTP

- Providing electricity to consumers at reasonable and competitive rates
- Ensure financial viability of the sector and attract investments
- Promote competition, efficiency in operation and improvement in the quality of supply
- Promote transparency, consistency and predictability in regulatory approaches across jurisdictions and minimize perceptions of regulatory risks.

Features of NTP

- Tariff by bidding process: Under this process, new projects are allowed to disburse power to SEBs based on competitive bidding, but expansion projects are an exception as they already have tie-ups for their supply. This method gives the right to buyers and sellers to set tariff of their price range.

- Returns to attract new investment: This policy ensures attractive returns so that investment in the power sector is higher than other industries.

Peak and off-peak hour's tariff: Tariff of peak hours and off-peak hours is the function of ABT, which is implemented in all regions. The rates are different for peak and off-peak hours and are decided by the CERC. This tariff is beneficial for both generator and the buyer as the generator gets higher rates of peak hours while the buyer tries to shift towards off-peak hours to pay less.

The reforms in the sector have restructured the vertically-integrated market structure to a competitive structure. Market efficiency has been improved over time as many laws and regulations have achieved the desired result. Mobility has increased in the power market and so have the number of players; the regulation has created a competitive market place, which in future will bring the open market in the power sector.

National Hydro Policy: The successive governments have accorded a high priority to the development of the hydro potential and have undertaken several policy initiatives to address the issues impeding the hydropower development[42] from time to time. This Hydropower policy is one such initiative which seeks to induce substantial private investments for its development[42]. The Government of India has set the following broad policy objectives for accelerating the pace of hydropower development[42] in the country:

i) Inducing Private Investment in hydropower development
ii) Harnessing the balance hydroelectric potential
iii) Improving Resettlement and Rehabilitation
iv) Facilitating financial viability

The Hydro policy has been planned and targeted for the long term development of hydropower and it is expected that by the end of 14th Plan the entire feasible hydro potential could be exploited[42]. With the objective of achieving the target and expediting the Hydropower generation in a systematic manner, CEA completed the ranking (a study based on the weight criteria for various aspects involved in the development of Hydropower projects) of balance hydro potential sites for all the basins in the country. These basins have further been graded in A, B and C categories in order of their priority for development[42]. The policy has recognised the importance of private investments and suggested for the Central Government to prepare several models to improve the private sector investment and public-private partnerships[42]. Even though public sector organizations would continue to play an essential role in the development of new schemes, this alone would not be adequate to develop the vast remaining hydro potential[42]. More significant investment from private sector players is needed for the development of hydro potential in the country[42].

Huge financial requirements, preparation of DPR, resettlement and rehabilitation issues, locational disadvantages, geological surprises, schedule delays etc., are some of the barriers in setting up of a Hydropower project. Adoption of Ultra mega power projects (UMPP) model for hydropower projects, capacity building and employment generation for project affected people, institutional mechanism for coordination among developers in a basin, river basin development are some of the measures suggested in the policy, for reducing the barriers that are hindering the growth of hydropower in a targeted way[42].

India Action plan (2017-2020): India action plan is a three-year agenda formulated by Niti-Aayog, based on extensive discussions with and inputs from central ministries and State governments[85]. The Three Year Action Agenda offers ambitious proposals for policy changes within a relatively short period, in which some may be fully implemented during the three years, implementation of others would continue into the subsequent years[85]. Provisions have been made for the State Governments to complement the efforts of the Central government, wherever required.

The objectives of this three-year action plan are eliminating poverty in all its dimensions such that every citizen has access to a minimum standard of food, education, health, clothing, shelter, transportation and energy which has been at the heart of India's development efforts since Independence[85]. The plan also focuses/ aims to add 61.6 GW electricity generation capacity through all conventional sources and also targets to realize the generation capacity of 6.9GW through large hydropower projects[85]. It also suggests the governments make efforts to expedite progress on capacity under construction through satisfactory Resettlement and Rehabilitation implementation[85].

Recommendations have been made for the central government to improve the renewable power by achieving the 175GW target by 2022 and also for balancing solar power in decentralized locations with target of 5000 MW from Small hydropower (SHP) projects by 2019-20 by viability gap funding and tariff support[85].

Draft National Electricity Policy: The draft Policy was released on 27th June 2017 which aims to chart the way forward to meet the targets of the government in the energy sector. Keeping in view the climate change concerns, it also aims at increasing the contribution of hydro and other renewable sources in the installed capacity energy mix in India[69]. Promoting flexible demand and supply resources to the power systems, especially those with a high share of renewable energy, require access to sufficient flexible resources (e.g., demand response, gas turbines, flexible thermal generation, hydroelectricity, etc.) to ensure the continued stability of the grid at every moment[69]. Recognition of power generation through the hydro resource has a large number of co-benefits including containment of flood, irrigation, fishery, groundwater etc., and dedicated for proper attention in developing Hydropower generation[69].

Box6: Objective of NEP

- Access to electricity – Available for all households in the next 5 years
- Availability of power – Demand to be fully met by 2012. Energy and peaking shortages to be overcome and adequate spinning reserve to be available
- Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates
- Per capita availability of electricity to be increased to over 1000 units by 2012.
- Minimum lifeline consumption of 1 unit/household/day as a merit good by the year 2012.
- Financial turnaround and commercial viability of the electricity sector.
- Protection of consumers' interests

National Electricity Policy also stresses the need for the promotion of Non-Conventional Energy Sources. The extract of the relevant provisions of the National Electricity Policy is given below –

Cogeneration and Non-Conventional Energy Sources

Non-conventional sources of energy being the most environment-friendly there is an urgent need to promote the generation of electricity based on such sources of energy. For this purpose, efforts need to be made to reduce the capital cost of projects based on non-conventional and renewable sources of energy. Cost of energy can also be reduced by promoting competition within such projects. At the same time, adequate promotional measures would also have to be taken for the development of technologies and sustained growth of these sources.

The Electricity Act 2003 provides that co-generation and generation of electricity from non-conventional sources would be promoted by the SERCs by providing suitable measures for connectivity with grid and sale of electricity to any person and also by specifying, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licensee. Such percentage for purchase of power from non-conventional sources should be made applicable for the tariffs to be determined by the SERCs at the earliest. Progressively the share of electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions. Such purchase by distribution companies shall be through a competitive bidding process. Considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the Commission may determine an appropriate differential in prices to promote these technologies.

Industries in which both process heat and electricity are needed are well suited for cogeneration of electricity. A significant potential for cogeneration exists in the country, particularly in the sugar industry. SERCs may promote arrangements between the cogenerator and the concerned distribution licensee for purchase of surplus power from such plants. Cogeneration system also needs to be encouraged in the overall interest of energy efficiency and also grid stability."

Draft National Hydro Policy 2017: New Hydro Policy 2017, a draft proposal was prepared by the Ministry of power for the development of Hydropower sector. According to the new policy, Hydropower is considered as a renewable energy irrespective of the capacity of the plant[86]. Under the policy, the government will provide interest subvention of 4 per cent during construction for up to seven years and for three years after the start of the commercial operation to all hydropower projects above 25 MW[87]. A hydropower fund would be created under the Ministry of Power for giving assets to the ventures under this policy[87]. Also, the funding for these projects will come from Coal cess or national clean energy fund or non-lapsable central pool of assets for North Eastern states up to 2024-2025[87][41]. The policy also mandates the purchase of hydropower by implementing hydropower purchase obligation for projects above 25 MW, under which all the DISCOMS have a statutory obligation to purchase a certain amount of energy from these projects[87]. The benefits under this policy would be available to hydropower developers, which would be able to begin the operation of the plant after five years of notification of this policy[87].

2.10 Policy-level initiatives in Uttarakhand:

Uttarakhand is a Himalayan state, endowed with perennial rivers and several streams that have enormous potential for generating power through hydro resources[88]**.** The state has an estimated potential of 18000 MW, in which 15000 MW is in the large hydro segment and remaining 3000 MW of hydropower in the small, mini and micro hydro segment. Out of this, only 3988.05 MW of hydropower projects have been installed in the state which also includes small and mini hydropower plants (UJVNL). There is a vast untapped potential of hydropower in the state. This potential if harnessed efficiently, can immensely help to fulfil Central government's goals like "24X7 Power For All by 2022", rural electrification, revenue generation, employment generation and upliftment of livelihood[88][89][40]. The government of Uttarakhand recognised the threat of climate change and envisaged the development of hydropower in the state as one of the vital mitigation measures for sustainable development through the promotion of the hydropower projects.

It has made several policies according to the capacities [89][88][90][91] such as:

i) Policy for development of mini and micro hydropower projects up to 2MW-2015

ii) Policy for development of small hydropower projects of capacity above 2 MW and up to 25 MW.

iii) Policy for development of hydropower in Uttaranchal through Projects of Capacity 25MW and above

iv) Policy for development of hydro-power in Uttaranchal through Projects of Capacity 100MW and above.

The government of Uttarakhand formulated these policies according to the capacity with proper scope and objectives for the development of hydropower in the state. Several initiatives and attractive arrangements for private sector investment and public participation are incorporated under these policies.

a) The micro/mini hydropower projects up to 2MW are reserved for Panchayat Raj Institutions, in which priority will be given for the Gram Panchayat (GP) where the proposed complete project site is located [12]. If the complete proposed project site falls within two or more gram panchayats, preference will be given to the GP within whose area the powerhouse is located [12].

b) As per the MoEF and CC, GoI, no prior environmental clearance is required for micro and mini hydropower projects as these projects will fall under eco-friendly projects.

c) In case of force majeure conditions like floods, fires, wars or revolutions, epidemics, quarantine restrictions and freight embargoes etc., the developer may surrender the allotment to the Government of Uttarakhand subject to the acceptance by the Nodal Agency [12].

d) Incentives, tax benefits, royalty benefits, guaranteed purchase of power by the State, assistance for approvals or clearances from forest/environmental agencies and other such benefits by the state government are provided for the development of private investments in the state.

Table:8 Incentives/Benefits for the Private Developers for the development of Hydro Power in Uttarakhand

Incentives/ Benefits	**Projects upto 2MW**	**2MW to 25 MW**	**25 MW to 100 MW**	**100 MW and above**
Taxes	No entry tax will be levied by the state government on Power generation transmission equipment and building material for projects	No entry tax will be levied by the state government on Power generation transmission equipment and building material for projects	No entry tax will be levied by the state government on Power generation transmission equipment and building material for projects	No entry tax will be levied by the state government on Power generation transmission equipment and building material for projects
Royalty Charges	No Royalty charges	No royalty charges for projects which are under 5MW. For the Projects above 5MW royalty charges are exempted for first the 15 years and from 16th year 15% of the net generated energy would be charged by the state government.	For the first 15 years 12% of the net generation and from the 16th year it is 18% of the net generated energy.	12% of the electricity generated shall be made available free of cost to the state during the entire life of project.1% per year on the 12% free power for each year of earlier completion. Delay will also entail a penalty of 1%
Wheeling of Power	Not allowed	Allowed by paying wheeling charges	Allowed by paying wheeling charges to UPCL	Allowed by paying wheeling charges to Central/State and also allows own evacuation
Water cess Charges	Exempted	Exempted	Not Exempted	Not Exempted
Banking	Banking is allowed	Banking is allowed	Not allowed	Not allowed
Open Access	Not allowed	Allowed	Allowed	Allowed
Sale of Power	Any consumer(Intra-State), Captive or Guarantee by UPCL	Any consumer(Intra-State), Captive or Guarantee by UPCL	Any consumer(Inter-State), Captive or Guarantee by UPCL	Any consumer (Inter-State). No Guarantee of power purchase from UPCL.

2.11 Recent and Anticipated Development in Hydro Power in India

One of the essential sources of energy in India is Hydropower which contributes around 45,480MW of installed capacity, i.e. 13 per cent of the country’s total installed capacity of 347 GW. Hydro is the third largest source of power after coal and renewables in India. However, the total hydropower potential of the country is about 145 GW. Only 30 per cent of the power has been exploited from its total potential. It has been estimated that only 5.4 GW of capacity has been added during the 12th five-year plan (2012-2017). Although the segment was opened for private participation since from 1991, so far only 7 per cent of the total hydro capacity has been commissioned by the private companies. There are various challenges associated with environmental, technical, financial, infrastructural and administrative issues that are significantly affecting the investment and project development of hydropower in India. Challenges including water-sharing issues among states, rehabilitation and resettlements (R&R) issues, geological surprises and limited availability of long-term financing, procuring clearances delays etc. The entire sector is looking forward to the new hydropower policy framed by the Ministry of Power which will take care of all these issues. The recent changes expected for development of hydropower in the country has been stated below

1. Classification of hydro as renewable power:

   On 7th March 2019, the cabinet approved the renewable status for large hydropower projects. Earlier, only the small hydropower projects up to 25 MW capacity were considered as renewable. By examining the hydro, irrespective of size as a renewable source of energy, the hydropower projects will secure long-tenor loans to make debt more suitable to its characteristics such as long construction period, greater risk at development period and significantly lower risk during the operational stage. This also includes the recommendation of soft loans for a longer period (20-25 years). Other important benefits include "must-run" status and interstate transmission charges exemptions.

2. Longer-tenor loans:

   One crucial challenge related to finance is the unavailability of long-term loans at low interest rates which made the hydropower so costly. This issue includes the problem of high capital costs and long gestation periods. Recently, bankers expressed their willingness to give standardised loans up to 20 years.

3. Use of latest technologies:

The segment has a barrier of availability of proper construction equipment and survey techniques due to which projects were not getting completed within scheduled time and cost. It is one of the reasons why hydropower projects have received a very bad reputation. However today, due to the availability of updated and latest best technologies, the projects are getting completed within the time frame and cost. One best example is NHPC’s Kishanganga project that used the latest construction technologies like tunnel boring machines for the construction of a 24 km long tunnel in snowbound area of Jammu and Kashmir.

a) **The Signing of PPAs:**

Signing the Power Purchase Agreements for hydropower is posing an enormous challenge to the segment. A series of regulatory changes have been suggested to overcome the challenge. For some costly hydropower projects like Kishanganga, the central government is providing a significant chunk of subordinate loans and providing support for signing PPAs with state governments.

b) **Increased depreciation period:**

In the upcoming new hydropower policy, it has been suggested to increase the project’s depreciation period from 35 years to 40 years which will bring down the power tariff.

c) **Peaking power policy:**

Introducing peaking power policy will facilitate the hydropower off take and will also help the DISCOMs to manage the peak demand in a better way by mandating higher peak tariffs combined with time-of-day metering. By introduction of time-of-day tariffs, signing of PPAs will also not be a constraint.

d) **Separate Hydropower Purchase Obligation:**

Another crucial proposal for the development of hydropower is mandating an independent hydropower purchase obligation (HPO). HPO under the currently mandated non-solar renewable purchase obligation would promote the off take of hydropower. This independent hydropower purchase obligation will significantly provide a safety net for hydropower developers as it would guarantee the electricity purchase and make the projects more viable and bankable.

e) **Hydro Power Development Fund (HPDF):**

Under the bailout plan which has been in work since 2017, the Central Government has created a HPDF of Rs. 160 billion packages to revive nearly 11,000 MW capacity projects that also includes 4 per cent interest subvention. This HPDF is sourced from Coal Cess and the National Clean Energy Fund. However, it is a known fact that all the cess is now subsumed under the new Goods and Service Tax regime and hence the Finance Ministry had asked the Ministry of Power to rework on the scheme to reduce the dependence on budgetary support.

f) **Updated basin-wise review of hydro potential:**

The CEA in association with WAPCOS limited carried out the reassessment study to review the hydro potential by considering the actual site constraints in terms of geology, submergence, etc. which also includes the environmental and forest impacts of the projects. This will be very useful for the development of these power projects in future.

g) **Financial Rehabilitation Plan:**

NITI Aayog in the draft of National Electricity Policy, which was released in 2017, mentioned about the financial rehabilitation plan where the state and central government will cooperate in reorienting the current hydropower strategy for course correction. This will be helpful in rehabilitation of ongoing/stranded and large hydropower projects so that the already invested fund can be put to good use.

h) **Increased project life:**

The usual project life of a hydropower project is considered as 35 years. However, there are hydel projects which have more than 50 years of life and are still running effectively. It has been suggested by NITI Aayog in the draft of the National Electricity Policy to have a longer project life of about 60 years instead of 35 years, which will enable in accessing long-term loans.

i) **Other needed developments in hydropower projects:**

The following are some of the developments required for the segment:

1. The government should control the unnecessary interference of NGOs and should ensure single-window clearances. Moreover, the additional burden of Catchment Area Treatment Plan, Wildlife Conservation Plan, etc. should not be loaded onto the hydropower projects which increases investment requirements and further reduces the participation of private players in the segment.

2. Regulators need to explore the need to extend the ancillary services markets which are currently limited to frequency support only. Spinning reserves, voltage regulation, black start, etc. can also be included in the ancillary services.

3. The land acquisition procedures should be made as simple as possible.

4. The development of trained and skilled manpower for the hydropower sector is critical.

5. A provision of benefits to the downstream affected people should also be taken into consideration.

Chapter 3

3.0 Literature Review on Barriers and Risks to the Development of Hydropower

Globally, the development of hydropower faces several barriers that consequently accentuate project risks. To manage these project risks, it is imperative that the root cause i.e. the barriers are accounted and addressed appropriately.

A barrier to the development of hydropower may be defined as a factor that negatively affects its adoption and subsequent utilization which hampers its widespread diffusion[43]. In Uttarakhand, private sector participation in the hydropower sector is noticeably absent[44][45]. Due to frequent damage of transmission lines, lack of availability of skilled labour in the remote areas, inaccessible locations are some of the factors that make an extremely unfavourable condition for the development of hydropower in the state[44][46][14][45][47][1].

Identified barriers for the development of Hydro power in India are as follows:

Longer gestation period and allocation of funds: Hydropower projects entails long gestation period, due to unavailability of geological, seismological and hydrological records, delays in land acquisitions, resettlement and rehabilitation issues, law and order problems and poor connectivity[48][49]. Whereas thermal projects have a short gestation period and get priority in fund allotments to get early benefits [27][50][47].

Land acquisition problems: Due to land acquisition problem many of the Hydropower projects faced prolonged project implementation and schedule delays[26][4], [5], [5], [7], [11], [14], [17], [25], [42], [49]–[58]. This problem can be minimized with co-operation of concerned state governments[59]. Thein Dam, Doyang, Ghatgar pumped storage plants are some of the projects affected in the past due to this problem[5]. Problems arise in acquiring private land[11].

Lack of Private Sector Interest: In the perspective of payback period, lack of availability of data, construction risks, regulatory and political issues, the private sector is not showing interest for investing in Hydropower projects[2], [16], [46], [47], [56].

Geological Surprises: As the hydropower projects being site-specific, they rely on geography, geology and hydrology at the site[1], [5], [5], [7], [17], [21], [22], [58], [60]–[62]. A geological survey should be done and analysed before starting any project[26], [56]. Even with a proper geological survey with technical advancements, a component of vulnerability stays in the sub-surface geography and the topographical amazements amid genuine development cannot be precluded[26], [56]. These, in turn, prolong the time and cost leading to constructional risks.

Hydrological Challenges: River discharge observations are made available to the developers on the pretext of confidentiality to the concerned government department only after the approval of the Ministry of Water Resources, GoI[17], [45]. Considerable time is lost in getting the approvals and the data[7].

Location Disadvantage: The hydropower projects are site specific[1], [5], [7], [17], [21], [22], [60], [62] Majority of Hydropower projects are constructed in remote locations and at high altitudes[42], [53], [62]–[64]. Proper connectivity to the site, transportation of machinery, lack of power evacuation infrastructure and adverse weather conditions, construction of these projects get delayed [65][50][7][44]

Lack of Political Commitment: India is endowed with economically viable hydro potential which has been assessed to be about 1,48,700MW at 60% load factor[5][54]. This potential cannot be exploited without a clear political vision with efficient scientific and technological support[47]. Political instability, government intervention in domestic markets, corruption and lack of civil society are major barriers[36], [47]

Lack of Public Awareness: Owing to negative perception in the public regarding the safety and environmental damage caused by hydropower projects, there is inadequate public involvement during the project planning stage[5], [7], [17], [64], [66], [67]. Also, no effort is taken to gain public acceptance through their involvement and transparency by the government agencies[5], [7], [17], [64], [66], [67].

Power Evacuation and Transmission Facilities: Hydropower projects are majorly built up in the hilly areas and remote locations where there is no transmission facility available. In such cases, developing proper transmission facilities for evacuation of power will take very long time which further delays the schedule of the project[5], [7], [11], [12], [17], [26], [44], [64], [68]. Also, there is a difficulty in getting power for auxiliary consumption at the time of construction.

Environmental and Forest Clearances: Due to several concerns on deforestation, submergence, monuments, seismicity, ecology, flora, fauna, wildlife protection and catchment area treatment getting environmental and forest clearances became a major issue in the development of hydropower projects[25], [26], [28], [42], [48], [54], [59], [67], [69]. Tehri is the best example of this issue as it took more than 36 years to start after conceptualization of the project, which has further delayed the realization of energy[5].

Public and Political Hesitations: Intermittent stoppage of projects due to local and political hesitations and frequent bandhs against the projects will cause delays in completing the project[17]. Sometimes the project may also have difficulty in even getting clearances due to the same reasons. [7][70].

Equity of State Governments: Many hydropower projects are constructed or developed as Joint Ventures between the private sector and State Governments[64]. In many cases due to negligence or not contributing in equity funding by the state governments, the private partner needs to contribute 100% of the project funds and the projects get delayed due to this lack of funds by states[64]. Equity contribution and commitment from all the partners is necessary for completing the project as per the schedule[64].

Resettlement and Rehabilitation Issues: As this is a public related and a sensitive issue, implementation of the resettlement and rehabilitation for the project affected people is difficult[5], [27], [50], [59]. It is one of the main reasons for the delay in the project execution, resulting in time and cost over-runs. Several projects like Tehri, Sardar Sarovar, Indira Sagar are affected due to R&R issues, where the opposition came from the environmentalists and the surrounding people[5], [58]. Hydroelectric power projects in India's mountainous north and northeast regions have been slowed down by rehabilitation controversies, coupled with political interventions and public interest litigations. [47][14][7][71][72][2], [5], [25], [27], [51], [52], [58].

Financial Constraints: High costs are involved. As many of these projects are located in remote locations and connectivity is an issue, costs incurred in developing the transport infrastructures (roads, protective measures for roads), bridges, housing infrastructure, royalties and custom duties are very high. [42], [53]

Lack of Local Infrastructure: Infrastructure here comprehensively allude to not just physical transmission facilities and distribution networks but also necessary equipment and services for the development of project[47]. Absence or very poor quality of access roads and bridges, delay in grid extension or absence of grid to match with commissioning of projects, poor communication facilities (mobile, internet etc.) at the project sites are the major infrastructural barriers affecting the development of HPPs[55].

Non-standard Designs and Manufacturing: Hydropower projects have complex designs[73]. Each new project typically has a unique and site-specific design as no standard designs are available; it requires long term for planning purpose[73]. This further engenders more design effort, more environmental review effort, and increased manufacturing effort, each of which increases schedule and cost[21], [74]. Lack of advances in design is also one of the major drawbacks in this regard.

Valuation of Forest land: Where forest land is required to be diverted for non forest use NPV is to be paid. The state governments also demand for the rights and privileges over the land. In some cases where tribal people live both NPV as well as Rights and Privileges become applicable[75]. The state governments also demand additional charges for carrying out forestry/wildlife activities and for bio-diversity management to be done at the project sites[75].This leads to increase in project cost and also takes much time in evaluating the land.

Law and Order Problems: Lack of support of the state government in ensuring proper law and order in the project area and lack of commitment in augmenting the local resources, are the main reasons hampering the project activities[4], [5], [5], [7], [17], [26], [51], [53], [58], [59], [64].

Regulatory and Policy Issues: Frequent changes in policy by the central and state governments, delay in getting environmental and forest clearances, delay in getting NOC from local village level institutions and government departments[55] are the major project barrier. Projects can be developed or operated only if there are proper regulatory mechanisms to address these barriers [50][48][2], [16], [46], [47], [56].

Dearth of Good Contractors: Experienced personnel must be adopted on to develop and initiate safe and reliable and maintenance protocols and procedures[42], [73], [74], [76]. A matter of concern in the execution of large projects is the dearth of competent and resourceful contractors, as it often results in time and cost overruns of hydro projects[5]. Non-availability of technically skilled manpower to operate advanced machinery/control panels makes projects difficult to manage [43], [55].

DPR Preparation: Data gathering from various agencies e.g. forest and wildlife clearances, environmental clearances, land and hydrology records etc, is time consuming. The data collected is often not accurate and has to be verified on ground before DPR finalization [7], [17], [42], [48]. Preparation of DPR is a lengthy and a time consuming process.

Power Purchase Agreements: In the present scenario, there is focus on renewable capacity addition (mainly Solar, Wind and Biomass) and it is becoming difficult to sell hydropower as its tariff is the major barrier[64]. There is hesitation concerning distribution utilities or DISCOM's to go into long term Power Purchase Agreements [64].

Tariff: Tariffs from hydropower projects are higher in the initial years as compared to other sources due to lack of incentives like tax concessions, financing cost and construction of projects in remote areas with inadequate infrastructure[64]. Due to the present tariff formulation norms for hydropower projects (based on a cost-plus approach) with no premium for peaking services and the provision for 12% free power to distressed states from the initial years are also proving to be obstacles. [77][26][27]

Small hydro segment: Development of small hydro often suffered due various reasons like inaccessibility of the sites, lack of power evacuation infrastructure, investigation and construction difficulties, land acquisition and financing difficulties, inadequacies in institutional support and in some cases law and order problems[5].

Inter-State Aspects: Under Indian Constitution, water is a state subject[7], [52][42], [48], [54]. A no objection certificate is required from each down-stream state for getting sanction even for Run-of-River projects and this is very time consuming[7]. Many of these hydropower projects have common river systems between the states and this end up with several inter-state issues[5]. Some of these projects have received techno-economic clearance (TEC) of CEA but the investment sanction could not be accorded due to inter-state aspects[3], [5], [54]. Several projects have also not been accorded CEA clearance on account of inter-state issues[5].

Market Trends: Hydropower may encounter everyday seasonal market challenges, deficient supply amid the dry season and oversupply amid the wet season[50]. During dry months, a relatively low percentage of generated power is sold at premium prices when demand is high[50]. During the wet season, prices are low and there is likely an oversupply of generated power unless it can be exported[50].

Security Concerns: Tremendous hydro potential of the nation is accessible in the zones influenced by revolt and militant issues[17]. The peace issue in such ranges prompt deferral in the execution of the projects and also cost over runs[17]. Also in several instances, Maoists targeted hydropower projects and damaged the machines and vital structures in the powerhouse. This also hinders in developing new hydro projects[78].

As a result of the abovementioned barriers, several risks get attached to hydropower projects. Some of the risks are a financial risk, construction risk, environmental risk, political risk, legal risk and regulatory risk [8]. For instance, a long gestation period of hydropower projects leads to financial risk whereas the remote location of the site exacerbates construction risk. Similarly, the inter-state flow of river may lead to political risk.

From the literature review, it is evident that hydropower development faces several barriers that creates project risks.

3.1 Literature Review

The literature review has been categorised on the basis of the theme of this study. They have been classified into 5 themes based which were considered relevant for this study. The literature was reviewed based on the following themes:

Theme: 1 Opportunities and Barriers to Hydropower development

Energy is essential to daily life in both the industrial and household sectors. Energy generation is one of the main factors that influence the economic growth and social development of all countries. More economic and social growth requires more energy generation. However, the occurrence of the environmental impact because of energy production from various sources must be considered. Fossil fuels, which comprise mainly coal, oil, and gas, are currently the most used source of energy, even though they cause environmental problems because of the release of greenhouse gases such as carbon dioxide into the atmosphere. Greenhouse gases contribute to global warming and climate change, which has become a very critical issue. Besides, fossil fuel combustion produces sulfur dioxide, which causes acid rain. In addition to environmental damage, the burning of fossil fuel cause human health risks as well. One of the high-risk emissions caused by fossil fuels is nitrogen oxide, which irritates the lungs. Soot and dust contribute to respiratory diseases and heart attacks. Because of this situation, clean and sustainable energy produced from renewable sources, including hydro, wind, biomass, solar, and geothermal sources, is the key to reducing the environmental impact.

Among all renewable sources, hydropower produces no air pollution and only a minimal amount of greenhouse gases in comparison to other large-scale energy options (Kanit & Somchai, 2015). Moreover, hydropower has a very high conversion efficiency of about 90% and a high-energy payback ratio (Kanit & Somchai, 2015). In addition, hydropower generation is carried out on both large and small scales due to its flexibility and reliability for integrating and developing energy systems. However, problems such as high capital costs and the resettlement of people occurred through large-scale hydropower projects. In the table below we review the list of the advantages and disadvantages of hydropower. Small hydropower systems are constructed on canals, dams, and run-of-river sites. In countries without integrated national electricity grids, small scale hydropower provides reliable access to electricity, resulting in a higher quality of life at the household level. In this way, the problem of un-electrified remote areas can be solved with the installation of small hydro systems. For these reasons, hydropower is essential to many countries. The state of Uttarakhand has many water resources in small and big areas that can be used to generate electricity. Therefore, a thematic study on advantages and disadvantages on the water resources, the current status of, the potential for, and policy on hydro energy in Uttarakhand is critical.

Advantages	**Disadvantages**
Economic	
– Provides low operating and maintenance costs – Provides long lifespan (50 to100 years or more) – Provides reliable service – Includes proven technology – Instigates and fosters regional development – Creates employment opportunities – Avoids fossil fuel use and cost	– High upfront investment – Requires long-term planning – Requires long-term agreements – Often requires foreign contractors and funding – Conflicting water uses can occur
Social	
– Leaves water available for other purposes – Often provides flood protection – May enhance navigation conditions – Often enhances recreation – Enhances the accessibility of the territory and its resources – Improves living conditions – Sustains livelihoods (freshwater, food supply)	– May involve resettlement – May restrict navigation – Local land-use patterns will be modified – Waterborne disease vectors may need to be checked – Requires management of competing for water uses
Environmental	
– Produces no pollutants but only very few GHG emission – Enhances air quality	– Inundation of terrestrial habitat – Modification of hydrological regimes – Modification of aquatic habitats

– Produces no waste – Avoids depleting non-renewable fuel resources – Often creates new freshwater ecosystems with increased productivity	– Water quality needs to be managed – Species activities and populations need to be monitored

Literature Reviewed for Theme 1

(Opportunities and Barriers to Hydropower Development)

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
1	Advantages and disadvantages of Hydropower	V. Rayan; 2005	Simple and effective advantages and disadvantages are mentioned.	The high cost of building dams and long-term profitability issue along with, flooding effect, geological problems reduce the viability of dams. The alteration of the natural way of river and sharing of water by two different states creates challenges.
2	Advantages of Hydro Power Production and Usage- The USGS Water Science School.	NA	Water power offers several advantages to the communitie s that they serve. Some of the benefits that hydropower has over others are provided.	
3	Technology Roadmap Hydropower-IEA	Internationa l Energy Agency; 2012	Current trends in Energy supply are unsustainable and creating GHG Emissions. For growing concerns in sustainable development and also to address several issues in sustainable development, IEA with a request of G8 prepared this report. Technological changes and advantages that can be implemented in hydropower in the upcoming future are explained.	This roadmap reflects the views of the IEA Secretariat and the Ministry of Mines and Energy of the Federative Republic of Brazil but does not necessarily reflect those of the individual member countries of the IEA or the OECD. The roadmap does not constitute advice on any specific issue or situation.
4	Barriers to renewable energy penetration; a	J.P. Painuly; 2001	A framework has been developed in this paper to	How renewable energy can play an essential role

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	framework for analysis		identify the barriers to renewable energy penetration. Suggest measures to overcome these barriers were also addressed.	in the sustainability for the developing countries which still don't have access to clean energy yet. There is no such framework is adequately determined and also the remedial measures are not addressed clearly.
5	Science for Environment Policy	European Comission; 2007	Despite the numerous benefits of Hydropower, it can also have serious negative consequences on the environment. Hydropower also affects the water temperature and silt built-up in downstream river stretches. The research also suggests that short-term peaks in water flow, which occur when hydropower plants are operating, also have a negative impact on fish and their habitat.	Hydropower is a barrier to fish migration. However, it is not clear how it is affecting them, what are the causes and what are the remedial measures. This is a basic idea and does not link with any proof of such with this paper.
6	New Pathways for Hydropower: Getting Hydropower Built—What Does It Take?	Norm Bishop, Deborah Linke; 2015	This report is part of the New Hydropower Innovation Collaborative (NHIC), a partnership between the Hydro Research Foundation	This report identifies 31 technological ideas. Several of the ideas address the need to nurture hydropower-

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			and Oak Ridge National Laboratory (ORNL), with support from the, Department of Energy Water Power Program, USA. The purpose of the collaborative is to identify technological innovations and innovative policy alternatives that will decrease the expense and time required to deploy new hydropower in the United States. These technological innovations are the subject of this report. Innovative policy alternatives are addressed in a separate policy alternative report. The report does identify technology advancements, but it also suggests prospective ways of mitigating the risks of small hydropower developments and reducing the timelines and costs of deployment.	specific innovation and education. Although the focus of this report is new small hydropower, many of the ideas presented herein apply to hydropower development in general. Several ideas were suggested with vision and the steps to be followed. However, there is no such information on How these suggestive steps were obtained.
7	Renewable Energy Development Hydropower in Norway	Gonzalez, David; Kilinc, Aygün; Weidmann, Nicole;2011	This report provides a thorough insight into the benefits of investing in hydropower. For this purpose,	This report is specific to Norway and this study is suitable for the countries generally having equal or

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			Norway presents itself as an attractive location for such an investment. In Norway, hydropower represents approximately 99% of the total electricity produced, and there is still room for further development. Norwegian expertise in hydropower construction and management of water resources stands out globally, offering an exceptional fundament for a sound investment. The economic background, institutional as well as legal framework of Norway are also mentioned in this report.	high potential of resources than Norway. The investment background, economic status, legal, political, institutional and regulatory framework may differ for several countries.
8	Regional Hydro-power Resources: Status of Development and Barriers	Nexant SARI / Energy; 2003	Comprehensive reference document, compiling the profile of resources, opportunities, barriers, investment background, and the present status of hydropower installed and the future plans of installation. Policies currently followed for hydropower development and problems, issues as perceived in the partner countries	Limited Hydropower potential. Dependent on neighbouring countries for meeting the energy demand. The lack of public information on projects, cost estimating and cost forecasting, capital cost saving projects, implementation of fish screen bypass, training in new technology and standard

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				electrical control is becoming a hindrance in the implementation of hydropower. Economic framework implementation, investment risk, demand forecasting, new and improved technology, tariff implementation, system loss reduction, load dispatching criteria ~~is~~ are the fields which need to be worked upon.
9	The Legal-Political Barriers to Ramping up to Hydro	Dan Tarlock; 2010	Missouri River dams constructed since the 1930s have decreased downstream sediment transport which has led to the detriment of endangered species along the Missouri and contributed to the loss of wetlands in the Mississippi Delta.	The primary concern in the implementation of hydro projects is legal and political barriers. These barriers become a significant hurdle to overcome. The concept of a small mill to dam transformation and finally big dam transition is a major challenge. Moreover, investment uncertainty due to lack of detailed report and investors' concern on political issues makes it a

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				challenge. Lack of in-depth study hinders smooth investment, increases performance cost and operations cost.
10	Prospects and Challenges of Small Hydropower Development in Jordan	J.O. Jaber;2012	Overview of the setbacks that inhibit smooth investment, operation of small hydropower plants in Jordan. It is estimated that installing small hydropower schemes on the most promising existing dams will generate more than 200 GWh/year of electric energy without affecting the natural environment.	The barriers which are hindering the development of the hydropower in Jordan are not addressed. Recommendations or remedial measures for the development of small hydropower plants ~~is~~ are not properly addressed.
11	Hydro Power Technology Brief	(IEA-ETSAP and IRENA); 2015	Summary of Key Data and Figures for Hydropower Technology followed worldwide along with costs in USD	Global potential has been identified, whereas the potential has not been mentioned country wise. Also, there is no information on the installed capacity of Hydropower aggregating to all the nations, where even the barriers are not addressed clearly.
12	Review of barriers to the dissemination of	Mohammed Yaqoot, Parag	Barriers impeding the distribution of decentralized	Lack of adequate institutional support to

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	decentralized renewable energy systems	Diwan, Tara C. Kandpal, 2016	renewable energy systems has been identified and assessed. Besides, appropriate remedial measures and corresponding responsibility centres are discussed.	R&D activities and commercialization of PV technology. Hence, for other DERS similar institutional support is needed to improve their dissemination.
13	Congestion management considering hydrothermal combined operation in a pool based electricity market	Kanwar-deep Singh, N.P. Padhy, J. Sharma, 2011	Proposed a novel congestion management strategy for a pool based electricity market considering the combined operation of hydro and thermal generator companies. The proposed congestion management problem is formulated as a mixed binary nonlinear programming problem to minimize the cost of re-dispatching the hydro and thermal generator companies to alleviate congestion subject to operational, line overloading and water availability constraints. ***Note** – sentence needs rephrasing.*	Congestion management technology to harness open access issues is needed to be developed along with maintaining a balance between freshwater and energy paradox.
14	Rescheduling of real power for congestion management with	Sadhan Gope, Arup Kumar Goswami,	Proposing congestion method a time-varying active power demand is assumed and this is	Fault management and line overloading techniques are needed to be solved.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	integration of pumped storage hydro unit using firefly algorithm	Prashant Kumar Tiwari, Subhasish Deb, 2016	done by introducing a scaling factor at each interval multiplying the demand at the base case. Overall generation rescheduling is lower in FA based solution as compared to the results obtained by PSO and ABC based solution.	
15	Were the hydro dams financed by the World Bank from 1976 to 2005 worthwhile?	Omotola Awojobi, Glenn P.Jenkins, 2015	An estimate is made of the value of the benefits produced by the investments to determine the magnitude of economic rates of return for the individual projects and the overall portfolio of dams.	The High degree of variability and uncertainty of costs in dam construction are not considered for improved decision making
16	Halting hydro: A review of the socio-technical barriers to hydroelectric power plants in Nepal	Benjamin K. Sovacool, Saroj Dhakal, Olivia Gippner, Malavika Jain Bambawale, 2011	Deploying the hardware is only one small piece of the overall hydropower puzzle. Spreading social awareness, promoting community ownership, moulding effective regulations, minimizing corruption, addressing poverty, improving institutional capacity these are the enduring challenges, and until they are targeted with the same rigour that engineers	Technology is only one part of the problem, only one eye. Often planners in Nepal look only through this eye so much that they get a distorted picture of how to effectively promote hydroelectricity by considering anything other than the dam itself.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			seek to design a dam, the hydropower potential of Nepal will remain just that.	
17	Barriers to renewable energy penetration; a framework for analysis	J.P. Painuly, 2000	RETs are cost-competitive with conventional energy sources in several applications, but despite this, it has not been possible to tap their full potential. The stakeholders include the RET industry (manufacturers of plant, equipment and appliances, owners of the plant), consumers, NGOs, experts, policy makers (government), and professional associations. The response from stakeholders can be obtained through structured interviews or questionnaires.	Major barriers like market barriers, economic and financial barriers, institutional barriers, and technical barriers have several elements (causes for the presence of those barriers). So, the dimension (direction and depth) of these elements may vary across RETs and countries/regions. As a result, measures to overcome the barriers may also be unique to a country/region. So, Stakeholder must identify the barrier elements and their dimensions to RET under investigation.
18	ASEAN towards clean and sustainable energy: Potentials, utilization and	N.W.A. Lidula, N. Mithulananthan , W.	Reports the outcome of the project on ‘‘Capacity building in formulating harmonized	ASEAN is not yet ready for full harmonization of the policies.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	barriers	Ongsakul, C. Widjaya, R. Henson, 2006	policy instruments for the promotion of Renewable Energy and Energy Efficiency in the ASEAN member countries''. With the growing concerns about greenhouse gas (GHG) emission and consequent climate change, renewable energy sources have become a more attractive option for electricity generation around the world.	
19	The costs of small-scale hydro power production: Impact on the development of existing potential	G.A. Aggidis, E. Luchinskaya, R. Rothschild, D.C. Howard, 2010	A significant barrier to starting small scale hydropower projects is an understanding of how much the scheme will cost. The approach differentiates between different turbine designs and presents formulae for all major small scale devices.	The developed formulae should be used with caution as they provide a first-order estimate only. In order to make balanced decisions, more detailed analysis should be carried out.
20	Barriers to renewable/ sustainable energy technologies adoption: Indian perspective	Sunil Luthra, Sanjay Kumar, Dixit Garg, Abid Haleem, Sunil Luthra,	28 barriers have been identified from an extensive literature review. These identified barriers have been categorized into seven dimensions of barriers, i.e.	All pair comparisons in AHP have been made based on expert opinions. As is natural, opinions of experts may be biased. Different multi-criteria

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
		2014	Economical & Financial; Market; Awareness & Information; Technical; Ecological and Geographical; Cultural & Behavioural; and Political & Government issues. This paper lays a foundation focusing their future efforts in adoption of 'renewable/sustainable energy technologies' in India. This may also be helpful in framing the policies and strategies towards adoption of renewable/sustainable energy technologies	decision-making models may be applied for the same problem and results can be compared in further studies. A real world case study may be carried out to validate this research work.
21	Renewable Energy and Green Growth in India	The energy and resource institute, 2015	The key barriers in development are: High cost of financing, lack of enforcement of RPOs, off taker risk, intermittency, permits and land acquisition, financing for off-grid power. The National roadmap is specific, measurable, achievable, and realistic and time-bound.	India should achieve 175 GW of renewable by 2022. The gap in the current scenario is R&R and land acquisition. R&R policy is set but not followed to the core.
22	Maoists attack Ballymena Power Station; damage	Odessa Now, 2009	The security at the hydropower plants needs to be increased to curb the threat of	The activists who have anti-government mindset can ruin the projects;

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	Valve House and Intake Tunnel		Maoists and local activists who are promoting anti-government movements. Damaging the intake valve causes the total shutdown of power generations. The decision of increasing security over various hide projects over the states was taken on the aftermath of the situation.	hence proper security measures has to be taken on the hydel projects to ensure proper generation.
23	IMPACT OF BHAGIRATHI ECO-SENSITIVE ZONE (BESZ) ON POWER SECTOR	B.C.K. Mishra, Manoj Kr. Kesharwani	Allotment of projects was before the declaration of BSEZ, implication on the environment is small for small hydro, wind and solar projects. Since it is a white collar project, the inflow of money along with the increase in sustainability of these projects needs to be approved. There is low or negligible impact on the bio-diversity.	Owing to the implementation of standards and measures, other state policies do not match the current scenario. Ecological effect in the sustainable factor.
24	Hydropower Project Development in India: Issues and Way Forward	MM Madan, 2016	Mega Power benefits should be reintroduced. Since taxes constitute 15-25 per cent of the project cost, Entry Tax, Excise Duty, Work Charge Tax, CST, etc. should be waived off in respect of project equipment (construction, E&M, HM), steel, cement, etc. as they are major contributors to the project cost of Hydro Projects.	Financial benefit has been provided, and the absence of better financial model has become one of the primary factors that is becoming a hindrance in the development of the hydropower projects.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			Also, the deemed export benefits as per Exim Policy would be extended to developers of Mega Power Projects.	
25	All India Installed Capacity of Power Stations	Government of India, 2017	Since hydropower has come in India, the development and growth in this sector has taken place and hence the total installed capacity of hydropower in India has reached 44765.42 MW.	Though there has been development and growth in the hydropower project, the percentage of net installed capacity of a hydropower plant in total installed capacity has decreased because of the continuous increase in the number of thermal power plants.
26	Advantages and Disadvantages of Hydropower	U.S. Department of Energy Efficiency and Renewable Energy, 2006	Hydropower offers advantages over other energy sources but faces unique environmental challenges. Hydropower is a fuelled by water, so it is a clean fuel source. Hydropower does not pollute the air like power plants that burn fossil fuels, such as coal or natural gas. The fish population can be impacted if they are unable to migrate upstream, past the impoundment dams to their spawning grounds or if they cannot migrate downstream to the ocean. Upstream fish passage can be aided using fish ladders or elevators, or by trapping and hauling the fish upstream by truck.	A lot of development has to be done to remove the disadvantages so that it could become a perfect source of energy in the future for India.

Theme: 2 Global and Economic overview

Energy is the backbone of our economies and an essential element for both economic growth and poverty reduction. Therefore, ensuring energy security has been the most critical goal for achieving sustainable development. According to the Asia Pacific Energy Research Centre (APERC, 2007) energy security is defined as "the ability of an economy to guarantee the availability of the supply of energy resources in a sustainable and timely manner with the energy price is at a level that will not adversely affect the economic performance of the economy". Based on this definition, there are several factors affecting the securities of energy supply, namely, the (physical) availability and the (geopolitical) accessibility of energy sources, the affordability of energy as well as the (environmental) acceptability.

Availability refers to the physical availability of oil (and other fossil fuels) and nuclear energy, mainly determined by primary energy endowments and exploration capacity. Affordability implies energy sources are secured at affordable and competitive prices, including both those of domestic energy and imported energy. Acceptability surrounds environmental issues dealing with the impact of energy production and utilization on the economy. Accessibility of energy security reflects the possibilities of energy supply in the transport channel and geopolitical aspects. Furthermore, a recent study by Fang et al. (2018) also considers develop-ability of energy security as the most critical performance indicator of energy sustainability. Accordingly, develop-ability reflects "the sustainable development capacity of the energy system in low carbon, clean, optimized mode" (Fang et al., 2018). Fluctuations in world energy markets and prices lead to macroeconomic and fiscal instability not only for economies that are highly dependent on energy imports but also for significant energy exporting countries. Political risks related to energy insecurity are particularly relevant to energy exporting countries that intend to employ energy deliveries as a political weapon (Kocaslan, 2014). Furthermore, rising energy consumption is often regarded as the cause of environmental problems such as local air and water pollution and climate change, which adversely and disproportionately affects human health and livelihoods. The situation is even worse in developing countries where misdirected energy subsidies and rents, poor governance, and corruption magnified these risks (Feinstein, 2002).

Developing countries also have good reason to concern themselves with energy security. First, they cannot adapt and apply imported energy technologies to local needs, leading to continuing dependence on foreign technical expertise. Second, these countries also lack open and transparent markets as well as good governance for effective development and management of sophisticated energy technologies. Third, in cases of disruption by natural or fabricated events, the energy infrastructure in developing countries is more vulnerable. Floods and droughts can threaten the viability of hydroelectric facilities. Furthermore, power stations, refineries, pipelines, and transmission lines could be early targets in cases of domestic insurrection, civil war, and international conflict (Feinstein, 2002). Energy for economic development, energy security, and climate change mitigation had been pursued as separate themes, each attracting its own constituencies. However, several studies have illustrated the linkages among these three agendas, implying each can be strengthened through reference to the others (see Feinstein (2002); Lu et al. (2006); Cherp et al. (2016); Prado Jr et al. (2016)). Energy security could be achieved through fuel diversification, which in turn forms the starting point for mitigating greenhouse gas (GHG) emissions and confronting climate change. In cases of lack of conventional energy services such as in the remote areas in the developing world, renewable energy could be the most feasible early market opportunities, which is also a key class of technologies for climate change mitigation (Feinstein, 2002).

There has been a vast literature on the nexus between energy consumption and economic growth, most of which examine the relationship between the two variables in a multivariate framework with the inclusion of pollutant emissions, trade openness, financial development and urbanization. For instance, recent studies include Karanfil and Li(2015) for a global sample; Kivyiro and Arminen (2014), Le (2016) for sub-Saharan African countries; Tang and Abosedra (2014) for Middle East and North Africa (MENA) countries; Śmiech and Papież (2014) for European Union (EU) countries; Gozgor et al. (2018) for OECD countries; Cowan et al. (2014) for BRICS countries; Tang et al. (2016) for Vietnam; Iyke (2015) for Nigeria; Wesseh and Lin (2018) for Egypt.

The empirical findings on the energy-growth nexus have critical implications for policymakers. If energy is found to positively influence growth ("growth hypothesis") or there is positive feedback between growth and energy ("feedback hypothesis"), conservative energy policy may adversely affect economic output while a comprehensive energy policy could lead to growth and economic development (Le, 2016). On the other hand, if no relationship is found between energy consumption and output (“neutrality hypothesis”) or only economic growth impacts energy consumption but not vice versa (“conservation hypothesis”), restrictions on energy use would be a feasible option (Le, 2016). If the “growth hypothesis” and “feedback hypothesis” hold, countries may also look for renewable energy sources in lieu of primary energy sources to support economic development. This gives rise to a recent strand of literature on the relationship between renewable energy and economic growth (for instance, Bhattacharya et al. (2016) for 38 major renewable energy consuming countries; Inglesi-Lotz (2016)for OECD countries; Koçak and Şarkgüneşi (2017) for Black Sea and Balkan countries; Sebri and Ben-Salha (2014) for BRICS countries; Zebet al. (2014) for South Asian Association for Regional Cooperation (SAARC) countries). Most of these studies found a positive impact of renewable energy consumption on economic growth. Another strand of related literature focuses on measuring energy security index in national, regional and international contexts (APERC, 2007; Yao and Chang, 2014; Tongsopit et al., 2016; Fang et al., 2018). Since its origination from oil supply instability in Europe during the Suez Crisis in 1956 (kazutomo, 2017), the concept of energy security has been widely used in academic and policy debates, but no consensus has been reached on its precise definition. Being originally perceived as a stable supply of energy against geopolitical risks (mainly oil supply stability), this classical concept of energy security has been expanded and changed to including new threats and energy sources to be protected (kazutomo, 2017). More recently, energy security is perceived as “reliable and adequate supply of energy” that “fully meets the needs of the global economy” and being “at reasonable prices” (Bielecki, 2002). Overall, the definition of energy security varies according to the context including, for instance, the subject of energy security, the threat to energy security, and the measures to promote energy security (Bielecki,2002; Yamaguchi et al., 2013). International Energy Agency (nd) defines energy security as “an interrupted availability of energy sources at an affordable price” ((IEA), 2018). Different aspects of energy security are proposed using short term and long-term approaches. In the short-term approach, energy security is considered as the system's ability to meet the specific country's energy needs, focusing on the security of supply (see, for instance, Sovacool et al. (2011); Kanellakis et al. (2013)). Meanwhile, in the long-term approach, energy security features the need to further consider the environmental and social perspectives (Simpson, 2007). The methodologies on measuring energy security proposed in the current thematic study review have been mostly concentrated on energy supply stability, while seemingly overlooked environmental and/or social aspects (see Yamaguchi et al. (2013)).

Despite the crucial role of energy security, its linkage with economic growth has not been examined much in the literature, particularly by quantitative approaches. This is partly because most of the studies on energy security indexes are qualitative ones. To the best of our knowledge, the quantitative studies conducted on the energy security-economic growth relationship only include Gasparatos and Gadda (2009), Balitskiy et al. (2014), Mahmood and Ayaz (2018). Gasparatos and Gadda (2009) investigate the energy security in Japan and its effects on the economic output of the nation and the environment. The concept of energy synthesis is employed to quantify resource appropriation and trends in production and consumption. The study finds that the energy required to produce 1 USD of economic output had been gradually declining. Balitskiy et al. (2014) evaluate the relationship between energy security and economic growth for 26 EU countries during the1997–2011 period. Energy security is proxied by natural gas consumption due to its environmentally friendly benefits. Furthermore, natural gas is a crucial source of energy in most European countries. The study found a long-run relationship between economic growth, natural gas consumption, labour and capital. In the short run, feedback causality exists between economic growth and natural gas consumption. While there are only a handful of studies quantitatively examining the relationship between energy security and economic growth, much research has been conducted on the nexus between economic growth and individual measures of energy security adopted in this study, but not in the view of energy security. Yao and Chang (2014) and Tongsopit et al. (2016) established a comprehensive and quantifiable energy security concept by using several indicators that capture four dimensions: the availability of energy resources, the applicability of technology, the acceptability by society, and the affordability of energy resources. More indicators are considered in these two studies as compared to our study. However, Yao and Chang (2014) only studied the energy security index for China (during disaggregated periods) and Tongsopit et al.(2016) examined the energy security status of ASEAN countries between 2005and 2010. Meanwhile, in this study, we cover a global sample of 74 countries during the period from 2002 to 2013. As such, our selection of indicators for energy security consideration is subject to the data available for our global sample.

Literature Reviewed for Theme: 2

(Global and Economical Overview)

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
1	International Energy Outlook 2016	IEA; 2016	Reference case, world net electricity generation increases 69% by 2040, from 21.6 trillion kilowatt hours (kWh) in 2012 to 25.8 trillion kWh in 2020 and 36.5 trillion kWh in 2040. Electricity is the world's fastest-growing form of end-use energy consumption, as it has been for many decades.	Hydro accounts for 1.9 trillion kWh energy generation around the world. Hydropower is one of the biggest sources of energy around the world, but the global market is going in a slump and amount of investment in hydropower is reducing. The growth in the power sector is not in parity with the growth in GDP. Due to the fundamental role of electricity in the growth of country slag in hydropower directly reduces the growth rate and economy of the country.
2	Faster Sustainable and More Inclusive growth. An approach to 12th 5-Year plan	Government of India; Planning Commission; 2011	Overview of the target set for 12th five-year plan which was characterised by the strong fundamentals, macro variables and in considering the good	The target of 9% GDP growth rate is ambitious and is not impossible; the GDP in the first four years of 11th five-year plan was 8.2 per cent.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			performance over 11th five-year plan. Rapid GDP growth targeted at 9 per cent per annum for generating income and employment opportunities. Also discussed regarding several flagship programmes and also regarding the progress in reducing poverty. Energy challenges, infrastructure development, natural resource management and sustainable development were the major targets of this plan.	Many flagship programs including the poverty reduction, Energy challenges, Infrastructure development viz., were addressed and should be implemented in a planned way to reach the target.
3	Causality between Energy Consumption and GDP: Evidence from 30 OECD and 78 Non-OECD Countries	Jaruwan Chontanawat, Lester C. Hunt, and Richard Pierse; 2006	Important role of Energy in the economic development carried out tests between Energy and GDP for 30OECD and 70 non-OECD countries.	This probably highlights that consumers in the poorest of nations still rely on primitive energy source such as biomass, wood, etc. so that conventional more advanced sources, such as electricity, are very minimal as the GDP grows from a very low base. This is probably related to the problem of

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				lesser developed countries not having access to advanced technologies which generally requires more energy. Hence the low technologies, used by the poorest countries restrict GDP and growth, therefore the finding that energy, in general, does not 'cause' GDP instead energy consumption may be an outcome of GDP.
4	What are the links between power, economic growth and job creation?	Overseas Development Institute; 2016	Energy plays a fundamental part in the economic growth process. Insufficient, unreliable or costly access to power can be a binding constraint to business. Electricity is a binding constraint for all sizes of business.	There is no one dominant prevailing theory. Similar conclusions can be drawn for the energy and employment relationship. There is a causal link between energy consumption and employment; however, there is no prevailing evidence of the direction of causality between the two. Relationships between energy and economic growth can vary between countries, within countries, and within time periods.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
5	Energy 12th Five year Plan Planning Commission	Planning Commission India;2014	Energy intensity in the USA, UK, Germany, Japan, Brazil, USA, China, South Korea, and India is analysed. Energy projections till 2022, Energy elasticity with respect to GDP in India	The guidelines of developing hydropower should be taken from USA, UK, Germany, Norway and the lack of energy elasticity is creating havoc. Lack of optimal investment in the energy sector is a major challenge. The energy elasticity trend from 1970 to 2012 gives a rough estimation of how the energy scenario is declining.
6	Power and Energy Planning commission, Government of India	Government of India;2014	Energy markets should be co mpetitive wherever possible for economic efficiency and for promoting optimal investment in energy.	The guidelines of developing hydropower should be taken from the USA, UK, Germany, Norway and the lack of energy elasticity is creating havoc. Lack of optimal investment in the energy sector is a major challenge.
7	Elasticity of Energy consumption in India	Shim S.L, Dr. Reji B; 2013	Historical pattern of energy consumption, energy production and GDP growth since 1970-71 and also	The energy elasticity trend from 1970 to 2012 gives a rough estimation of how the energy

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			calculates the energy elasticity of India for 1970 to 2012	scenario is declining.
8	Energy Statistics 2015;2016	Central Statistics Office; National Statistical Organisation; Ministry Of Statistics And Programme Implementa-tion Government Of India	The highest CAGR (9.46 per cent) was in the case of Thermal utilities followed by Nuclear (3.99 per cent) and Hydro (2.55 per cent). At the end of March 2014, thermal power plants accounted for an overwhelming 70.25 per cent of the total installed capacity in the country, with an installed capacity of 199,947 MW. The share of nuclear energy was only 1.68 per cent (4.78 GW). Hydro power plants come next with an installed capacity of 40,531 MW, accounting for 14.24 per cent of the total installed Capacity. Non-utilities accounted for 13.83 per cent (39,375MW) of the total installed generation capacity.	Increase in share of thermal power plants in the generation led to degradation in shares of hydro plant, the non-utilities accounted for 13.83 per cent of the total installed generation capacity. The present scenario of India is installed capacity of 40531 MW. Whereas, the share of coal-based thermal power plants is approximately 207 GW.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
9	Power sector in India by IBEF(India Brand Equity Foundation)	IBEF (Indian Brand Equity Foundation); 2016	The present share of the Indian power sector, initiatives by the Government for developing the sector, favourable policies, growth in renewable and what are the advantages in investing in the power sector are explained.	The power sector in India has seen a trajectory growth during the past decade but also faced several issues due to AT&C losses, revenue realization and several techno-commercial issues which are not addressed here.
10	Relationship between Electricity Energy Consumption and GDP: Evidence from India	Asit Mohanty & Devtosh Chaturvedi; 2015	The paper examines whether the electric energy consumption drives economic growth or vice versa in the Indian context using the annual data covering the period from 1970–1971 to 2011–2012. Applying the two-step Engle-Granger technique and Granger causality/ Block erogeneity Wald test, the study suggests that it is the electrical energy consumption that fuels economic growth both in the short run and long run.	The main factor that governs the economic growth of the country is its electricity consumption. The growth in the short run and the long run is governed by the electric consumption of the country stated by Wald test and Engle Granger casualty. The growth rates and compound annual growth rates show the percentage distribution of the publication.
11	World Economy Outlook-Update	International Energy Outlook; 2016	Overview of Global growth, currently estimated at 3.1	The global market scenario is estimated to

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			per cent in 2015, is projected at 3.4 per cent in 2016 and 3.6 per cent in 2017. The list of countries includes 90% of Global GDP contribution.	grow by 3.1 per cent in 2015, is projected at 3.4 per cent in 2016 and 3.6 per cent in 2017, this marks a slowdown in the global market for developing countries. This slowdown is sharper-than-expected and has a sudden rise in global risk aversion ideology. An escalation of ongoing geopolitical tensions has led to trade slowdown in Asian countries. The export growth slowdown sums a mix of cyclical and structural factors. The large hydropower debts are becoming a barrier in implementation. The countries are inviting financial aid to stabilize excess amount of debt. In spite of the global economy slowdown Indian economy is growing but still, there is

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				less investment in the hydro sector. Implementation of GDP in India has further slowed down investment in the hydro structure. The taxation in the sector has increased many folds due to implementation of GDP.
12	Asian Development outlook 2016 update meeting the low-carbon growth challenge- ADB	Asian Development Bank;2016	Steady progress in reform helps India realize its growth targets. Despite growth moderation in the first quarter of FY2016 (ending 31 March 2017), the ADO 2016 forecast for growth at 7.4 per cent in 2016. Recovery in private investment, as corporations successfully deleverage and bank reform boosts lending, will help drive growth to 7.8 per cent in 2017.	Developing Asia is cautiously navigating steady growth despite a delayed recovery in the advanced economies. The region is poised to achieve 5.7 per cent growth in 2016 and 2017, as forecast in Asian Development Outlook 2016 (ADO 2016) in March, only slightly lower than the 5.9 per cent growth recorded in 2015. Whereas many initiatives were taken for reducing the carbon emissions by installing green energy. However,

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				due to the barriers or challenges the achievement is getting difficult.
13	India GDP growth rate	Trading Economics;2016	India is the world's 10^{th} largest economy and the second most populous country. The most important and the fastest growing sector of the Indian economy are services. Trade, hotels, transport, communication, financing, insurance, real estate, business services and community. Social and personal services account for more than 60 per cent of the GDP.	The GDP growth rate in India for the time period (1996-2016) was projected and also given the contribution of various sectors in achieving the GDP.
14	Indian economy growth overview	Indian Brand Equity Foundation; 2016	According to the IMF World Economic Outlook Update (January 2016), Indian economy is expected to grow at 77.75 per cent during FY 2016-17, despite the uncertainties in the global market. The Economic Survey 2015-	The report has given the forecast of Indian economic growth based on several perceptions and also forecasted the growth of GDP until 2019. The report was based on the survey of economists and finance experts.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			16 had forecasted that the Indian economy will grow by more than 7 per cent for the third successive year 2016-17 and can start growing at 8 per cent or more in the next two years. According to Fitch Ratings Agency, India's Gross Domestic Product (GDP) will be likely to grow by 7.7 per cent in FY 2016-17 and slowly accelerate to 8 per cent by FY 2018-19. According to Mr Jayant Sinha, Minister of State for Finance, Indian economy would continue to grow at 7 to 9 per cent and would double in size to USD 4–5 trillion in a decade, becoming the third largest economy in absolute terms. Furthermore, initiatives like Make in India and Digital India will play a vital role in driving the Indian economy.	

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
15	Impact of GST on GDP	India Briefing; 2014	According to NCAER (National Council of Applied Economic Research) implementation of GST would raise GDP growth by 0.9 to 1.7 per cent	GDP growth is linked with the implementation of GST in India. Whereas several implications in implementing the GST were not addressed. Several developed countries have already implemented GST; hence by learning lessons from those countries, we can implement it in the right way.
16	Fact Sheet On Foreign Direct Investment	FDI;2015	This is a fact sheet giving an in-depth detail of FDI's during the period April 2000 to March 2105. It is evident that 28 per cent growth (FY 2014-15) in FDI inflows in India when compared to (FY 2013-14), i.e. India is increasing its FDIs by implementing several technologies.	FDI sectoral data has been revalidated in line with the RBI, which reflects minor changes in the FDI figures Complete/separate data on NRI investment is not maintained by RBI. However, the above FDI inflows data on NRI investment which includes investment by NRIs, who have disclosed their status as NRIs, at the time of making their investment.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
17	An Overview of Glaciers, Glacier Retreat, and Subsequent Impacts in Nepal, India and China	WWF Nepal Program; 2005	This report gives the Overview of Glaciers, Retreating Glaciers, and Their Impact in the Tibetan Plateau. Climate change is impacting the rate of glacier melt.	Nepal is a country covered by mountains and is landlocked in nature. It depends solely on hydroelectricity but the changes and differences caused by hydro projects in Nepal's hydrology and climate are adversely affecting Nepal causing high floods and change of flow for rivers.
18	Hydroelectric Power A Guide for Developers and Investors.	International Finance Corporation; 2012	Aspects of hydropower project development, emphasizing the importance of interactions among technical, commercial, permitting/licensing, environmental and social, and financing activities.	The major barrier faced in developing hydropower in countries like India is an adverse effect of dams in the ecology and change in rivers attributes.
19	Hydro Power Vs Thermal Power: A Comparative Cost-Benefit Analysis	Adesh Sharma, 2010	This study seeks to trace the importance of Hydroelectric Power (HEP) vis-à-vis coal based Thermal power (TP), and establish a case for HEP plant by way of a comparative cost-benefit analysis which proves that HEP is, in fact, cheaper than	Since India is not able to maintain a proper balance between the economic and financial development, we are not able to utilize the economic benefits from hydropower plants, as the cost of procurement is

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			TP for a mega power plant (1000 MW) even if other factors like social and environmental benefits are not considered.	higher than the cost of electricity.
20	THE HYDROPOWER	D. Oprea, 2012	Hydropower is an extremely flexible technology for power generation. Hydro reservoirs provide built-in energy storage, and the fast response time of hydropower enables it to be used to optimise electricity production across grids, meeting sudden fluctuations in demands.	Hydropower plants can be used to instantly generate electricity when required during peak demand, which can balance the grid. However, due to a high power demand and lower installed capacity of hydropower plants, India is not able to economically use the hydropower plants to serve the peak time demand.
21	SOURCES OF INDIA'S ACCELERATED GROWTH AND THE VISION OF INDIAN ECONOMY IN 2020*	Bakul H. Dholakia, 2001	The process of economic liberalisation initiated in mid '80s- has completely transformed the pace and composition of growth in the non-agricultural private sector. Not only has the growth rate of the private sector doubled during the	India's economy has been growing in a rapid rate and so has the demand As a result, India installed a generation capacity over the potential required and hence, major thermal and hydropower plants are working at a lower PLF.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			post-1985 period, but almost 40 per cent of this growth has resulted from the growth of TFP.	
22	Changing rules of Indian power sector: Empowering the economy	PwC, 2015	The Indian power system is the fifth largest in the world and among the most complex. While almost 61 per cent of the power generated is from coal, India is looking to alter the generation mix in the years to come, by focusing on a low-carbon growth strategy, although coal production continues to be on the agenda of policymakers.	India wants an energy mix scenario where major portions will be from renewable sources. With the focus over solar and other renewable energy resources, India has great potential in the reliable hydro energy source.
23	Power Scenario Of Uttarakhand	Electrical India, 2017	Uttarakhand has grown at a faster rate in order to eliminate the differences between itself and other existing states. An efficient and financially sound power sector is a prime factor for growth as well as poverty reduction.	The article discusses about the brief power scenario of Uttarakhand and mentions about factors causing a setback for power in the state. Despite the techno-economic discussed in the article, the socio-economic barriers have been neglected in this paper.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
24	FIVE THINGS YOU NEED TO KNOW ABOUT HYDROPOWER: CANADA'S NUMBER ONE ELECTRICITY SOURCE	https://canadahydro.ca/facts/, 2017	Hydropower being a constant clean and a renewable source it's leading an edge from 130 year benefiting local and aboriginal communities.	Benefiting the world is one face of the coin but the other face is that there are some barriers which need to be discussed in the paper.
25	Future of India The Winning Leap	PWC	Future of India - the Winning Leap is driven by the belief that India can build shared prosperity for its 1.25 billion citizens by transforming the way the economy creates value. Corporate India has a critical role to play in this story, not only by creating value by addressing key societal needs but in supporting a vibrant entrepreneurial sector. Additionally, it needs to partner with the government in order to implement new developmental approaches.	It does not show how the private sector would establish corporations and entrepreneurial companies will play a crucial role in orchestrating winning leap and that the government can serve as a powerful enabler.
26	Hydropower: A key to prosperity in growing world	INTERNATIONAL ENERGY AGENCY	This paper shows the technology changeover from 2000 B.C. to 1993, showing	Lacks various distinguished barriers and its remedies.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			how hydropower meets the world demand.	
27	Hydroelectric Power and Dams - A look at the Environmental, Social and Economic	Agriculture and Food Research Initiative Competitive Grant, 2011	Water is a renewable resource that can be a cleaner energy source than natural gas/oil or coal. Hydroelectric power encourages electric price stability, Dams reduce flooding, they store water, provide recreational and economic opportunities. Cities near a dam benefit from tourism associated with recreational opportunities.	
28	Local Area Development Fund	GoI, 2012	Various zones have been identified that come under the area which gets affected by the project. Special funds are realised to develop a new area for resettlement.	Lack of proper R&R methods due to the techniques and methods used by the government for R&R increases problem for citizens and for the developers as well.

Theme: 3 Opportunities and Potential of Hydropower in Uttarakhand, in India and the World

Natural resources such as the wind and sun are effectively utilized to produce energy. Since these types of resources are theoretically infinite, it offers an attraction to be consumed and developed extensively. In 2008, about 19 per cent of the primary energy for the world's consumption is sourced from renewable resources. Large hydropower project constitutes the highest percentage followed by biomass. Modern technologies like wind, solar, geothermal and other technologies produce very less of the world's demand.

The objective of this literature review is to detail how the factors that affect the performance of hydropower schemes may be influenced by climate change and interactions with the complex built, natural and social systems providing water, energy and food security. It describes the importance of identifying trade-offs and synergies when deciding how to balance investments in water, energy and food security, commonly referred to as the water - energy - food security nexus.

This review also considers the main issues that affect hydropower performance including; Funding mechanisms and the role that public and private finance plays; Availability of data; Physical and environmental factors; Climate change; Operation and maintenance; and Type of hydropower scheme. Methods of the performance of existing and greenfield hydropower schemes are discussed in the context of making these schemes more resilient to climate change. This review explores different approaches available to assess hydropower performance in the broader context of water – energy – food security. Even just within the energy sector, there are ~~a~~ several challenges when comparing the performance indicators of different power generation technologies. There is often a disagreement between different organizations concerning the water footprint, greenhouse gas emissions and costs per unit of power of different power generation technologies. Assessing the position of hydropower within the energy sector is challenging; hence assessing the position of hydropower within the water –energy – food nexus adds two additional dimensions of complexity. There are, however, some trade-off techniques that can be used to assist planners to maximize the benefits of hydropower schemes to other sectors without significantly compromising their performance. The following have been concluded from this literature review:

1. Hydropower will play an increasingly important role in supplying electricity in low-income countries in Africa and Asia over the next 30 years

2. Existing hydropower schemes should be "re-operated", improved and rehabilitated before investing in new infrastructure. The largest enhancements in the performance of existing hydropower will be where the key components such as turbines have deteriorated and can be replaced, or operations can be changed (i.e."re-operated") to benefit ecosystem services, irrigable agriculture and water supply without significantly compromising power generation.

3. New hydropower schemes need to be assessed within the context of comprehensive catchment-wide planning

4. There is a paucity of suitable hydrological data that allows us to plan new hydropower schemes in many low-income countries. Hydropower schemes based on limited and unreliable hydrological data have the potential to underperform and not to attain the benefits the infrastructure is designed to generate. In recent years there has been a significant decline in the number of hydro-meteorological stations in many low-income countries.

5. Emphasis should be placed on investing in hydropower schemes that maximize flexibility and adaptive management.

6. Climate change scenarios should be incorporated into the planning and design of new hydropower schemes. There is evidence to suggest that the effects of climate change are not being considered when new hydropower schemes are being planned. More work is required to assess the impacts of climate change.

7. Evaluations of proposed new hydropower schemes should include an assessment of their water footprint and greenhouse gas emissions. There is evidence to suggest that in tropical and sub-tropical countries these are larger than previously anticipated. There is a need to estimate these accurately when the performance of new and existing hydropower schemes are evaluated.

8. Technological innovations can improve environmental performance and reduce operational costs of hydropower schemes. Recent research into variable-speed turbines, fish-friendly turbines, new sediment management techniques, more efficient tunneling methods, use of models to assess and optimize the trade-offs between energy, irrigation and water supply

shows a requirement of integrated river basin management that can reduce operational costs and minimize adverse environmentally impact.

9. Environmental and social issues will continue to play a significant role in the development of new hydropower opportunities.

10. Improvements are required in the understanding of the water – energy – food nexus and the place of hydropower within it.

11. Investments in new hydropower schemes should ensure that they increase climate resilience.

12. Regional pools of sustainable power should be diversified to reduce the dependency on energy sources that can be affected by climate change such as hydropower - Creating a diverse energy supply is critical for climate change adaptation in water stressed regions. Frameworks such as the on developed by the Southern African Power Pool (SAPP) provides a means for diversifying power production and reducing dependency on energy sources that can be affected by climate change, which in some cases will include hydropower.

The following need further research and are areas where there are evidence gaps:

1. **Trade-off assessments** - Although there have been a number of researchers carrying trade-off assessments that allow the position of hydropower to be assessed within the water – energy – food nexus there is still a need for more research and guidance in this area.

2. **Estimation of greenhouse gases from hydropower scheme reservoirs** - Hydropower is often cited as a green form of energy; however, recent research indicates that for hydropower schemes with large reservoirs located in "hot" countries emit significant quantities of greenhouse gases. Further research is required in tropical and sub-tropical low-income countries to have a more accurate picture of emissions from hydropower schemes.

3. **Minimization and utilization of greenhouse gases generated by hydropower scheme reservoirs to generate power** – It may be possible to extract methane from

the water in reservoirs and burn it as a source of energy; however, further work is needed to assess the technical and financial feasibility of these methods.

4. **Consumptive use of different power generation techniques and water foot printing tools for power production techniques** – There are limited, accurate data on consumptive water use in the energy sector for different power generation techniques, compared to the data for the actual water withdrawn from the aquatic environment. A widely accepted water tool is required to allow hydropower to be compared to other power generation techniques in terms of water consumption and with water use in other sectors.

5. **Impacts of hydropower on ecosystem services, including their cumulative effects** - There is still insufficient knowledge about the effects of hydropower schemes on ecosystem services. There is also a need to improve the assessment of environmental risks associated with cumulative effects, resulting from cascades of storage dams.

6. **Role and effects of small-scale hydropower schemes in low-income countries-** More work is required to accurately assess the role and impacts (both positive and negative) of small scale hydropower schemes (i.e. <10 MW) in low income countries.

7. **Financing of small-scale hydropower schemes in low-income countries** – There is a need to carry out more research into sustainable funding and business models that are required to facilitate the development of off-grid small hydropower in low-income countries.

8. **Private sector participation in the development and operation of new hydropower schemes** - There is need to carry out more research into how the private sector can effectively participate in hydropower scheme development and operation.

Literature Reviewed for Theme 3

(Opportunities and Potential of Hydropower in Uttarakhand, in India and in the World)

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
1	Laggards and leaders: The energy transition in BRICS countries	Green Peace; 2015	A brief country-by-country overview of the electricity mix, energy consumption, and carbon emissions in the BRICS countries.	The report has given the energy mix, consumption and carbon emissions, whereas it has not discussed regarding the development of renewable power or hydropower or what are the major causes of these emissions and how to reduce.
2	Hydro power status report 2016-IHA	International hydropower association; 2016	Total 33.7GW of new installed capacity in 2015 (including pumped storage) China dominated the market adding 19.4 GW of new capacity within its borders Other countries include Brazil (2.5 GW), Turkey (2.2 GW), India (1.9 GW), Iran (1 GW) and Vietnam (1 GW).	Many other companies have developed and utilized the potential of hydro and even succeed to store the energy for the time of requirement. Whereas India is still lagging, even in efficient and effective utilization .
3	All India installed Capacity (In Mw) of Power Stations (As On 30.09.2016) (Utilities) CEA	CEA; March 2018	State wise and nation wise installed power capacity.	Total installed capacity of hydropower in India is very less; the development and addition of hydro

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
4	Executive Summary Power Sector March-2018 Central Electricity Authority New Delhi	CEA; March 2018	Total installed potential and growth until 31.03.2018 is given. The growth of hydro is slow paced.	potential are not up to mark.
5	State Wise Numbers And Aggregate Capacity Of SHP Projects (Upto25mw) Potential, Installed & Under Implementation(As On31.03.2014)	MoP SHP;2014	State wise numbers and aggregate capacity of SHP projects (up to 25 MW) potential, installed and under implementation (as on 31.03.2014)	
6	Region wise list of Hydro Electric Stations, as on 31.03.2014, with capacity above 25 MW	CEA; 2014	In support to the 1998 National Hydropower policy, GoI plans to wipe out all energy shortage by the end of 2011-12, i.e. by the end of the XI Plan and also to provide spinning reserve and ensure uninterrupted quality power at an affordable cost.	
7	List of Hydro Power Stations (Existing/ Under Construction/ Development)	UERC; 2016	List of Hydro Power Stations (Existing/ Under Construction/ Development)	Uttarakhand also made plans to cope with time and develop the hydro potential but still lagging behind and facing
8	Details of Identified Hydro Sites in	UREDA and AHEC;	Details of Identified Hydro	

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	Uttarakhand State as on January 2008, Identified by UREDA	2008	Sites in Uttarakhand State along with potential.	opportunity losses due to unutilized hydro potential.
9	Hydro Electricity	Wikipedia; 2014	Hydropower and its development in India and other countries. History of hydropower, generation methods, various types of turbines and top countries who have more hydropower installed in their energy mix. Also given the advantages and barriers in the development of hydropower in general perspective.	Not addressed all the possible barriers and advantages in the development of hydropower. Discussed in general perspective. According to several country perspectives the barriers may differ.
10	Thermal Power-Make in India	GOI;2016	The growth of thermal power business is highlighted. A total CAGR of 5.5 per cent between 2007-13.	India has developed thermal power generation so rapidly in the few years, the potential of hydropower was not fully utilised, even though India has various feasible sites for the development of HPP.
11	Distribution generation scenario in Indian context: An Review	Pallavi Singh, Vaneeth Singh; 2015	Distributed generation scenario with progress and achievement in India. Contribution of Distributed generation in Renewable sector in India is explained.	Distributed generation in Wind, Solar and Hydro are explained in general, Whereas it is not mentioned in detail.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
12	Report of The Working Group on Power for Twelfth Plan (2012-17)	GOI;2012	Growth of the electricity sector in India, targets achieved in the 11th Financial year, targets need to be achieved in the 12th 5-Year Plan and growth perspective of the power sector is mentioned.	Targets achieved in the 11th 5-year plan and need to be achieved in the 12th 5-year plan are mentioned for the power sector.
13	Hydropower development in India- Challenges and way forward	MM Madan;2016	Discussed regarding sustainable development, the role of hydropower in sustainable development and challenges in enveloping the hydropower in India. The growth of hydropower in India with respect to thermal power is slow.	Development of hydropower is essential for sustainable development. The potential should be fully utilised and the focus should be on identifying all the barriers and to take necessary action for overcoming these barriers. There arises a desideratum for sustainable development of water resources, to ensure continuous availability of water for hydro generation with flood moderation for a population living downstream.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
14	Rajya sabha starred question no.106 answered on 09.03.2015 per capita availability of power government of India ministry of power	Shri. C.P Narayanan; 2015	The report is the statement of reply for the questions raised regarding the per capita consumption of electricity in India and also regarding the entire value chain of the power sector i.e. generation, transmission and distribution.	The power sector is seeing a trajectory growth where the major focus is on the generation at present. It also questions what will be the situation of generation, transmission, distribution and the per capita consumption of electricity in India by 2020. The increase in per capita consumption is vital for the growth of the economy.
15	Hydro power Development	AHEC;2011	Power potential of Uttarakhand along with an average tariff of Hydropower in Uttarakhand is analysed.	Uttarakhand has tried to utilise the available hydro potential but it proved to uneconomical due to high tariff.
16	Load Generation Balance Report	Ministry of power; 2014,15,16, 17	The projection of electrical energy deficit in Uttarakhand for FY 2016-17 is given in report. The demand and supply of all India power in India is given for FY 2015-16. The demand and supply of all India power based on Load generation balance report is given for FY2014-15.	The demand and supply for all India is deficient by 1.5 per cent during peak power demand.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
17	Energy supply, its demand and security issues for developed and emerging economies	M Asif, T Muneer; 2005	Overview of the past (2005) and projected energy of five countries, that presently have a significant impact on the global energy situation.	The global energy situation in future for the emerging economies will be a great challenge, because of the continuous increase of demand and also there is a need to develop the renewable generation for reducing carbon emissions. Also, capacity addition through Thermal (Coal, gas etc.,) and Nuclear sources face several security issues.
18	Renewable energy in India: Historical development and prospects	S.C Bhattacharya, Chinmoy Jana; 2009	The share, growth and targets of renewable energy in India are highlighted. Historical trends in developing several renewable technologies since 1995 till 2009 was taken into consideration for expecting the prospects. The role of renewable energy in future energy supply was probably underestimated.	Renewable energy is one of the basic needs for sustainable development. The potential should be fully utilised and the policies should in such a way which supports the development of Renewables in Energy Mix.
19	Small hydro power: technology and current status	Oliver Paish; 2002	This paper summarises the different small hydro technologies, innovations being developed, and the barriers to further development.	Development of small hydropower in India faces various barriers and has a significant role in the global energy

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				scenario. The gaps in the national electricity policy plan highlight the major barrier of the hydro implementation in India.
20	Small hydropower development in western Himalayas: Strategy for fast implementation.	Deepak Kumar, S.S.Katoch; 2014	The study discusses the reason for the slow pace of progress in SHP and gives a glimpse of some suggestion for its fast implementation.	Small Hydro Plant development has been delayed because of a lot of reasons that could have be avoided.
21	Small Hydro Power in India: Is it a suitable business	Rakhshanda Khan; 2013	By analysis of data collected through 28 in-depth interviews with various stake holders of SHP. This data was collected from New Delhi, Himachal Pradesh, Uttarakhand and J&K	
22	Small hydro power in India: Current status and future prospective	Mukesh Kumar Mishra, Nilay Khare, Alka Bani Agarwal	At the current rate of capacity addition, India will not be able to exploit SHP potential even by 2050 fully.	Development rate of the hydropower plant in India is not enough to utilise the full potential, because of the lack of proper facilities and incentives.
23	Small hydropower for sustainable energy development in India	H.Nautiyal, S.K Singhal,Varun, Ashish Sharma	SHP development for proper use of water resource. Utilization of SHP for sustainable development. Government policies and private sector incentives are provided.	

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
24	Pumped hydro energy storage system : A technological review	Shafiqur Rehman, Luai M.Al-Hadhrami, Md. Mahbub Alam; 2015	It is an overview of the technological details of several pumped storage hydro schemes, including large hydro, small hydro, wind, solar and photovoltaic pumped hydroelectric energy storage scheme.	Developing a pumped hydro scheme not only ~~a~~ complements for a sustainable development, but it is also necessary for developing the stability of the grid.
25	Refurbishment and upgrading of hydro power plants—A literature review	O.P.Rahi, A.K.Chandel; 2015	Importance of refurbishment of Hydropower plants is explained in this paper. Simulation of hydropower plants, technical improvement, planning and decision making for the growth of hydro development is explained.	Hydropower development is going ~~in~~ at a very slow pace when compared to other sources of generation in the Indian energy mix. To overcome the slow pace and to utilise the potential, technological improvement is essential.
26	Small hydro power in India : Current status and future perspectives	Mukesh Kumar Mishra , Nilay Khare, Alka Bani Agrawal; 2015	The current status of Small hydro power projects, development initiatives, advantages and the future perspectives are listed down in this paper	India has a huge hydropower potential. Harnessing the potential is necessary by adopting all the available technologies for its sustainable development. It will also be addressing the future demands of energy in the country without polluting the environment.
27	Resource potential and development of small hydro power projects in Jammu and Kashmir in the western Himalayan region: India	Ameesh Kumar Sharma, N.S.Thakur; 2015	Western Himalayan region is endowed with huge potential of hydropower. The potential of hydropower, development and initiatives for the development are explained.	

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
28	Comparing drivers, barriers, and opportunities of business models for renewable energies :A review	Maximilian Engelken, Benedikt Römer, Marcus Drescher, Isabell M.Welpe, Arnold Picot; 2015	Several renewable technologies in power generation, drivers in the development of these technologies, barriers in the progress and the opportunities in supporting the same are given in this paper.	Barriers in development of hydropower should be clearly addressed for achieving its full potential.
29	A comparative review of China, India and Pakistan renewable energy sectors and sharing opportunities	Saeed Ahmed, AnzarMah mood, Ahmad Hasan, Guftaar Ahmad Sardar Sidhu, Muhammad Fasih Uddin Butt; 2015	Renewable energy sectors in India, China and Pakistan and several sharing opportunities among these nations are comparatively studied in this paper.	Renewable development will be achieved only when it is compared with several opportunities to attain its potential. Also, the barriers in the development of these renewable technologies should also be addressed.
30	A review of pumped hydro energy storage development in significant international electricity markets	Edward Barbour, I.A.Grant Wilson, Jonathan Radcliffe, Yulong Ding , Yongliang Li; 2016	Pumped hydro storage schemes in several international electricity markets, significance, importance and advantages of development are well explained.	
31	Opportunities, barriers and issues with renewable energy development – A discussion	Souvik Sena, Sourav Ganguly; 2016	Opportunities in the development of renewable energy, issues with the development and the barriers which are involved in this are given in this paper.	Several opportunities in the development of hydropower by addressing all the barriers are necessary for renewable energy development.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
32	Operation and Maintenance problems in hydro turbine material in small hydro power plant	Ravi Kumar, S.K. Singal; 2015	Several problems in the maintenance of hydro turbine material in small hydropower plant and several improvements needed have been explained.	Small hydro development is necessary in India for improving the renewable energy sector and also reducing several problems in maintenance.
33	Hydro electricity: Future Potential and Barriers	Joa˜o Lizardo de Araujo, Luiz Pinguelli Rosa, Neilton Fidelis da Silva; 2010	History of hydropower, several technologies and barriers hindering the potential are given; and also the future perspective in achieving the potential is mentioned as well.	Barriers in the development of hydropower should be clearly addressed.
34	Paths of technological capability building in complex capital goods: The case of hydro electricity generation systems in Iran	Mehdi Kiamehr, 2016	Contrary to the conventional approach to technology capacity building like in Asian and Latin American electronics firms, the technological capabilities discussed in this article discussed a non-linear movement within the stages of designing and installing complex capital goods in projects. Starting from the middle stage (engineering and realisation of complex goods in projects), moving to the last stage (operation and	The study was carried out in the context of systems integration of large power plant projects, which are made up of some complex product systems among which core equipment comprises a large share of the project costs. The findings of this research may not be directly relevant to other CoPS industries where technological characteristics might

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			troubleshooting of complex goods), and eventually coming back to the first stage (conception and design of complex goods).	differ significantly. For instance, where a lower volume of engineering tasks is required to deliver each project, or where software comprises a larger share of project costs.
35	Small hydro power projects under clean development mechanism in India: A preliminary assessment	Pallav Purohit, 2008	Estimation of the CDM potential of SHP projects that are in India. CDM helped to achieve the maximum utilization potential of SHP projects more rapidly as compared with the current diffusion trend if supportive policies are introduced.	The supportive policies for utilising the maximum potential of CDM are missing.
36	World Energy Resources Hydropower	World Energy Council, 2016	Hydropower is the leading energy source in the country. China accounted for 26 per cent of the global installed capacity in 2015, far ahead of USA (8.4 per cent), Brazil (7.6 per cent) and Canada (6.5 per cent). Climate bonds market attracts strong hydropower interest as a means to demonstrate the sustainability of hydropower. There is an	The development of hydropower in the local regional area is a challenge and attracting domestic markets, the evolving energy mix and market dynamics and water energy paradox.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			increasing trend towards building climate resilience and potential climate change impacts into decision-making processes for hydropower owners and operators.	
37	Benchmarking small hydro industry in India: a road to superior performance	Bhimaraya A. Metri, 2005	Through benchmarking, SHP companies can understand where they stand compared with the best-performing companies at national and international levels and they may further identify critical areas of SHP for quality improvement and competitive advantage.	The Benchmarking Model lacked market consistency and was used to find critical areas of SHP for quality improvement.
38	The Relationship between Energy and Socio-Economic Development in the Southern and Eastern Mediterranean	Emmanuel Bergasse, Marek Dabrowski and Luc Dewulf, 2013	This report aims to identify, explain and detail the links and interactions in southern and eastern Mediterranean countries (SEMCs) between energy supply and demand and socio-economic development, as well as the potential role of energy supply and demand policies on both. Another related aim is to identify and analyse, in a quantitative and qualitative way, the changing	According to the finding in the report, there is a big imbalance between the working and functioning of the hydropower development in India, social and economic inequality is another significant factor for the poor growth of the hydropower sector.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			role of energy (both demand and supply) in southern Mediterranean economies, focusing on its positive and negative impact on socio-economic development.	
39	GLOBAL SUSTAINABLE DEVELOPMENT REPORT	United Nations, 2016	Sustainable development has become of one the key factors in the mindset of the project developers and hence they have started moving towards hydro, solar and wind energy.	Though hydropower could play an important role to attain the sustainable goal of country, it has been struggling to achieve the potential that it could reach.
40	Hydro Power Potential in Uttarakhand	M.C. Joshi, 2007	Small hydropower offers a wide range of benefits- especially for rural areas and developing countries. The resource is environmentally responsible and has substantial economic advantages. Small hydropower up to a capacity of 25 MW which also includes the mini-and-micro hydropower projects which are usually confined strictly to local use. A potential of over 15,000 MW has been identified from small	Small hydropower plants are good to serve an isolated small rural area where demand is low. In a country like India, where demand is very high and concentrated at different locations, it becomes imperative to install large hydropower plants in a water resource rich state like Uttarakhand.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			hydropower and the Government of India has been according top priority to SHP development as thrust area.	
41	Cabinet nod soon for hydro power policy	R K Singh, 2017	As per the draft hydropower policy, it will aim to provide Rs 16,709 crore support for 40 stalled hydel projects with 11,639 MW capacity and to classify all such ventures as renewable energy. Once it is approved, the distinction between large and small hydro plants will go, which would help India to achieve clean power capacity of 225 GW by 2022.	Though the government has planned to achieve extra 50GW by hydro potential by 2022, it is very difficult to accomplish as the political and financial barriers due to the emergence of new hydropower projects across the country.
42	INDIA THREE YEAR ACTION AGENDA	Niti Aayog, 2017	The region has a vast potential for generation of hydropower, solar power and wind energy. The region also boasts of significant shale oil reserves. Despite this, the region lacks in energy self-sufficiency. The main factors contributing to this are low capacity utilization of power generation units, weak connectivity with the eastern grid and a limited	There is a major challenge associated with HPP due to higher cost and procurement time. Major work has to been done to reduce this time and cost.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			carrying and distribution capacity. The per capita electricity consumption of the region was around 292 kilowatt hour (kWh) compared to the national average of 884 kWh as of 2011-2012.	
43	Evaluating the Benefits of Stochastic Optimization for Hydro Assets	Florian Kämpfer and Eric Winnington , 2012	Deterministic optimisation approaches lack the possibility to deal with uncertainties in prices and inflows. This study focuses on the advantage a stochastic optimisation offers in the two fields dispatching and pricing. The focus lies on the commercial tool TS-Energy from Time-Steps AG.	Optimisation approaches cannot deal with uncertainties in prices and inflows; better methods have to be developed that more realistic to develop better financial models.
44	National Action Plan on Climate Change	GOI	India has implemented various policies in order to accomplish the green mission and to tackle climate change. National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem etc.	The implementation of the policy which is planned is the major requirement. National Solar Mission includes rooftop solar which is intermittent in nature. The water policy has a major focus on solving the paradox clean water and energy.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
45	Green Growth and Hydropower in India	The energy and resource institute, 2015	The contribution of hydro power in energy mix is about 17 per cent as of 2014. Private sector has a share of 7 per cent, central 32 per cent and State 61 per cent. The intervention of green growth has sparked changes in the industry. Clean development mechanism and catchment area treatment, muck management plan is the way of development.	A drastic increase in installed capacity is needed to implement the green growth initiative. Implementation of interbasin project and completion of projects which are in the pipeline is a must.
46	Reclamation: Managing water in the west	US department of interior bureau of reclamation	The growing demand for power in the country is the most pressing issue. The deregulation of the electricity wholesale market and ramp up of hydro policy is required in a major way. Hydropower's ability to provide peaking power, load following, and frequency control helps protect against system failures that could lead to the damage of equipment and even brown or blackouts.	Water resource management is a challenge while maintaining the ecological balance. To harness the main potential proper ramp-up of the scenario is required.
47	Preliminary Ranking Study of Hydro	CEA	Major rivers can be categorised into Ganga Basin,	Sole focus is on the completion of the

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	Electric Schemes		Indus Basin, Brahmaputra Basin, Central India rivers and east flowing rivers and west flowing rivers. 400 schemes, with an aggregate installed capacity of about 1,07,000 MW prioritised in all six river systems of the country categorised into 5 Grades.	unfinished business and not on the potential opportunities.
48	Sustainable Development Goals	UN report	The UN's major focus is on sustainable development, climate action, economic growth, affordable energy and no poverty, clean water and sanitation	The major threat to the development of hydropower is disruption of the local ecosystem, reduction in the bio mass index and R&R issues.
49	Power sector at a glance	Ministry of power	Growth of power sector is 4.33 per cent in 2017-18, PLF of the private sector is decreasing, while the negative peak deficit is prominent.	The sector-wise generation shows the dip of the private sectors PLF over time due to renewable policies and energy demand factor.
50	Power Market regulation	CEA	Three types of markets: Intraday/contingency, DAM, TAM; Principle of the market and market design, 10000 MU turnover attracts registration charge of 30 Lacs, 5000 MU attracts 5 Lacs.	The need for market research is very high.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
51	Hydro power policies and guidelines	Water for welfare secretariat, 2008	It is well known that as a state, Uttarakhand has not utilised even one tenth of its potential for generating hydropower. However, it is heartening to note that the government has recognised the need of the hour and the challenge has been taken up to convert Uttarakhand as a leading power generating state of India. A large number of hydropower schemes are under different stages of planning/execution and many more are envisaged in the future.	Transportation limitations are not being listed much with proper policies, especially with small independent hydroelectric projects in the hills, mainly the Himalayas where small streams are available. These being mostly medium/ high head utilising small discharge; and low head utilizing larger discharge.
52	Reasons for delay in selected hydro-power projects in Khyber Pakhtunkhwa (KPK), Pakistan	Aysha Batoola, Faisal Abbas,2017	Allai Khwar, Duber Khwar and Khan Khwar, Khyber Pukhtunkh projects were completed with an average time over-run of 200 per cent and incurred 2.5 times more cost than originally estimated. Parties of hydropower projects i.e. client, consultant and contractor are at fault.	The pipeline projects are being delayed intensively. Ranking of factors from most important to least ones would help the implementing agencies to keep an eye on weak points and potential improvement fields so that the same may be avoided in future hydro power projects.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
53	Power – Renewable Energy	Madan Sabnavis, Ashish K Nainan, Mradul Mishra	Solar energy has been the frontrunner in the market and due to financial instruments, tariff is decreasing at an exponential level. Various incentives offered help in the tariff decrease. The renewable energy sector has a big focus with various challenges like long term financing, AT&C losses, Budgetary allocation etc. The government focuses on providing universal access and 24X7 supply of electricity.	Solar components being taxed at 5 per cent after GST was not taxed earlier. 40GW solar rooftop target out of 100 GW solar by 2022 which is very ambitious. Huge capital requirement to be filled with green bonds and climate bonds.

Theme: 4 Challenges and Risks involved in development of Hydropower projects

The review and discussion take place in the context of the following definitions:

- Risk is the "probability that an adverse event occurs during a stated period of time" (Royal Society 1991).
- Risk analysis is "the systematic assessment of decision variables which are subject to risk and uncertainty". The risk analysis process comprises of the following: the establishment of probabilities of the happening of adverse events; the background of assumptive bounds to associated uncertainties; and the extent of the potential impact of risk event consequences.
- Risk management is a systematic methodology for dealing with risk. A risk management system should: establish an applicable context; set goals and objectives; identify and analyse risks; influence risk decision making; and monitor and review risk responses.

ANALYTICAL REVIEW OF RISK LITERATURE

The justification for choosing a themed temporal approach to the literature analysis is that it is comparable, at least in part, to the process of expanding knowledge about any form of human work. In the search for knowledge, basic principles are first expounded and explored, and then the principles are applied to the chosen turf. Subsequently, the application process is organised in a systematically, to maximize benefits and minimize failures. Finally, the system is itself investigated as a means of optimizing its effectiveness in terms of the participants. This reasoning has been applied to more than 280 written articles and texts which have appeared in authoritative English-language publications over the period from 1960 to 1997. Some limitations must be noted. Firstly, material on the pure mathematics of risk has been excluded on the grounds of its antiquity. Secondly, no attempt has been made to exhaust the extensive literature of decision theory itself, concerning basic research in human decision making. It is the extent to which this has spilt over into the construction and project management literature which is of interest in the present study.

While earlier publications may include some reference to risk and uncertainty in construction, 1960 marks the point where substantive treatments of the topic first begin to appear in construction publications and this date is used a starting point for the 5-yearly interval groups of the temporal analysis. Some 20 years after the applied construction risk research has commenced and is entering its most prolific phase, systems theory becomes a popular vehicle for the development of construction risk management, with a growth rate of research publications almost matching that of the applied research. The adoption of a systems approach to construction risk management occurs about 15 years after the birth of systems theory itself in the early 1970s. Finally, interest in a 'soft systems' approach (not labelled as such until some years later) to risk management makes a modest start at about the same time as the applications phase but accelerates rapidly in response to the development of 'soft systems' theory (Checkland & Scholes 1990). In terms of the literature sources, the early period (1960-1980) is dominated by works published in the Journal of the Construction Division of the American Society of Civil Engineers. Since 1981, the publication frequency honours have been shared between the Journal of Construction Management and Economics and the International Journal of Project Management, both UK journals. However, this should not be seen conclusively as a geographical shift in the research effort: there is some evidence from the content of the publications to suggest that some of the UK work, particularly in the area of risk analysis applications to construction, has simply lagged, by 10 to 15 years, behind that previously published in the American journals. On the other hand, the publication of ‘soft systems' approaches to construction risk research has exclusively been the privilege of UK authors over the whole review period. Contributions from the CIB (Counsel International du Bâtiment: the International Council for Building Studies and Documentation) began to occur with the Proceedings of the Second W65 symposium (Organisation and Management of Construction) in 1978. Since then, these have been regularly found in the subsequent symposia of the W65, W55 (Building Economics) and W92 (Procurement Systems) Working Commissions of the CIB.

Texts about project and construction risk include authors such as Pouliquen (1970), Reutlinger (1970), Lifson & Schaifer (1982) and Marshall (1991) in the USA. In the UK, these are followed by Beeston (1983),Hertz & Thomas (1983, 1984), Hayes et al. (1986),Cooper & Chapman (1987), Murdoch & Hughes(1991), Flanagan & Norman (1993), Chicken (1994),Raftery (1994a), Edwards (1995) and Chapman &Ward(1997). Byrne & Cadman (1984) and Byrne (1996), in a revised version of the earlier text, have written about risk and uncertainty in the context of property development. Given this overall temporal view of construction and project risk research, it is now possible to examine the research literature thematically. To make individual reference to each of the more than 280 journal articles, conference papers and texts reviewed would be impractical in the context of the present paper. Only the earliest papers on the themes or the material thought to be the most important are discussed. In this sense, the material referred to can be considered as landmarks.

The text of Hayes et al. (1986) includes one of the earliest systematic treatments of construction risk, dealing with risk identification, risk analysis and risk response. Most texts before this had concentrated upon the mathematical approaches to risk analysis (e.g. Hertz& Thomas 1983, 1984; Byrne & Cadman 1984). Interestingly, Hayes et al. 1986, also sought to show how probabilistic cost distribution curves might change, from mesokurtic to leptokurtic, during the progress of a project, as uncertainty diminishes. The opposite appears to be proposed by Byrne & Cadman (1984), but their three-dimensional temporal illustration of probability distributions was intended to illustrate a static view of several variables taken from the start of a project and not a dynamic view of a single variable. The CRM Manual (1987) provided a procedural, task-based guide to construction risk management, as did Flanagan & Norman (1993) and Raftery (1994a). Later texts with a similar approach include Edwards Institute Manual (PMI 1996).

Cooper & Chapman (1987), although touching upon some aspects of risk management, concentrated largely upon risk analysis, using a case study approach to demonstrate techniques of moment analysis and influence diagrams. Raftery (1994a) adopted a similar approach but used less complex quantitative analyses for his examples. Chicken (1994) also concentrated upon risk analysis, in terms of the technical, economic and socio-political risks associated with government decision-making for large infrastructure projects, and demonstrated mainly subjectively based evaluation to produce risk rankings of alternative project solutions. Despite their emphasis on risk analysis, Cooper & Chapman (1987) provided a useful summary of the rationale for formal risk management, suggesting that it is essential for informed decision-making on projects involving large capital outlays, unbalanced cash flows, new technology, unusual contractual arrangements, important political concerns, sensitive environmental issues or stringent regulatory requirements. By 1989, attempts had been made to use expert systems techniques in the analytical processes of risk management (Kangari & Boyer 1989). Expert systems were also suggested for dealing with uncertain reasoning in construction legal issues (Diekmann & Kraiem 1990). The use of 'fuzzy sets' linguistics approaches has been proposed (Kangari & Riggs 1989). More recently, Mak & Wong (1997) also advocated 'fuzzy sets' as a technique for combining risks in estimating (cf. Beeston1986). Li (1995a, 1995b) has developed a neural network approach to uncertainty in construction cost estimation. Chapman (1994) cautioned against the unfettered use of contingency allowances for risk, noting that unspecified contingencies simply tempt people to use these for other purposes. Useful research could be carried out into how pre-construction project risk contingencies are subsequently dealt with in terms of the financial administration of contracts. Guidelines have been published for the development of 'risk severity matrices' in risk management (AS/NZS3931 1995; AS/NZS 4360 1995) and the concept of a project life-cycle context for risk management has been proposed (Ward & Chapman 1995). Raftery (1994b) suggested that the risk identification stage has not been adequately addressed in the risk management literature to date and his assertion is supported by the evidence of the present study. Williams (1994) advocated a 'risk register' component in the management system of a project to generate an accessible database of risk experiences. However, the manner in which managers go about identifying risks is also important. Similarly, given the emphasis on analytical techniques in the risk management literature to date the issues of goal setting for construction and project risk management, risk response processes, and risk monitoring and review procedures are all worthy topics for research.

Literature Reviewed for Theme 4

(Challenges and Risks involved in development of Hydropower projects)

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
1	Social Impacts and Social Risks in Hydropower Programs: Pre-emptive Planning and Counter-risk Measures	Michael M. Cernea; 2004	The author addressed the conference and discussed the social impacts and risks in hydropower. The question is not which are the social impacts of the dam, but rather: how should we think about the social impacts, of the dam. The question is valid because if we think about the social impacts then we can act accordingly against these impacts.	Discussed the questions raised in risk identification, how to recognise the risk and the risk mitigation measures. There should be a proper framework in planning and reducing these risks.
2	Effective Allocation of Excavation Risk in Hydropower Projects	A. Hodgkinson & A. Wilson	The risks associated with excavation works make up a significant proportion of the total project risk on many hydropower projects. Correctly identifying these risks and their interrelationship is critical to managing the overall project risk.	The risks related in excavation works is most important in the case of hydropower projects. Identifying these risks and solving them at the proper time will reduce these risks. Reference documents should be well studied for excavation and sub excavation processes.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
3	Environmental and Social Risk Briefing	Barclays; 2015	This Environmental and Social Risk Briefing(ESRB) covers the power generation industry and includes power stations and the use of fossil fuels, nuclear power and renewable energy sources such as hydroelectric power, wind farms, geothermal energy, photovoltaic's and energy generation from biomass and waste.	Hydropower developments over the past decades have been highly controversial due to accompanying social and environmental concerns. A challenge for hydropower developers and operators, as well as government planners and regulators has been to develop tools that promote good practice and sustainable hydropower projects. Focussed studies on risk identification and risk briefing are necessary and may be helpful in identifying potential, social and environmental risks associated with certain project activities.
4	Sustainable Hydropower– Issues and Approaches	Helen Locher and Andrew Scanlon; 2012	Meeting the energy demands is the issue for many countries and they started increasing the installed capacity day by day and year by year. However, we also need to keep in mind	Hydropower is the mature technology and has proven results and also it is free of carbon emissions. To develop hydropower we need to

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			that we need to control the CO2 emissions for protecting our environment. For protecting the environment and for sustainable development we need to install renewable power. Hydropower is only renewable power which is proven and reliable.	develop several approaches and also it is the responsibility to identify the drawbacks in developing the hydropower.
5	Risks and Decision Making in Development of New Power Plant Projects	Asbj6rg Kristinsdttir ; 2012	A data mining analysis of performance indicators of around 300 power plant development projects worldwide, classified by geographical location, energy technology, and developer type is highlighted.	Risks are related to the barriers. First, we need to identify the barriers for the development, then to identify the consequent risks with respect to the barriers. A clear study of all the impacts due to risks in decision making.
6	Applying Engineering Contractor Skills To Manage And Mitigate Risks On Power Plant	DJ Irving; 2002	This risk-based approach has proved invaluable as a rationalisation and prioritisation tool, ensuring the resource is devoted to the areas which really are at risk. Owner-operators can use the results of this approach to plan their long-term strategies for the asset, while also minimising difficulty in obtaining insurance cover.	Correctly identifying these risks and their interrelationship is very difficult.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
7	Status of pumped hydro-storage schemes and its future in India	N. Sivakumar, Devadutta Das, N.P.Padhy, A.R. Senthil Kumar, Nibedita Bisoyi, 2012	A critical review of the necessity of pumped storage schemes in India.	It lacks a study of the power system regarding the availability of surplus energy, and only after the same is established, the implementation should be taken up. Such a calculated strategy can only ensure the projected performance benchmark and financial efficiency.
8	A closer look at small hydro power projects in India: Social acceptability of two storage-based projects in Karnataka	Johanna I. Höffken, 2014	This paper investigates the social acceptability of small hydroelectric plants in India by empirically looking at how people engage with these plants. Tells the importance of studying technologies in their local context. The article highlights the importance of having a broader perspective in the development of SHP that goes beyond a mindset of technological fixes.	The occurrence of local engagement activities is largely neglected in policies here with general debate about SHP projects in India.
9	Hydropower - Key to sustainable, socio-economic development of Bhutan	Mr. Sonam Tshering, Mr. Bharat Tamang, 2004	Hydropower is the backbone of the Bhutanese economy. The rugged terrain, compounded by the fact that	Though hydropower has a lot of potential benefits like drinking water supply, irrigation

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			the country is landlocked does not provide much economic advantage to Bhutan. Transportation costs are high and unless Bhutan can think of certain niche products, her exports are not going to be competitive.	facilities, reducing carbon emission, etc but still it could be an economic failure due to higher capital cost of procurement and R&R.
10	Hydropower in the Context of Sustainable Energy Supply: A Review of Technologies and Challenges	Chiyembekezo S. Kaunda, Cuthbert Z. Kimambo, and Torbjorn K. Nielsen	Environment and climate change management influence choices made by investors. International financing institutions primarily support energy projects and hydropower projects all over the world but not in India.	Hydropower projects are the primary choice of investors but in India, no one prefers it because there is always a risk of over expenditure due to uncertain political and economic behaviour.
11	North –East, 'The Power House of India': Prospects and Problems	Pranab Kr. Das	The history and growth of hydropower projects, the present scenario of power generation, consumption and distribution patterns of North-East India are highlighted with the prospects and problems.	Despite large hydro potential in the North-East, the issues related to interlinking of river or rehabilitation are not listed in the paper.
12	Hydropower and the World's Energy Future	Interna-tional Hydro-power Association	Concerns over disruptive fossil fuel markets and uncertain pricing, the current decline of nuclear energy as a viable energy source and the	Certainly, it could be said that in the coming future, there is a chance that the energy mix will be containing more of other

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
		Compton, West Sussex, United Kingdom, 2000	significant environmental consequences of thermal energy sources have placed greater emphasis on sustainable energy policies that include the significant development of renewable energy supplies.	renewable energy apart from hydro as well as nuclear energy may be there, if the proper step has not been taken by the government.
13	Impact analysis: National tariff policy	GoI, 2006	Other key amendments relating to renewables include Renewable Generation Obligation (RGO) on new coal/lignite based thermal plants set up after a specified date and bundling of renewable power with power from thermal plants whose PPAs have expired or which have completed their useful life subject to development through competitive bidding.	The same process for the renewable energy sector, especially for the hydropower is absent which is tempering development and maintenance of the hydropower plant.
14	Risk management of hydropower development in China	Wenzhe Tang 2013	Little research on resettlement of migrants, ecological and environmental impact, enhancing capabilities of humans, promoting collaborative risk management, sustainable hydropower risk management.	Less promotion of collaborative risk management system, the scope of safety management is low and should be expanded, low capabilities of workers.

Theme: 5 Hydropower, Policies, Energy outlook and its development in and around India

Sustainable Energy Security (SES) is defined as "provisioning of uninterrupted energy services in an affordable, equitable, efficient and environmentally benign manner" (Narula, 2014) and has been proposed as an end goal of the energy policy for a developing country. Energy security is a property of the energy system (Mitchell and Watson, 2013) and the physical energy system of a country can be divided into three distinct sub-systems, 'energy supply' sub-system, 'energy conversion & distribution' sub-system and 'energy demand' sub-system. The energy supply sub-system deals with primary energy, either extracted as fossil fuels (coal, crude oil, natural gas); renewable energy (solar, wind, hydro) which is harnessed directly to generate electricity; biomass and; nuclear energy which is extracted as uranium and is then converted to electricity.

Energy security is often used synonymously with the security of energy supply. World Energy Outlook- 2015 (IEA, 2015) forecasts that India will move to the centre stage of the world energy system and the change in demand for energy for the period 2014–2040 will be the highest amongst all countries. Thus the energy supply sub-system will need to grow to meet this demand and there is likely to be a large increase in import of fossil fuels and renewable energy generation from domestic resources. Tracking of the performance of the energy supply sub-system of a country based on an assessment of various competing sources of energy is therefore essential. This theme attempts to contribute to the methodological advancement for undertaking a multidimensional evaluation of an energy system for a country. The generic methodology is valid for any country or region and the paper applies it for conducting a comprehensive analysis of the Indian energy supply sub-system. There are a set of indices in literature, which attempt to assess a country's energy security and sustainability. A few of them are: Energy Security Index (ESI price and ESI volume) by IEA(2007), willingness to pay function' for security of supply (Bollen,2008), Oil Vulnerability Index (Gupta, 2008), Vulnerability Index (Gnansounou, 2008), geopolitical energy security measure (Blyth and Lefevre, 2004), risky external supply index (Le Coq and Paltseva,2009), economic and socio-political risk index under project Risk of Energy Availability: Common Corridors for Europe Supply Security (REACCESS, 2011), energy development index (IEA, 2010), energy sustainability index (Doukas et al., 2012), Aggregated Energy Security

There are two main approaches to project energy consumption and GHG emissions (Stephane, Aditya, Nikit, & Amol, 2019). One makes use of aggregate macro data at the country or sub-national/state level to estimate the income elasticity of consumption by econometric analysis over a relatively long period of time. These models include computable general equilibrium (CGE) models and are often referred to as “top-down” models. The other approach uses micro-level data that reflects individual technologies and household behaviour. These models are referred to as “bottom-up” engineering models and enable a detailed assessment of technology investments. While top-down models analyze an energy-demand relationship through a reduced-form equation, bottom-up models examine the ownership and the use of energy-consuming products and consider end-use technology scenarios from an engineering point of view (Stephane, Aditya, Nikit, & Amol, 2019). Previous work has shown the limited ability of economic models to forecast technologies trends. For example, Creutzig et al. show the inability of these models to forecast solar photovoltaic deployment. Anderson and Peters question the overrepresentation of supply-side technologies such as bio-energy with carbon capture and storage (BECCS) and afforestation as solutions. The potential of demand-side low carbon technologies is often underestimated because end-use technologies are not included in top-down assessments. With India’s forecasted economic growth, many economy-wide models have been developed to forecast how such growth will affect India’s carbon footprint. These include government forecasts multilateral organizations; and nonprofits. Besides, sector-specific models have been developed to forecast how sectoral demand growth will contribute to India’s increasing emissions.

The NITI Aayog India Energy Security Scenarios (IESS) 2047 is an open source web-based scenario tool that simulates alternate energy pathways based on predetermined levels of effort to deploy clean energy technologies (Stephane, Aditya, Nikit, & Amol, 2019). It is a tool for policy makers to better understand the impact of different policy options. However, the tool does not “forecast” likely trajectories and technology options are provided inboard level categories. The International Energy Agency (IEA) developed an India Energy Outlook which analyzes future pathways of India’s energy consumption up to 2040 based on a computable general equilibrium model. The IEA provides some results at the sub-sectoral level, but does not provide detailed information on technology assumptions.

The United Nations Environment Program (UNEP) uses AIM/End-Use, a bottom-up optimisation model that integrates a detailed breakdown of end-use technologies. The key outcomes include the identification of technology options for designing near-term (2015–2020), medium-term

(2020–2030) and long-term (2030–2050) policies. The end-use energy demands are introduced exogenously and technology costs are the main drivers that change output results. The Research and Energy Institute also uses a bottom-up optimisation model based on the MARKAL system and models a business-as-usual (BAU) and a 100% renewable energy scenario for India. The model results identify energy efficiency as a key approach to gain savings (~59%) by 2051. Dhar et al. modelled three scenarios for India' slow carbon transformation: a Nationally Determined Contribution (NDC) scenario, a 2 °C scenario, and a NDC+2 °C scenario using the ANSWER/MARKAL energy optimisation model. The time horizon for the model was a medium term (until 2030) and long term (2030–2050). The main conclusion of the paper is the need to adopt a socio-economic approach to energy efficiency instead of using it simply as a technological intervention in order to achieve transformational change toward allowing carbon transition. While these models are based on a bottom-up representation of technologies, they rely on optimisation of technology costs to model demand projections. In the optimisation approach, the share of any technology is based on its cost relative to the cost of all other technologies. However, the information on investment and operating costs are not always available and often a source of uncertainty, notably in mid-term scenario analysis. In addition, optimisation models neglect the implication of market imperfections and local circumstances that contribute to investment decisions. Others have looked at emission reduction scenarios using global models that provide results for India as a region with limited details on the end-use sectors. Finally, Rajan developed a LEAP model for India in 2006 focusing on the impact of climate policy on energy access. While the study provides interesting results on household energy demand, little is provided in terms of energy end-use demand, technology penetrations or energy efficiency assumptions. The Lawrence Berkeley National Laboratory (LBNL) India Demand Resources Energy Analysis Model (DREAM) takes a different approach. It is a simulation model which provides a descriptive quantitative projection of energy demand based on exogenously determined drivers and technologies penetration with the objective to model observed and expected decision-making that does not necessarily follow a cost minimizing pattern.

Literature Reviewed for Theme: 5

Hydropower, Policies, Energy outlook and its development in and around India

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
1	A comprehensive analysis of strategies, policies and development of hydropower in India: Special emphasis on small hydropower	Naveen Kumar Sharma, Prashant Kumar Tiwari,Yog Raj Sood	Special emphasis on small hydro and its importance to face the energy crisis; Policies and developments are explained briefly.	The energy crisis and the policies regarding it is a major barrier. The global energy situation is increasing but the share of hydropower is less. The role of renewable is underestimated in the current scenario of India.
2	Workshop on Smart Cities Mission – MNRE	MNRE; 2016	The growth of smart cities would increase the energy consumption. Smart cities and role of renewables in Smart cities has been explained.	Waste to energy technologies and renewable technologies are clearly mentioned, whereas how to achieve is not mentioned in this report.
3	Overview of the initiatives in renewable energy sector under the national action plan on climate change in India	S.S. Chandel, Rajnish Shrivastva, Vikrant Sharma, P. Ramasamy	Power generation initiatives under various components of NAPCC, along with gaps in implementation are identified	Several initiatives are mentioned however the significant part is not the initiative, it is the implementation.
4	Hydropower development in India -A Sector Assessment	K Raman-than, P Abeyguna-wardena, ADB	India ranks 5th in terms of usable hydropower potential. However less than 25 per cent	Less consideration of various factors such as dearth of adequately

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
		(Asian Development Bank); 2007	has been developed or taken into development.	investigated projects, environmental concerns, R&R issues, land acquisition problems, regulatory issues, lengthy clearance approval procedures, power evacuation problems, the dearth of good contractors, and in some cases, inter-state issues and law and order problems contribute to the slow pace of hydro development.
5	Hydropower in Uttarakhand: Is 'Development' the Real Objective?	Dunu Roy;2008	For the local consumption free or affordable, sources of energy have been promised as 12 per cent of the hydropower produced is to be given free of cost to the local state.	Inspection of the environment and it's assessment of impact can bring out various deficiencies.
6	Revision Of Rates Of NPV Applicable For Different Class/Category Of Forests	Forest Survey of India (FSI), Dehradun; 2014	The rate revisions are mentioned in this report. The NPV applicable to the different classes of forest land is clearly mentioned according to the category of forests.	Land rate is one of the significant cost for any project. Revision of the land cost may reduce or increase the project cost.
7	Hydropower - Key to sustainable, socio-	Mr. Sonam Tshering, Mr. Bharat	The role and importance of hydropower for the social and	Will Social and Environmental concerns

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	economic development of Bhutan	Tamang; 2016	economic development of Bhutan that covers aspects related to planning and policy. Direct sale of electricity contributed as high as 45 per cent approx. of the gross national revenue during the 8th Plan, mainly from its export to India. Accessed on 07/09/2016: The United Nations Symposium on Hydropower and Sustainable Development was held from 27 to 29 October 2004 in Beijing, China.	of hydropower development incorporate sustainable development strategies?
8	Hydropower In The Northeast: Potential And Harnessing Analysis	VVK Rao; 2006	Related to irrigation projects and their impact. The dams resulted in uncompensated upstream impacts. The statistical assessment of dams is based on a 2005 study conducted at Massachusetts Institute of Technology and Yale University (Duflo and Pande 2005). Input to the study “Development and Growth in Northeast India: The Natural Resources, Water, and Environment Nexus.	Greater acceptability of storage projects could be achieved by forming a policy on R & R specifically Socioeconomic and cultural Milieu of the northeast region.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
9	The Political Economy of Indian Power Sector Reforms Program on Energy and Sustainable Development At the Centre for Environmental Science and Policy Stanford Institute for International Studies	Rahul Tongia; 2003	Agriculture consumes almost one third of the power in India yet provides less than 5 per cent of the revenues. The individual sector consumption of electricity and their GDP contribution are studied to relate electricity and economy of India.	
10	Renewable Energy In Northeast India: Issues And Prospects	Debajit Palit; 2003	This paper attempts to review the renewable energy programme in the region especially the solar, hydro and biomass technologies and suggests measures for development of the sector.	There is an urgent need to formulate “Integrate renewable energy policy” for regions focussing more on the sustainable region.
11	Development Of Small Hydro	G. Baidya; 2006	SHP and their advantages along with state-wide SHP potential in India.	Despite various incentives available, factors like low load factor and revenue, O&M cost, tariff, tow interest of private developers, statutory clearances and financing small hydro should be taken under consideration.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
12	North –East, ‘The Power House of India’: Prospects and Problems	Pranab Kr. Das; 2003	According to the report of CEA on 1.10.2013, 23.53 per cent of the hydro potential i.e. 35002.8 MW of the country has been harnessed so far. Analytical approach to the hydro potentiality of North-Eastern part of India. Both quantitative and qualitative data have been used in this paper. The data has been taken from several reports from the Central Electricity Authority of Government India and NHPC.	The barriers are mentioned whereas the framework is very important for the development of hydropower by using its entire potential. It leads to economic growth and sustainable development. Being a sustainable source of energy, factors like seismicity and tectonic factors, ecological factors, water disputes with neighbouring countries, huge investments, and transmission problem should not be left disguised.
13	Report of The Working Group on Power for Twelfth Plan (2012-17) New Delhi	P. Uma Shankar Secretary to the Government of India (MoP); 2012	Development of the Power Sector shall be Commensurate with the overall economic growth of the nation. This report deals with the power scenario of the 11th plan and 12th plan.	Does not cover the impact of addition of electricity.
14	Policy On Hydropower	Government of Uttarakhand	The objectives of this policy are to attract investors for the	The government of Uttarakhand should

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	Development By Private Sector In The State Of Uttarakhand (25 Mw & Above)	; 2006	development of the state's water resources in an environment-friendly manner and to generate revenues from the development of its hydel resources while ensuring project viability.	earmark project sites for allocation to private developers by advertising and inviting participation for development through RFQs & RFPs.
15	Potential of Hydro Power Plant in India and its Impact on Environment	Roshni Bhoi and Dr. S.M Ali, 2014	A hydro plant is profitable in an environmental aspect as well in the economic aspect. Since it a green and clean renewable energy, its development can meet the future demand in electricity.	Despite having a tropical climate in major parts of India, environmental and socio economic factors are its major concerns. Hydro has huge dependencies on technical difficulties, political opposition; dearth of adequately investigated projects, land acquisition problem, environmental concern, regulatory issues, power evacuation problem, long clearances and approval procedure, dearth of good contractors, this interstate issue will result in slow development.
16	Power and North-East: The Hydro Power Scenario of North East	Kaushik Handique, Anshuman Dutta; 2014	The present hydropower scenario in the north-east region. It also highlights the prospects and challenges ahead in the hydropower sector of this region. The conflicts around hydropower development in the region cover a wide range of issues including displacement, loss of livelihoods, various types of ecological impacts– especially seismicity and the fragile nature of Himalayas.	

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
17	Small Hydro Power- A review	S. Khurana Anoop Kumar; 2011	The world's installed capacity of small hydropower is 888.8GW against an estimated potential of 180,000 GW. The development of small hydropower appears strong in many parts of the world, especially in Asia, where it accounts for more than 19,000 MW to the grid. Within Asia, China alone contributes more than 15,000. MW to the grid. It is predicted that by 2005, an additional 8000 MW of small hydro capacity could be in service throughout the world; and by 2020 that number could reach 65,000 MW.	Will small hydro emerge as a cost-effective, reliable and environment friendly means to provide power in present scenario?
18	The Energy Poverty and Gender Nexus in Himachal Pradesh, India: The Impact of Clean Fuel Access Policy on Women's Empowerment1	Dr.Jyothi Parikh; 2016	This research project has focused on poverty, gender, energy and health issues in the state of Himachal Pradesh (HP) in India, a mountainous state. Where the energy uses include space and water heating requirements. This paper is based on primary	Do frequent flash floods and soil erosion, felling of trees blamed on Hydroelectric projects. New ways maybe required to regulate insatiable temptation to overbuild on Himalayan landscape and alter riverbeds.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			and secondary data collected from multiple sources. Kerosene and firewood are used as major fuel by the village folk.	
19	Visualizing Hydropower Across the Himalayas: Mapping in a time of Regulatory Decline	Kelly D, Alley; 2014	The need for information and data exchange for helping in Hydro projects is covered.	Complex knowledge frames can help identify the benefits, costs, and consequences of rapid hydropower development.
20	Local Knowledge in the Assessment of Resource Sustainability: Case Studies in Himachal Pradesh, India, and British Columbia, Canada	C. Duffield, J. S. Gardner, F. Berkes and R. B. Singh;1999	This paper describes sustainability indicators which were enumerated by local people in two differing cultural-historical, but environmentally similar, contexts. These indicators may be reflective of local, indigenous knowledge about the environment and therefore may be of significance in impact assessment and monitoring environmental change.	Highly discriminated set of indicators grouped as forest cover indicators, forest linked indicators, forest management indicators, agricultural livelihood indicators, socioeconomic indicators should reveal their impact on locals due to hydropower.
21	Small hydro in India: environment friendly alternative energy source	B S K Naidu;1998	This paper highlights the benefits of small hydro, accounting for its potential in	Rediscovered as the most potent source of RE for sustainable development,

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			hilly and plain regions of India.	environmental aspects are hurdles in hydropower generation. Training and human resource development is considered important as per MNRE.
22	Hydropower Development In India -AHEC	Praveen Saxena; 2010	Despite hydroelectric projects being recognised as the most economic and preferred source of Electricity, the share of hydropower in our country continued declining since 1963. The hydro share declined from 50% in 1963 to about 25% in 2010.	
23	Hydro Power Vs Thermal Power: A Comparative Cost-Benefit Analysis	Adesh Sharma; 2014	An estimate shows that for every 1 per cent economic growth, power generation capacity for India needs to grow by 5-6 times to sustain the levels of growth for the years up ahead. The comparison between Hydro and Thermal by considering the data from CEA and CERC. The impact of growth of electricity in Indian economy is mentioned.	Considering geological changes, flora and fauna, soil quality, fish populations are adversely affected by hydropower in India.
24	FERC's economic analysis of	FERC;2016	Economic analysis is to provide a general estimate of	India presently suffers from a major shortage of

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	hydropower project relicensing involves an assessment of the costs and benefits of operating a project under various proposed modes and conditions		the potential power benefits, the costs of a project and reasonable alternatives to project power. The analysis helps to support an informed decision concerning what is in the public interest.	electricity generation, where power cuts are common throughout India. The resulting failure to satisfy the demand for electricity has badly affected India's economic growth. There are major obstacles for fuel such as coal and nuclear energy based on power industries when compared to hydroelectric power generation. India's electricity sector faces a lot of challenges such as poor infrastructure and high cost of production to harness its coal bed, shortage of natural gas, less availability of nuclear resources etc.
25	Status of Electric power generation in India with special emphasis on Hydropower expansion	D. S. Subrahmanyam; 2013	On global scenario, India ranks 5th with enormous amount of hydroelectric potential and in terms of exploitable hydro-potential. As per Central Electricity Authority, India is endowed with economically exploitable hydro-power potential to the tune of 1, 48, 700 MW of installed capacity.	
26	Factors affecting the development of hydro power projects in Hydro rich region of India	Ameesh Kumar Sharma, NS Thakur; 2016	Case study of Jammu and Kashmir along with North-western Himalayan region provides an idea of acceptance of hydropower by local people.	The total hydropower potential of India is, 50,000 MW out of this the total hydro potential of only 40,195 MW is exploited until 2014,

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				which implies that most of its potential is going in vain.
27	Global Electricity Initiative 2014 Report	GEI; 2014	This report is a summary of questionnaire responses and statements by utility leaders. This report has been drafted by the GEI project team consisting of the World Energy Council, World Business Council for Sustainable Development, Global Sustainable Electricity Partnership and the Project Partner Deloitte Africa, Southern Africa Office.	Electricity is one of the essential infrastructures in any economy. It shows how the development of power sector leads to economic growth.
28	India Energy Outlook World Energy Outlook special Report-International Energy Agency	Outlook; 2015	The contribution of hydropower to Indian power generation has been on a declining trend in recent decades, from close to 40 per cent in 1980 to 12 per cent in 2013.	Hydropower is becoming an essential pillar in the relationship with Bhutan, with three projects of around 1.5 GW in total already developed with Indian assistance, a further ten projects in various stages of construction or preparation and plans to strengthen transmission

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
				lines to export surplus power to India. Similar arrangements are in place with Nepal, including the approval of projects with a combined capacity of 1.8 GW in 2014.
29	24*7 Power for All_ Uttarakhand	Mop, GoI, Govt. of Uttarakhand	Government of India with the support of Ministry of Power and the Government of Uttarakhand has give the report for achieving the target of 24*7 power supply in the State of Uttarakhand.	24*7 power supply is the initiative taken by. the government whereas implementation and achievement is the major challenge.
30	Report of The committee to study development in hill states arising from management of forest lands with special focus on creation of infrastructure, livelihood and human development	Shri. B.K Chatuvedi Member, Planning Commission; 2013	Uttarakhand has its upper catchments in snow and glaciated areas and traverse through deep gorges. These perennial rivers are an important sources for hydropower generation and also supply water to some of the largest irrigation networks of the world. There are ambitious plans to exploit more hydropower through several micro- and mini- hydel projects including run-of-the-river power plants.	The installation and development of the hydropower plant is continuing declining, due to which the utilization of its potential is not going up. Moreover, lack of transmission facilities is also tempering the transfer of power from surplus states to the deficient states.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
31	Policy dimensions of development and financing of water infrastructure: The cases of China and India	Cecilia Tortajada	This paper gives the policy dimensions of development and financing of water infrastructure in India and China which is the major requirement for the economic growth for these two nations.	Infrastructural development plays a key role in the development of any economy. It has been seen how investment and development in infrastructure has a direct impact on the economy and growth of the country.
32	A comprehensive analysis of strategies, policies and development of hydro power in India: Special emphasis on small hydro power	Naveen Kumar Sharma , Prashant Kumar Tiwari, Yog Raj Sood, 2012	SHP projects may be built in isolated areas to improve the quality of life in areas where there is no national electrical distribution network. Considering the large untapped potential and the intrinsic characteristics of SHP in promoting the country's energy security and flexibility in system operation, the government is giving a thrust to accelerate SHP development.	For hydroprojects there is a problem in finding suitable site characteristics as further energy expansion is not possible and there is low power produced in summer months. There is a need for further policies and expansion to be introduced by the government.
33	Tariff policy	GOI, 2006	Linkage of tariff to cost services, cross subsidy surcharges and additional surcharges for open access, framework for revenue requirement and cost, multiyear tariff and its uses.	Demerits of MYT. Renovation and modernization acceptability of the tariff policy.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
34	Tariff_Policy-Resolution_Dated_28012016 HINDI	GOI, 2016		
35	The status quo analysis and policy suggestions on promoting China's hydropower development	Yun Li,Yanbin Li, Pengfei Ji, Jing Yang,2013	China ranks first in the world in terms of hydropower resource with more than 542 million kWh resources. The 12th 5-year plan focused on hydropower with reduction in fossil fuel reserve and increasing environmental concern. China did not meet its target in the 1st 5-year plan. Policies need to be improved in order to achieve the set targets.	The energy flux of China accounts for 70% of coal, where the transition of the energy sources from coal to hydro becomes challenge. The major gap for China is developing hydropower in geographically challenging locations. The safety and ecological barriers are the primary concerns for its sustainable development.
36	Hydro power development	GoI, GoK	The per-capita consumption of electricity in Uttarakhand has steadily grown from 1,012 kWh in FY 12 to 1,154 kWh in FY 15 at a CAGR of 4.46 per cent. The population of the state has grown from 84,89,349 in 2001 to 1,00,86,392 in 2011. The average household consumption has grown from 2.85 kWh/day in FY 10 to	The main challenge is generation planning along with solving transmission congestion. To improve the energy efficiency while handling the financial position and fund allocation issues.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			3.70 kWh/day in FY 14 Agricultural consumption accounts for a mere 5 per cent, Share of the industry as a percentage of total electricity consumption will continue to remain in the 58 per cent -62 per cent range.	
37	STATUS OF POWER SECTOR IN UTTARAKHAND- NEED FOR POLICY INITIATIVES	Government Of Uttarakhand	The pace of advancement of hydropower projects in Uttarakhand, is the fundamental for growth of state income. State has endured an environmental setback due to various religious gathering of individuals.	The power deficit of the Uttarakhand needs to be mitigated; closure of the projects needs to be done as soon as possible. The policy of the state needs to be improved in order to accommodate new projects and complete the existing one.
38	POLICY ON HYDROPOWER DEVELOPMENT BY PRIVATE SECTOR IN THE STATE OF UTTARAKHAND (25 MW & ABOVE)	Government Of Uttaranchal	GoU identified hydro potential of 25000 MW against which only 3164 MW has been harnessed. The target of 3000 MW for the hydropower sector was fixed in the 11th Plan.	Limited to 25 MW and above not exceeding 100 MW.
39	POLICY ON PRIVATE SECTOR	Government Of Uttaranchal	GoU identified hydro potential of 15000 MW, 7900 MW	Only limited to 100MW and above project.

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
	INVESTMENT IN HYDROPOWER PROJECT ABOVE 100 MW CAPACITY.		projects in the pipeline. This policy holds for projects above 100 MW by private participants. Policy shows prerequisites, process and terms of allotment, royalty, sale and evacuation of power, infrastructure and incentive schemes.	
40	Draft National Electricity Policy	GoI, MoP	In the 12th Plan, likely capacity addition from conventional sources, will be 1,01,645 MW against a target of 88,537 MW. Private players have started playing a dominant role in capacity addition. Supercritical technology based coal power plants is likely to contribute around 39% of the total capacity, A capacity addition of 17,930 MW from Renewable Energy Sources has been achieved during the first four years of the 12th Plan. As a uniform approach for the formulation of DSM regulations, there would be a reduction in electrical energy.	Demand projection is the major challenge and DSM .The rate of capacity addition is not as per the energy requirement in the country,
41	Draft National Energy Policy	GOI, 2017	Access and availability of power is the main factor for	Ensuring energy security is a challenge, the

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			development. The energy security should increase on a large scale while the equity will decrease. Energy market and the infrastructure is directly connected, while the government works as an animator of markets.	assumption made is GDP trajectory will remain constant throughout along with the population and the rate of urbanization. Equal level of service and energy demand is a hurdle in the development scenario.
42	New Hydro Policy 2017	Ministry of power 2017	All hydropower comes under renewable sources.	The MNREs scope only covers projects less than 25 MW.
43	Management of local area development fund	MoP,2013	A primary concern is the development of the local area, compensation benefits for project affected families, and compensation of project affected zone. The extra generated power should be given for development of the local area. Separate LADC for each district if the project consists of more than one district, timely realization should be done.	A body should be set in order to monitor and enforce the actions. Proper dispense of the funds should take place.
44	Land acquisition Act	Gazette of India,2013	Land acquisition, rehabilitation and resettlement authority will clear all the disputes swiftly. The state	The process to reduce the influence of local politicians and eminent bodies should be

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			government will have a state monitoring agency. All benefits including reservation benefits will be entitled to the local inhabitants of the area. The award shall be filled in the collector's office.	implemented. R&R should be the major focus of the local bodies. Any damage to the property should be borne by the occupant.
45	Hydropower Policy	GoI, 2008	Our country is endowed with an enormous hydropower potential, last assessed to be about 84,000 MW at 60 per cent load factor, which translates to 1,48,700 MW in terms of installed capacity. In addition to the above, 6,782 MW of installed capacity has been assessed from small, mini and micro hydel schemes (i.e. schemes of capacity up to 25 MW). Further, 56 potential pumped storage sites, with an aggregate installed capacity of 94,000 MW, have also been identified.	There is a lack of proper policy framework to utilize this potential as many R&R, infrastructure, and various other uncertain situations associated with hydropower projects has to be tackled. The policy has to be designed in order to reduce the risk for the investors.
46	Twenty-Five Years of Indian Economic Reform	Swaminathan S. Anklesaria Aiyar, 2016	Once an object of pity, India has become an object of envy. It has been called a potential superpower and the only	Though the policy has grown rapidly and many amendments have been done in regards to benefit

S. No	Title of the paper	Author and year of Publication	Findings	Research Gap
			credible check on Chinese power in Asia in the 21st Century. Hence, the United States has backed India for a permanent seat in the United Nations and has persuaded the Nuclear Suppliers Group to exempt India from the usual nuclear non-proliferation rules.	the upcoming projects, the policies have failed to support the hydro projects as per expectations.
47	25 MW Hydro Power Policy 2015	Government of India, 2015	The Government of India has clearly defined the policies that beneficial for the development and procurement of the small hydropower plants.	Government of India has not provided any special privilege to any short of the hydropower present at remote local. The policy must be developed in order to improve the development rate of small HPP in a remote location.

Important Learnings from the Literature Review:

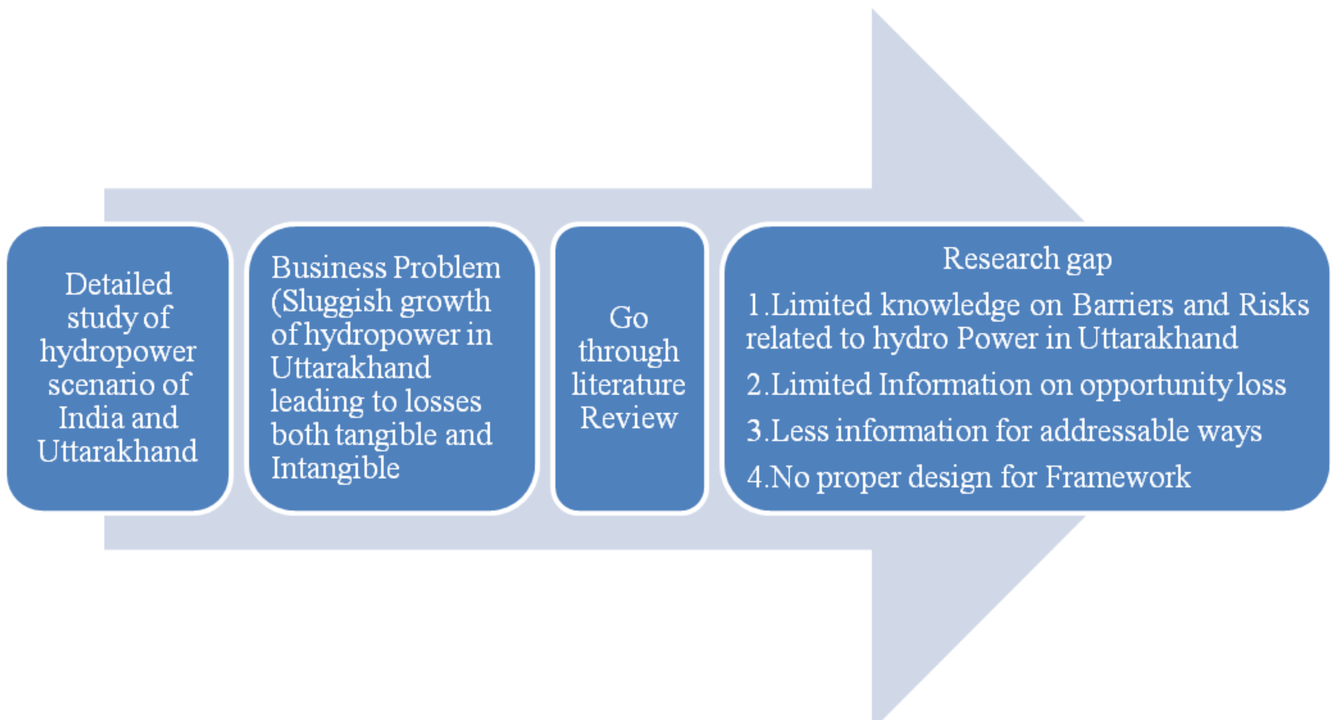
1. Identified several barriers that are hindering to the development of hydropower in Uttarakhand.

2. Identified the consequent risks related to the barriers.

3. Energy surplus state (2001) to energy deficit state (2017).

4. Sluggish growth in the development of hydropower in Uttarakhand.

3.2 Research Mapping:



3.3 Thematical Research Gap:

Theme: 1 – The comprehensive study on advantages and barriers to Uttarakhand has not been done in a neutral way.

Theme: 2 - Guidelines and suggestions for future hydropower development have not been properly mentioned in the literature.

Theme: 3- Study on barriers, harnessing the growth of economy for Uttarakhand and also regarding the opportunity loss for the state are not properly found in the literature.

Theme: 4 - No practical suggestions and guidelines have been mentioned for mitigating the barriers for hydropower development.

Theme: 5 - Study of sustainable and socio-economic development has not been mentioned properly along with the adequate care of development of Hydropower.

3.4 Research Gaps:

- Limited information on barriers and risks attached to hydropower project development in Uttarakhand from the perspective of all stakeholders
- Limited information on opportunity loss attached to the delay in hydropower development
- Limited or no information on mitigation measures and way forward for properly addressing the barriers and risks
- No information on proper design of framework for development of hydropower in Uttarakhand in particular and India in general

3.5 Research Problem:

- What are the barriers and risks associated with the development of hydropower in Uttarakhand and how to mitigate these barriers and risks to enable the state to harness the opportunities related to hydropower development.

3.6 Research Questions:

- What are the major barriers and risks affecting the growth of hydropower in Uttarakhand from the perspective of each stakeholder?

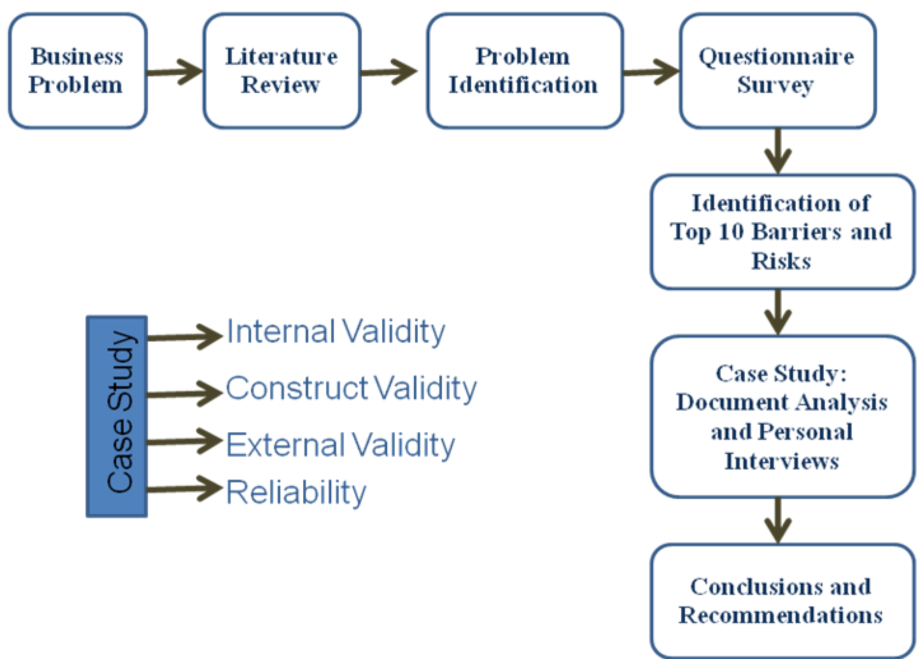
- Why these barriers and what are the measures to address them and risks associated with hydropower development in Uttarakhand?

- How to develop hydropower projects in Uttarakhand that can address issues of all stakeholders and enable the state to harness the opportunities related to hydropower development in the state?

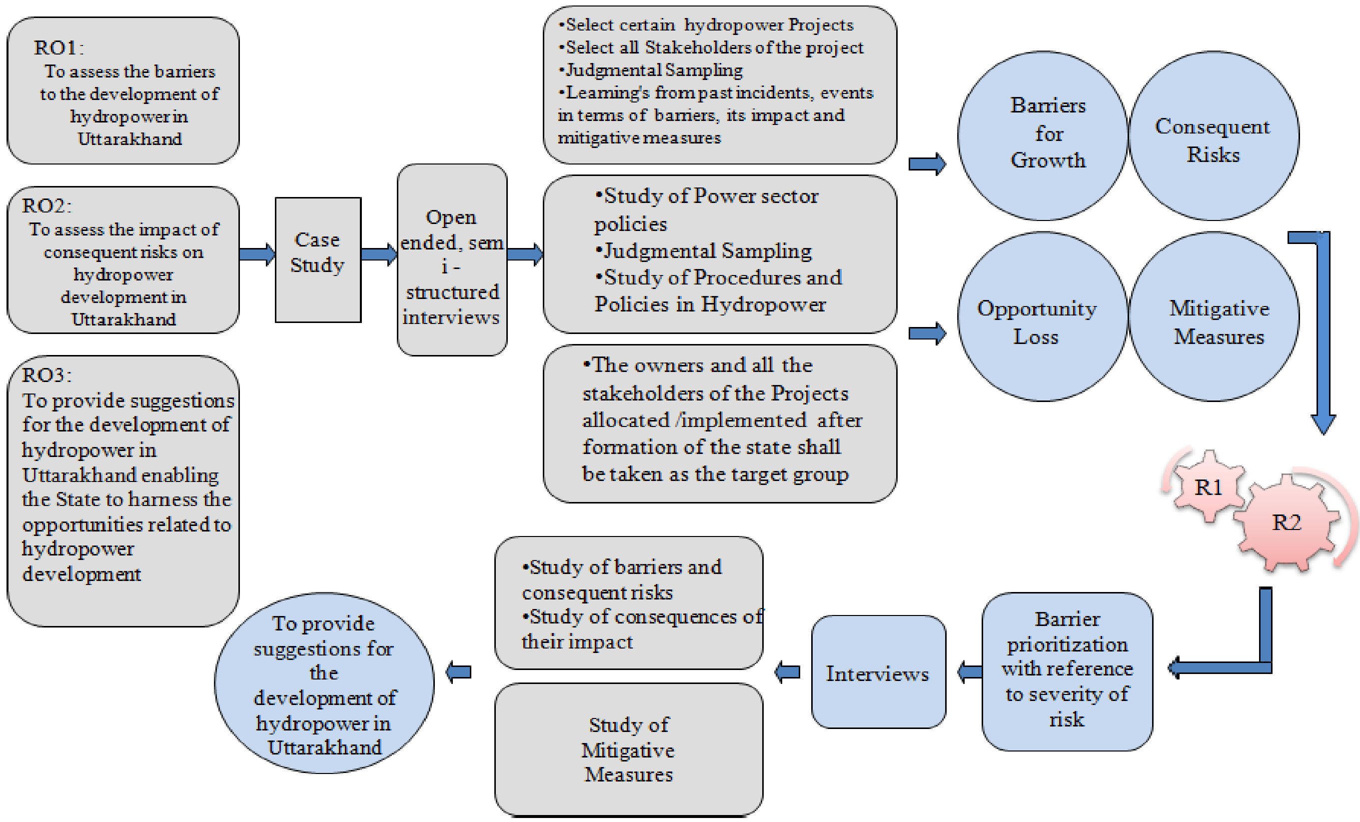
3.7 Research Objectives:

- To assess the barriers to the development of hydropower in Uttarakhand
- To assess the impact of consequent risks on hydropower development in Uttarakhand
- To develop a holistic framework for the development of hydropower in Uttarakhand

3.8. Research Roadmap:

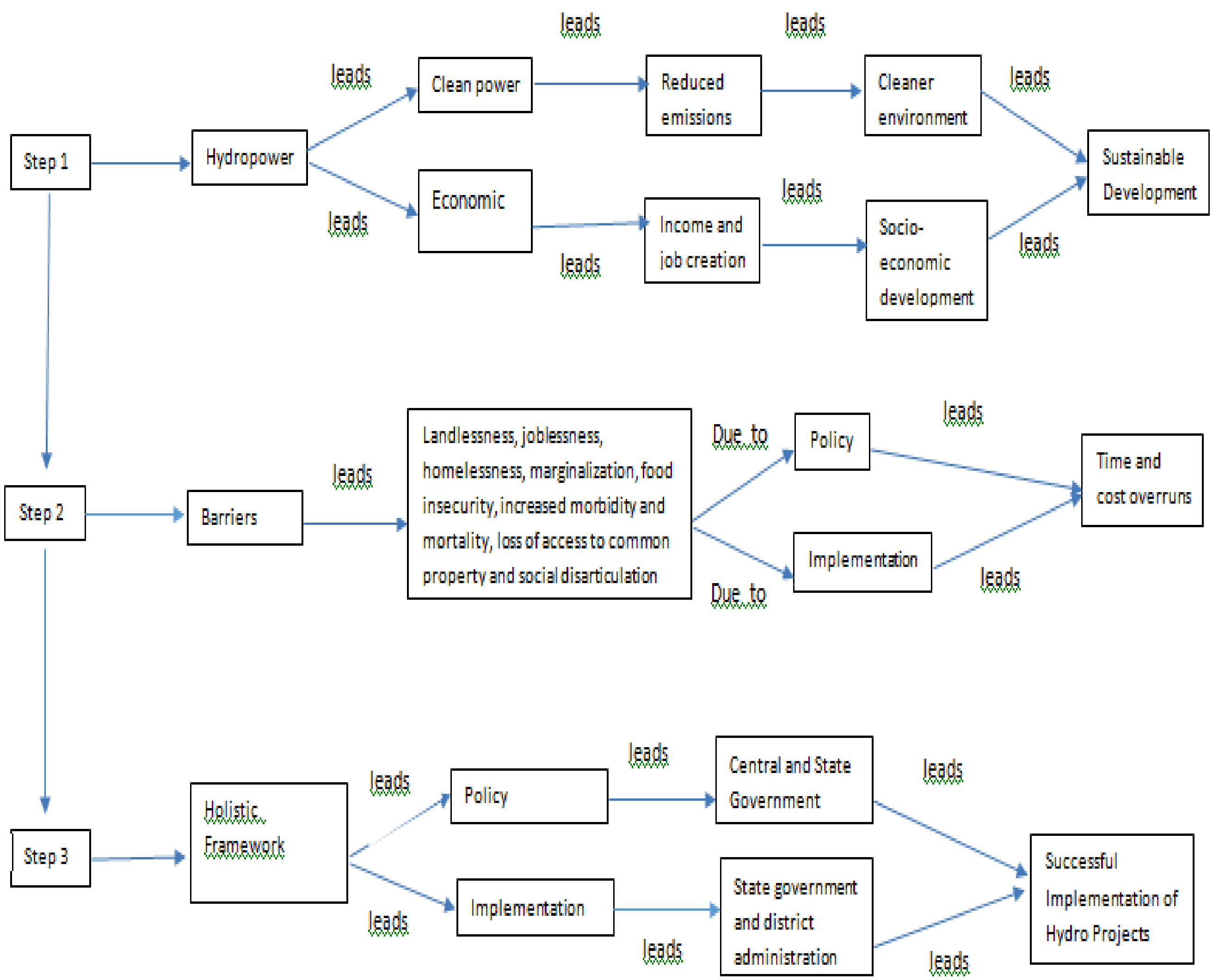


3.9 Initial Conceptual Construct



Conceptual lens:

Conceptual lens of a researcher is a collection of experiences and beliefs through which a set of data is observed (Source: Vygotsky LS 1981, Thought and Language, The MIT Press, Cambridge). The conceptual lens for the study has been developed after comprehensive review of policies, research papers, news articles and other data repositories. The conceptual lens used in the study is as follows:



Case Study Protocol:

Chapter 4

4.0 Research Methodology

Introduction

This chapter explains the methodology used in accumulating the data and analysis in response to the research questions. After this introduction, a framework of research paradigms is presented in Section 2 of the chapter where practicality as the scientific research paradigm appropriate for this study is justified. In Section 3, the choice of case study method is justified as a laborious empirical inquiry for this study, while in Section 4, a range of criteria for judging the quality of case study design is presented. The issue of the theory with the case study research and the arguments therein is explained in Section 5. Section 6 presents the choice of a case study with multiple embedded sub-cases justified by extensive references to the research identifying criteria for justification. In Section 7, the research instruments for data accumulation are discussed, including the role of the case study protocol and the selection criteria for interviewees. Section 8, highlights how the data collected would be analyzed. Limitations of case study research are discussed in Section 9, while the ethical considerations are discussed in Section 10.

Justification of Research Paradigm

This section describes the nature of research paradigms, outlines four significant paradigms and justifies the selection of scientific realism for this investigation as detailed in Table 3.1. The pursuit of scientific inquiry encourages researchers to examine their important assumptions about what constitutes reality, knowledge and inquiry regarded as issues in ontology, epistemology and methodology respectively (Guba, E.G., Lincoln, Y.S. 1994; Perry, C., et al.1999; Sobh, R., Perry, C. 2005; Lincoln, Y., et al.2011) (Bugabo, 2013). The research community has coined different sets of rules into what has come to be known as the ‘scientific paradigms’; understood as perspectives for determining how researcher’s outlook, inspect and understand reality (Bugabo, 2013) (Creswell, J. W. 2007; Bryman, A., Bell, E. 2011).

A paradigm is “a worldview consisting of a set of basic beliefs or metaphysics that deals with ultimate or first principles” (Guba, E.G., Lincoln, Y.S. 1994: pp107). It involves a framework of beliefs, values shared by the members of a professional research community (Carson, D. J., et al. 2001; Bryman, A., Bell, E. 2011). In this sense, a paradigm defines the nature of the world, the individual’s place in it and the range of possible relationships to that world and its parts. People whose research is based on a traditional paradigm are committed to the same rules. “The commitment and the apparent consensus that it produces are the bases for the genesis and continuation of a particular research focus and set of answers” (Kuhn, T.S. 1962: pp11). Inquiry paradigms ‘define for researchers what they are about and what falls within and outside the limits of legitimate inquiry’ (Guba, E.G., Lincoln, Y.S. 1994, pp108).

There are two approaches to theory development: deductive theory testing and inductive theory building (Perry, C. 1998; Bryman, A., Bell, E. 2011). Their differences are reflected in two main scientific paradigms: the deductive approach represented in the positivist paradigm, and the inductive approach represented in the phenomenological (Easterby-Smith, M., et al .2008; Smith, A. 2009) or interpretive (Carson, D. J., 2001; Bryman, A., Bell, E. 2011) paradigm. The latter includes three further differentiated paradigms including critical theory, constructivism and realism. These alternative inquiry paradigms compete on three fundamental but interconnected assumptions (Guba, E.G., Lincoln, Y.S. 1994; Healy, M., Perry, C. 2000; Sobh, R., Perry, C. 2005) given below:

1. Ontology, which refers to the form and nature of the reality that researchers investigate;

2. Epistemology, which explains the relationship between the researcher and that reality; and

3. Methodology, which defines the techniques used by the researcher to examine that reality.

Comparison of the respective assumptions of these paradigms in terms of their perspectives on the elements of ontology, epistemology and methodology are presented in the table below.

Paradigm	Elements of			Application in this study
	Ontology	Epistemology	Research Method	
Positivism	Reality is real, apprehensible and independent of the knower.	The researcher does not influence what is known even in acts of knowing such as deductions and interpretations.	It is concerned with quantitative methods such as experiments and surveys to generate data and verify hypotheses.	Paradigm is not suitable for this study as it calls for an analysis of extensive quantitative data.
Critical Realism	Reality is "real" but only imperfect, probable, apprehensible and so triangulation from many sources is required to try to know it.	This reality can be known mostly by induction; the knower is fallible influencing and being influenced by what is known and must create processes to establish and maintain objectivity.	Case studies involving in-depth interviews and triangulation of data sources.	Suitable for this study because the concern is to understand complex phenomena, whose results are to be tested for objectivity and theory building.
Critical Theory	Reality is not subsistent but is shaped by social political, economic and other forces. The role of the researcher is to liberate participants from deterministic social structures and interpretations.	The researcher transforms the reality studied proposing alternative frameworks and interpretations in accordance with own values.	Action Research	Not suitable because this perspective seeks change whereas this study seeks to explore, understand and interpret the phenomena.

Paradigm	Elements of			Application in this study
	Ontology	**Epistemology**	**Research Method**	
Constructivism	There is no subsistent reality but rather only that which is constructed by knowing Subjects.	Objectivity is not a concern as the reality is constructed by the knower	In-depth interviews	Not suitable because objectivity is a critical concern for this study

Source: Adapted and modified from Sobh, R., & Perry, C. (2005: pp1195); Perry, C., Riege, A., Brown, L (1999: pp1950).

A researcher often chooses the paradigm that best suits the nature of the inquiry being conducted. For research purposes, data can be quantitative or qualitative (Perry, C. 1998; Yin, R. K. 2009; Bryman, A., Bell, E. 2011). Qualitative research provides insights and understandings, while quantitative tries to generalize these insights into a population. Qualitative research is appropriate when 'the need is to understand certain phenomena' (Carson, D. J., et al. 2001: pp 64).

Theories are developed through the process of inductive reasoning (Perry, C. 1998), described by Zikmund, W.G. (1997:pp28) as 'the logical process of establishing a general proposition based on the observation of particular facts'. The constructivism paradigm holds that individuals or groups construct realities that are not 'true' but are based on their own perceptions of reality (Perry, C., et al. 1999). Thus, the findings of the research are constructs about which there is a general consensus. On this basis, the constructivist paradigm was also rejected for this study.

The critical theory paradigm (Table 3.1) was rejected in that the concern of this study is to identify what are barriers in development of hydropower stations in the state of Uttarakhand in India.

Justification for the critical realism paradigm

The research for the study was an in-depth study seeking to identify and assess the 'barriers in hydropower station development in Uttarakhand'. In the process of seeking to identify barriers there were many perceptions to observe directly in the social world. Human behavior includes un-observable phenomena such as emotions, perceptions, interpretations, values and beliefs, which cannot be understood without reference to the meanings and purposes attached by human actors to their activities (Guba, E.G., Lincoln, Y.S. 1994; Sobh, R., Perry, C. et al 2005). Such observable phenomena constitute the qualitative data for this study in the attempt to provide answers to the research problem (Easterby-Smith, M., et al 2008). The task of the researcher was to understand the different constructions and meanings people placed on their experience. The data by which such phenomena were observed consisted of words which provided rich insight into meanings and behavior (Carson et al. 2001). In this context, qualitative research methods served the investigation of management decision-making better than many other research methods (Carson, D. J., et al. 2001; Easterby-Smith, M., et al. 2008; Bryman, A., Bell, E. 2011). Based on the argument in this section, the choice of the critical realism paradigm is justified for this study.

Research Methodology Selection

Academic research is mainly classified in terms of purpose, process, logic and outcome. However, each category is further classified into different sub-categories. In terms of the purpose, research is categorized into exploratory and explanatory (Roberts, A; Wallace, W. 2005). In terms of the process, the research is classified into qualitative and quantitative. In terms of logic, research is classified into deductive and inductive. In terms of outcome, research is classified into applied research and pure research (Roberts, A. et al. 2005). Academic research perspectives sometimes are based on grounded theory. Each of these distinctions was explored in turn and the research strategy classified accordingly. The case study research methodology was considered an appropriate research strategy for this study on the basis of the justification given below.

Exploratory and Explanatory Research

In identifying the purpose of the research, it is essential to provide answers to the fundamental questions such as why the subject needs to conduct research (Aaker, A. A., et al. 2001). The purpose can be framed as either exploratory or explanatory. Explanatory (analytical), seeks to show a relationship between two variables in which one variable leads to a specific effect on the other (Cooper, D.R., Schindler, P.S. 2008), whereas, Exploratory research aims to look for patterns, ideas or hypothesis rather than testing or confirming a hypothesis against empirical evidence, in which the data is based on observation or experience (Trochim, W. M. 2006; Yin, R.K. 2009). The focus is on getting insights and familiarity with the subject area for more rigorous investigation at a later stage. Exploratory research forecasts the likelihood of a similar situation occurring elsewhere while identifying and controlling the variables in the research activities (Bryman, A., Bell, E. 2011). The purpose of this study is to explore the barriers of hydropower development; hence, the research is more of exploratory in approach than otherwise.

Qualitative research and Quantitative research

In terms of the process, research can be divided into two parts: qualitative and quantitative. The findings of the qualitative research are not arrived at by statistical procedures (Guba, E.G., Lincoln, Y.S. 1994). The data collected is concerned with the real views/opinions of people: what they say, how they perceive, understand and experience the EWRM implementation. It is about organizational functioning, social movements, cultural phenomena and interactions between social factors (Creswell, J.W. 2007; Cooper, D.R., Schindler, P.S. 2008). The findings of the quantitative research focus on the quantification of phenomena to produce findings using numerical data through an objective, formal and systematic process (Guba, E.G., Lincoln, Y.S. 1994; Saunders, M., et al. 2009; Bryman, A., Bell, E. 2011).

A lot of debate has been raging on, about the two approaches. However, in this study quantitative and qualitative data is collected for the same study (Patton, M. Q. 2002), and employed in a complementary fashion (DeRuyter, K., Scholl, N. 1998), to the extent that it has not involved an either-or methodological choice (Mason, J. 1996) except where it is appropriately justified. The mixed approach techniques allowed the strong points of one to balance the weak points of the other (DeRuyter, K., Scholl, N. 1998). It is not a question of whether quantitative research is better than qualitative research, but which approach is more relevant to the research problem and the context of the investigation (Gable, G.G. 1994). In view of the above, a mixed approach is considered appropriate for this study.

Inductive research and Deductive research

Research can be classified into either inductive or deductive research. Inductive research is a study in which theory is developed from the observation of empirical reality (Bryman, A., Bell, E. 2011). General assumptions are induced from particular instances; from individual observation to statements of general patterns or laws. Thus, inductive research moves the study from specific to general. In contrast, deductive research is a study in which a conceptual and theoretical structure is developed and then tested by empirical observation (Bryman, A., Bell, E. 2011). The particular instances are deduced from general inferences in order to move from general to particular (theory- hypothesis- observations-confirmation). Arising from literature review little has been written about the nature of EWRM implementation barriers in African telecommunications enterprises, so there is no sufficient basis to develop a hypothesis. Hence this research is classified as inductive.

Applied research and Pure research

In terms of the outcomes applied research is designed to apply its findings to solve a specific and existing pragmatic problem (Easterby-Smith, M., et al.2008; Saunders, M., 2009). Applied research develops a real-world scenario utilizing pure research. In this sense, applied research builds on selected findings from pure research (Saunders, M., 2009). Like pure research, applied research focuses on original investigation in order to acquire new knowledge (Yin, R.K. 2009). However, it is diverted primarily towards a specific practical aim or objective (Easterby-Smith, M., et al .2008; Zikmund, W.G., et al. 2010). In contrast, pure research is less specific in nature and is conducted primarily to improve understanding of general issues without emphasis on its immediate application. The research questions in applied research are designed to produce comprehensive information on both the implementation and the effects of interaction. Applied business research in this sense includes identification of barriers of hydropower development, also how to mitigate the barriers and is essentially problem solving rather than theory generating; hence this is what is pursued in this case study.

Case Study Method

The case study research method involves learning about a complex phenomena based on an in-depth understanding of that phenomena (Noor, K. B. M. 2008; Vissak, T. 2010). The understanding is obtained by extensive description and exploration of an analysis of that phenomenon taken as a whole in the context of specific organization (Eisenhardt, K., M. 1989; Yin, R.K. 2009; Briggs, A., Coleman, M. 2007). Case study method is defined as:

"…a research method which focuses on a particular part of an organization or an industry within its context in order to rigorously explore and analyze contemporary real-life experiences in-depth, using a variety of evidence." (Riege, A., Nair, G. 1996: pp142)

An entire organization may be studied in-depth with meticulous attention to detail, with in-depth interviews providing understanding of a complex situation, gaining insight and suggesting hypotheses for quantitative research (Zikmund, W.G. 1997; Noor, K. B. M. 2008). Yin.R.K (2009, pp11) suggests that:

"…the case study's unique strength is its ability to deal with a full variety of evidence—documents, artefacts, interviews and observations—beyond what might be available in the conventional historical study".

The design of case study research is not totally isolated but often uses other methods such as grounded theory to some extent (Yin, R.K. 2009; Bryman, A., Bell, E. 2011). The case study approach is selected for the current study and the reasons are explored below.

Aim of the Case Study

Case studies describe phenomena, which help to develop theories (Yin, R.K. 2009). Case studies make it possible to understand the means social actors or managers assign to their own experiences. The detailed, in-depth description rendered by the case study permit the understanding of the empirical foundations of the theory (Vissak, T. 2010). The case study approach appears ideal for this study since it is used to present an account of the state's hydropower development. Case study research satisfies the qualities of qualitative research of describing, understanding, explaining and identifying the barriers in the hydropower development which this research is set to explore.

Why Case Study fits with the research paradigm

The interpretive/realism paradigm addresses concerns related to the changing and dynamic nature of EWRM from a holistic perspective. The key objective of this research is to explore the barriers in the Hydro power development from an interdisciplinary perspective. It is achieved through analyzing the issues and concepts related to Hydro power development as established in the literature and the phenomena perceived in power and economic scenario for state of Uttarakhand in India. It is necessary to explain the direct experiences of managers from the perspective of social relationships that constitute their experiences towards the risk management in the development of infrastructure. It is from the above perspective that the case study is found to be an ideal method when holistic, in-depth investigation is needed (Carson, D. J., et al. 2001; Yin, R.K. 2009; Bryman, A., Bell, E. 2011) and the case study approach is deemed suitable to serve the purpose of this study.

Strategy	Form of research question	Control required over behavioral Events?	Focuses on contemporary Events?	Application in this research study
Experiment	How, why?	yes	yes	Not applicable as the study has no control over behavioral events
Survey	Who, what, where, how many, how Much?	no	yes	Not applicable as none of these questions are being addressed by this study
Archival analysis	Who, what, where, how many, how much?	no	yes/no	Not applicable as none of these questions are being addressed by this study

Strategy	Form of research question	Control required over behavioral Events?	Focuses on contemporary Events?	Application in this research study
History	How, why?	no	no	Not applicable because the study focuses on contemporary events
Case Study	How, why *what?	no	yes	Applicable for this study. The question being asked is ‘*what’ (Yin 2009:pp11), whereas the usual is a ‘how’ or a ‘why’. The study has no control over behavioral events and focuses on contemporary events

Source: Yin (2009: pp8).

Case study method is preferred when the question is a ‘how’ question, (this case study has posed the main problem as *a ‘what’ as the initial focus -Creswell, J. W. 2007:pp107; Yin, R.K. 2009:pp11) since the inquiry focuses on contemporary events, and the researcher has no control over the events being studied (Yin.R.K. 2009). The research problem is “What are the Barriers for the development of hydropower development in the state of Uttarakhand?” Events were not historical in that the inquiry sought to generate contemporary descriptive data for analysis. Given that the data sought were qualitative and involved the perceptions, interpretations, meanings, emotions and values of interviewees, the researcher could not have control over the events being studied. Based on this background, a case study research strategy is justified for this study.

Criteria for judging the quality of case study design

This section discusses the criteria by which the quality of case study research is judged by the construct validity, internal validity, external validity and reliability (Cohen, L., et al.2007; Yin, R.K.2009). The specific tactics employed at each stage of this research to ensure a high-quality outcome, are summarized in the table below and discussed further.

Tests for Quality in Case Study Method

Tests	**Case study Method**	**Phase of research applicable**	**Methods in this Research study**
Construct validity	Use multiple sources of evidence, establish chain of evidence and review draft case study	Data collection	1) Multiple sources of evidence consisting of multiple embedded Sub-cases with in-depth semi-structured interviews. 2) Chain of evidence created through development of case study protocol; linking of protocol content to research questions.
Internal validity	Pattern-matching	Data analysis	Choice of multiple embedded Sub-cases.
External validity	Use replication logic, in multiple case studies	Research design	Choice of multiple embedded Sub-cases, using replication logic.
Reliability	Use case study Protocol. Develop case study data base	Data collection	1) Development of case study protocol used across all sub-cases. 2) Development of case study database consisting of case study notes, documents including interview transcripts.

Tests	Case study Method	Phase of research applicable	Methods in this Research study
Credibility Dependability Conformability	Literature Review Research Design Data Analysis Implications and Conclusions		1) Careful interpretation of literature review 2) Careful justification of the qualitative research methodologies established in this chapter. 3) Careful structuring of the data analysis to ensure full and descriptive evaluation and assessments.

Construct validity

It deals with the development of a sufficiently operational set of measures used to collect data (Yin, R.K.2009). Tactics are used to increase construct validity in this research, which includes triangulation (Appendix M) of data through the use of multiple sources of evidence. These sources include an extensive literature review, case study research protocol, pilot study, documents collected during the case studies, and multiple interviewees for collection of both quantitative and qualitative data.

Internal validity

It is concerned with the internal coherence of the findings and the validity of causal relationships between variables investigated (Yin, R.K.2009). Case study research generally only allows for such relationships to be suggested within the study context rather than establish causation (Perry, C., et al. 1999), however, in this type of research, a high degree of internal validity is achievable due to the possibilities for cross-checking. For this research, internal validity was enhanced by the use of pattern matching and explanation building. Pattern matching involved comparing predictive patterns with multiple embedded

Sub-cases and explanation building involved analyzing the collected data about the Sub-cases (Yin, R.K.2009).

External validity

This relates to how a generalization of findings of the study can be applied more generally to other cases beyond the immediate case study (Easterby-Smith, M., et al .2008; Yin, R.K.2009). In case of study methodologies, the researcher is generalizing the findings to a broader theory - analytic generalization - rather than to a broader population - statistical generalization (Yin, R.K.2009; Bryman, A., Bell, E. 2011). In this research, external validity was enhanced by the use of theoretical and literal replication (Section 3.6.4) in the selection of cases and via comparison of the findings with the literature (Yin, R.K.2009).

Reliability

This is concerned with the minimizing of errors and biases in the study so that a later investigator following the same procedures would arrive at the same findings and conclusions when conducting the same case study (Yin, R.K.2009). The reliability of case study research is often criticized due to its flexibility and absence of experimental control (Bryman, A., Bell, E. 2011). Reliability in this research was enhanced by the use of a case study research protocol, database and an interview guide.

Prior theory and case study research

The role of prior theory and the extant literature in case study research is discussed in this Section. Prior theory is critical in the defining of the research question in theory-building research and aids in determining both the type of organization to be studied and data to be collected (Eisenhardt, K. M. 1989).

Prior theory in qualitative research

It has been suggested that the theory-building researcher should commence with no prior theory or hypothesis as “pre-ordained theoretical perspectives or propositions may bias and limit the findings” (Eisenhardt, K. M. 1989: pp536). However, prior knowledge will inevitably influence the researcher who should be aware of this and avoid “uncritical appropriation of this reserve of ideas" (Perry, C. 1998: pp788). Thus starting from scratch with an absolutely clean theoretical slate is neither practical nor preferred.

Indeed, prior theory can enhance a constructive validity by allowing the development of more accurate measures in interview protocols and questionnaires and internal validity and reliability via the comparison of research findings with the extant literature (Eisenhardt, K.M. 1989). Inductive research is where theory emerges from data, whereas deductive research involves theory definition by the data (Eisenhardt, K. M. 1989; Easterby-Smith, M., et al. 2008). While some researchers have argued for more induction in case study research (Eisenhardt, K. M. 1989) and others for more deduction (Yin, R.K. 2009), it is unlikely that any researcher could, in reality, pursue a pure form of either approach, or want to. Perry, C. (1998, pp6) observes:

"Pure induction might prevent the researcher from benefiting from existing theory, just as pure deduction might prevent the development of new and useful theory"

Other researchers have argued that inductive and deductive methods are in fact complementary and should be exploited as such via research that combines both elements (Bryman, A., Bell, E. 2011). This is the approach considered most appropriate for this research as it allowed the researcher to benefit from existing theory. Thus, the prior theory is viewed as some additional evidence that is used to triangulate on the external reality of the case study (Sobh, R., Perry, C. 2005). A prior theory provides sensitizing concepts for the research, while the data provides indigenous concepts for analysis and comparison. Thus, based on these perspectives the researcher reviewed the literature on barriers of hydropower development which gave a basis for formulating the research questions.

Criteria for selecting the one case study with multiple embedded Sub- cases

Qualitative research in general, and case study research methodology in particular, is faced with the challenge of overcoming a conceived bias, particularly from the academic community in relation to what are regarded as appropriate outcomes for the interpretive paradigm (Tellis, W. 1997; Carson, D. J., et al. 2001; Vissak, T. 2010). The conceived bias is based on assumption that the best scientific research produces statistical generalizations. This creates a source of a misunderstanding of the kind of generalizations and outcomes appropriate for qualitative research (Tellis, W. 1997; Carson, D. J., et al. 2001; Yin, R.K. 2009). The bias stems from the traditional dominance of the positivist paradigm in scientific inquiry. The proposal of a one case study, albeit with embedded Sub-cases (Yin, R.K. 2009), may risk falling foul of such bias and confusion. Tellis, W. (1997, pp2) expressed it as:

"The inappropriate manner of generalizing assumes that some sample of cases has been drawn from a larger universe of cases. Thus, the incorrect terminology such as 'small sample' arises, as though a single-case study were a single respondent".

The kind of outcomes which underpinned the choice of the single case study with embedded Sub-cases for this research was clarified and justified in the following sub-section.

Summary of Authors who considered a single case study as a substantive, in-depth and valuable research methodology

A review of the methodological literature identifying six criteria for justification.	***Authors who regard the single case study as a Substantive and valuable research methodology***
1) Comprehensive, rigorous exploration	Yin, R.K. 2009; Eisenhardt, K. M. 1989
2) Meticulous attention to detail	Tellis, W. 1997; Zikmund, W.G., et al. 2010; Yin, R.K. 2009.
3) In-depth analysis	Carson, D. J., et al. 2001; Yin, R.K. 2009
4) Results in in-depth understanding	Carson, D. J., et al. 2001; Zikmund, W.G., et al. 2010; Yin, R.K. 2009.
5) Provide analytical generalization	Carson, D. J., et al. 2001; Yin, R.K. 2009
6) The researcher must be closely involved with the phenomena and have the capacity of in-depth analysis and understanding and good descriptive and analytic language.	Carson, D. J., et al. 2001; Yin, R.K. 2009

Source: Bugabo, 2013 (Pg. 77)

Yin's three criteria on justification of the single case design.

Further justification of the single case study is proposed by Yin, R.K. (2009:pp47). He suggests that any one of three conditions justifies the choice of single case design:

a) "The first is the critical or extreme/unique case which provides an opportunity for testing a well-formulated theory, that is where the theory has a clear set of propositions, as well as the circumstances within which the propositions are believed to be true. This is not applicable to this case study".

b) "The second is that of the extreme or unique phenomenon; which occurs so rarely that an investigator has an opportunity to observe and analyze a situation or event previously inaccessible to scientific investigation. Again this is not the situation in this study".

c) "The third condition is that of the 'single revelatory case'. This occurs when an investigator has an opportunity to observe and analyze a phenomenon, not rare, but previously inaccessible to scientific investigation. This happens when few social scientists have had the opportunity to study the phenomenon closely and justifies the use of a single case study on the grounds of its revelatory nature".

This is precisely the situation in (point c) which this investigator found. Chapter of Literature Review established that there was little research in this area. The importance of the researcher being close to the phenomenon, in fact immersed in it (Carson, D. J., et al. 2001) as mentioned above, and provides a rare opportunity to study a revelatory case. 'This closeness constitutes the quality of the research process that gives the richness and meaning to outcomes' (Carson, et al. 2001: pp218). Thus, Yin's third rationale clearly justifies the choice of the single case study for this investigation. It may be appreciated; however, the study is not merely a single case, but one with the added richness of embedded Sub-cases- the subsidiary companies of Jaypee Group selected for this study. Within each Sub-case, an in-depth analysis involved in-depth semi-structured interviews of senior and middle level management had been detailed in chapters following this one. Based on the arguments, the choice of a case study for this investigation is justified.

Case study protocol

A case study protocol included an overview of the study, the field procedures followed, interview questions and a guide for the research report (Yin, R.K. 2009.pp79). Its development and use enhanced the reliability of multiple Sub- case study design allowing the researcher to outline prior to data collection the procedures to be followed and data collection instruments to be used. Case study questions for this research were constituted by the research questions.

Selection of Number of Cases

There is no agreement on how many cases should be included in a study. The decision regarding the number should be left to the individual researcher (Romano, C. 1989; Patton, M.Q. 1990). Gummesson, E. (2000) suggests that the researcher should stop adding cases when theoretical saturation is reached. However, other researchers (Hedges, A. 1985; Miles,M. B., Huberman, A. M. 1994; Ellram, L. M. 1996) suggest that the maximum number of cases should not be over 12 to 15 because any number greater than 15 could generate too much information for the researcher to follow the possible local dynamics; and lower limit of two to four cases is seen as the minimum acceptable requirement (Eisenhardt, K. M. 1989).

Selection of Unit of Analysis and Number of Interviewees

This Sub-Section justifies the selection of stakeholders and the interviewees for the study. The researcher selected stakeholders to ensure richness of data obtained for good analysis and construct validity.

From each of the stakeholders, two interviewees were planned. They were selected because of their unique positions (Yin, R.K. 2009.pp91) within each case. They have ability to provide perspectives on the implementation barriers of hydropower, in their respective operations. Senior management provides the tone from the top for the implementation of the EWRM, and it should be supported by the middle-level management. The decision to include the two levels of management categories was guided by the desire to examine whether or not the experience, attitudes, understanding and perceptions of the middle-level management contrasted with those of their more senior colleagues with respect to the implementation barriers.

Triangulation

The concept of triangulation argues that researchers should employ more than one method or source of data in the study of a social phenomenon so that the findings may be cross-checked (Bryman, A., Bell, E. 2011:pp720). In critical realism, especially in research where the organizational and social reality is complex (Yin, R.K. 2009) there is a need for investigation of the different aspects and viewpoints of that one reality. Triangulation was achieved in this study by interviewing multiple managers (Roberts, A. et al. 2005:pp3/6) from the functions as described in sub-section 3.7.5 (the embedded sub-cases) and compared interview results with publicly available documents on the company websites (see Appendix M). Triangulation was achieved by collecting data from the sub-cases (X, Y & Z) using semi- structured in-depth interviews (See Appendix A, and the Appendices D-H for selected comment outcomes), and cross-checked the information with the web-based documents (Appendix M). Multiple sources of evidence enhanced the validity of the data analysis (Patton, M.Q. 1990; Yin, R.K. 2009).

Data analysis procedures

Case study based research has its foundation on review of relevant literature, careful selection of cases, and by careful analysis of data to build a new theory about complex issues (Perry, C. 1998). Gaps from the literature were expressed in the form of open research questions. The quality of the cases selected, the validity, meaningfulness and insights generated from qualitative inquiry, depending on the analytical capabilities of the researcher (Carson, D. J., et al. 2001:pp106). To ensure high-quality analysis, four principles guided the analysis of the data in Chapter Four (Yin, R.K. 2009:pp160) namely:

a) An illustration that the analysis relied on all relevant evidence,

b) Inclusion of all major rival interpretations,

c) Identification and discussion of the most significant aspect of the study,

d) Use of the researcher's prior expert knowledge to further the data.

Given the nature of the data collected and the level of development of prior theory, a clear framework was developed to present and analyze the data, thereby allowing the data to be put together with descriptions, explanations, analysis and commentaries (Chenail, R. 1995). As stated earlier, the unit of analysis was sub-case-company as presented in the following chapters. Each unit was analyzed first, beginning with a brief profile of the company. Data relating to each of the research questions were analyzed in terms of in- case and intra- case in graphical presentations.

Limitations of case study research

This study is that of a single case with multiple-embedded Sub-cases, scientific generalization is not possible. While scientific generalization is not the aim of the study, its absence points to a limitation in that what is discovered about this one firm may not be generalized to all firms (Noor, K. B. M. 2008). In this sense, the study does not provide a test of this theory. Theory testing will be a further development of the findings of this research (Yin, R.K. 2009). Case study research has frequently been accused of subjectivism or risk of bias (Perry, C. 1998; Rowley, J. 2002; Noor, K. B. M. 2008; Yin, R.K. 2009; Vissak, T. 2010). However, the origin of this criticism could be traced to the dominance of the positivist paradigm with its own illusion of objectivity (Yin, R.K. 2009; Vissak, T. 2010; Bryman, A., Bell, E 2011). Issues of reliability, validity and transparency are addressed in the methodology itself (Gummesson, E. 2000; Carson, D. J., et al. 2001; Yin, R.K. 2009) very comprehensively in Section 3.4. Based on the methodology as described; the criteria for trustworthiness, including the dimensions of credibility, dependability and conformability are met for purposes of this study.

Ethical considerations

Carson, D. J., et al. (2001) and Zikmund, W.G., et al. (2010) summarize ethical considerations to include the right of interviewees to confidentiality, anonymity, privacy, and informed consent. The investigator ensured the security of data, the protection of the identity of all interviewees and the maintenance of confidentiality and security of information, as described in Section 3.7.3. Interviewees were assured of anonymity and privacy by means of the coding represented in tables 3.6 & 3.7 respectively. Permission of each interviewee and associated recording was sought. Safe keeping and the location of tapes and transcripts were explained. The fact that there was only one investigator simplified the task of security of data. Tape recordings are retained by the investigator and transcripts are kept in a safe place.

4.1 Theoretical Premise for Research Method

4.1.1 Theory of Natural Resource Utilization and Economic Growth:

Various theories of natural resource utilization and management indicate that there is a strong linkage between sustainable natural resource utilization and economic growth [Chambers and Guo, 2007]. Hydropower is generated through sustainable utilization of natural resource (water reservoir) that enables a state to generate green power and earn a significant amount of revenue (as estimated earlier). It also leads to the creation of ample job opportunities during its planning, construction and operation. Thus, hydropower development in the State of Uttarakhand is linked to the ‘Theory of Natural Resource Utilization and Economic Growth’.

4.1.2 Theory of Opportunity Cost:

The opportunity cost of a choice is the value (not a benefit) of the choice of the best alternative lost while making a decision. A choice needs to be made between several mutually exclusive alternatives.

4.1.3 Prospect theory adopted for Uttarakhand:

Hydropower constitutes the main power generation apparatus in Uttarakhand. The state is currently developing three mega projects with an installed capacity above 400 MW and many more hydroelectric projects are being considered. In spite of the need to expand electricity service coverage, the social consciousness about the necessity of new hydropower generation developments and the expertise teams behind their execution, uncertainty over environmental impact is rarely totally estimated. This study uses the cumulative prospect theory by Kahneman and Tversky, to determine the scenarios in which large organisations tend towards losses among the uncertain environmental impact situations. It also will set prospect theory in an original and practical update arena to modelling the decision-making process and propose a policy, which manages to turn losses, linked to uncertainty, into income opportunities by enforcing the uses of external data.

4.2 Research Approach

An entirely new situation arises when your case study has been deliberately designed to be part of a larger, mixed methods study (Yin, 2006). In this situation, the larger study encompasses the case study. The larger study will contain completed case study but also should report separately the findings about the data from the other methods. The larger study's overall report would then be based on the pattern of evidence from both the case study and the other methods.

This mixed methods situation deserves a bit more attention so that we will understand its implications for our case study, even though we might not compose our case study any differently than if it had been a "stand-alone" report. At least three different rationales might have motivated the larger study to use mixed methods (Yin, 2014).

First, the larger study may have called for mixed methods simply to determine whether converging evidence (triangulation) might be obtained when different methods had been used. In this scenario, our case study would have shared the same initial research questions as those driving the other methods, but we would likely have conducted, analyzed, and reported our case study independently. Part of the larger study's assessment would then be to compare the case study results with those based on the other methods.

Second, the larger study may have been based on a survey or quantitative analysis of archival data – for example, a study of households' financial situations under different income tax conditions. The larger study might then have wanted case studies to illustrate, in greater depth, the experiences of individual families. In this scenario, the questions for our case study might only have surfaced after the survey or archival data had been analyzed, and the selection of cases might come from the pool of those surveyed or contained within the archival records. The main implications for your case study effort are that both its timing and direction may depend on the progress and findings of the other inquiries.

Third, a more extensive study might knowingly have called for case studies to elucidate some underlying process and used another method (such as a survey) to define the prevalence or frequency of such processes. In this scenario of complementarily as opposed to convergence, the case study questions are likely to be carefully coordinated with those of the other methods, and the complementary inquiries can occur simultaneously or sequentially. However, the initial analysis and reports from each inquiry should be conducted independently (even though the final analysis may merge findings from all the different methods.

In this study, mixed method study has been used because of the second rationale mentioned earlier. The barriers and risks associated with the development of hydropower projects in Uttarakhand have been assessed with the help of a survey and the barriers and risks have been ranked. Subsequently, with clear understanding of the barriers and risks affecting hydropower projects in Uttarakhand, the study conducts mainly three case studies– one each from central, state and private sectors in Uttarakhand. This is to assess, in greater depth, the hurdles to the development of hydropower projects in Uttarakhand and the potential measures to address them and harness the opportunities associated with hydropower projects in the state.

The entire study was made from several sources and inputs were gathered from different stakeholders through interviews, case studies and article review. All the keywords that emerged during the study were identified and put into a spreadsheet. There were about 3000 keywords identified. The keywords were studied in context to what it was indicating to, based on the response, interview or literature in which it was identified. Based on its relevance these keywords were grouped into the above pre-identified barriers and opportunities as indicated above. Each opportunity and barrier has been assigned unique O-CODES and B-CODES for the purpose of identification and ease of segregation. Once this initial grouping of keywords into O-codes and B-codes was completed, it was found that a total of about 800 keywords have been identified initially. The keywords of responses also fell under either the same O-code or B-code. Also, the respondents took repeated words either from the same O-code and B-code. Considering all these repeated O-codes and B-codes of the same respondent would have skewed the entire study. Hence repeated O-codes and B-codes need to be eliminated.

Further, some keywords were either so general that they did not specially point to any of the opportunities or barriers (O-codes /B-codes) pre-identified for the study framework, or were vague, irrelevant or out of context such keywords, wherever identified, were classified into 'NIL' category. Hence these responses also need to be eliminated.

For achieving saturation in the study, the identified O-codes and B-codes also had to be looked backed and examined to check where the same responses have been made by any previous respondents in either the same questionnaire of interview or article.

Tackling the above problem with near to 3000 keywords selected from the study is a task which could not be done manually and would require a tool to handle such a large amount of data.

Open source RDBMS, MySQL was used to handle this large amount of data.

RDBMS - RDBMS is a software system that facilitates the process of defining, creating, and manipulating the databases for different applications. Defining a database includes specifying the data types, structures, and constraints for the data to be stored in the database. Creating the database is the process of storing the data itself on some storage medium that is controlled by the DBMS. Manipulating a database includes such functions as querying the database to retrieve specific data, updating the database to reflect changes in the mini world, and generating required reports from the data.

The RDBMS (Relational DBMS) is an excellent tool used as a Decision Support System. In RDBMS, the data is stored in table rows and columns. The different table are related through various relationships defined through metadata using keys. Structured Query Language (SQL) is used to store, update and fetch the data from these related tables. Based on the relationships between the tables and data, the suitable set theory concepts like join and intersection are used to fetch the desired information through queries. Benefits of using DBMS to store and fetch the data have many benefits including reduced redundancy and fast retrieval of data. There are many licensed RDBMS like Oracle, IBM DB2 and Microsoft SQL Server.

Once the data from the spreadsheets were ported into the RDBMS, Set Theory was used to group the responses to visualize and organize the data to fit the research framework and arrive at an accurate conclusion.

SET THEORY - Set theory is a branch of mathematics which defines sets (a grouping of things with similar properties) and operations on them. The data organized in tables (rows and columns) is used to perform joins and getting data in all the possible combinations through relationships.

JOINT SETS - Joint sets are sets that share members

DISJOINT SETS - Disjoint sets are sets that have no shared members.

SET Unions - A combination of all databases. A set union can include the overlaps once or twice from a pair of joint datasets. These types of unions are typically carried out by outer joins, a union, or a union all.

SET Intersections - it contains overlapping members of the subjected datasets and members which exist in one dataset must exist in the other dataset. Intersections are typically carried out by equijoins (natural joins or even inner joins), an IN, and/or an EXISTS.

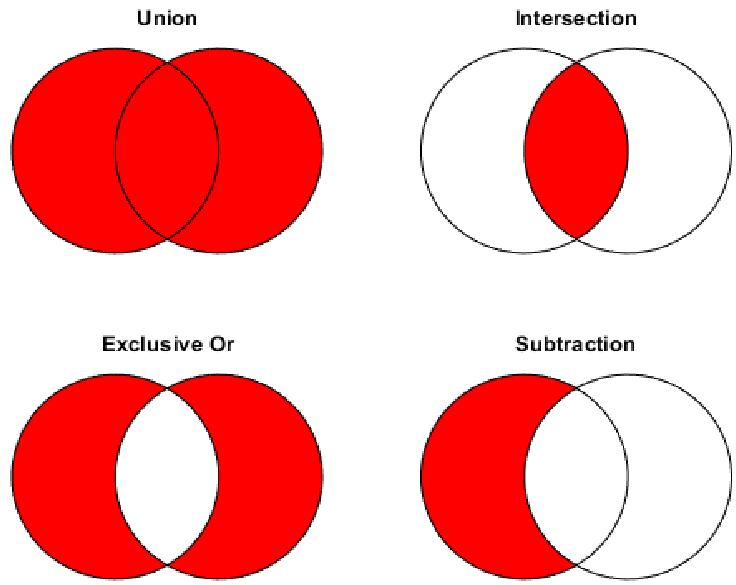
SET Subtractions - A set subtraction is the elimination of one dataset from a second dataset. Subtractions are typically carried out by a NOT IN and/or a NOT EXISTS.

SET Multiplications - A notion of set multiplication for datasets is a **Cartesian product**. The cartesian product of a given collection of datasets "explodes" to a dataset consisting of all possible combinations of elements from all datasets. They are typically creating by forming joins with no conditions.

Joins - A join is an operation which combines elements of two or more datasets by specifying which combinations (within the Cartesian product) are valid. A join then displays the combined results as a new dataset. A join may be thought of as the product of two or more sets, pivoted about some key or column and a comparison operation. The results that are returned or that are linked are those that match the search criteria specified. The results are those rows or records that are duplicated or joint on the join criteria. You can embed a join in a select, update, insert, delete, or subquery. Other search conditions and clauses may follow the join conditions.

Joins and the relational model - The join operation is the hallmark of the relational model of database management. More than any other feature, the join distinguishes relational database management systems from other types of database management systems. In a relational database management system, relationships among data values are left unstated in the definition of a database. They become explicit when the data is manipulated when you query the database, not when you create it. According to the rules of good database design, called normalization rules, each table should describe one kind of entity – a person, place, event, or thing. That is why, when you want to compare information about two or more kinds of entities, you need the join operation. Relationships among data stored in different tables are discovered by joining them.

To find out unique O-codes and B-codes, a set of O-codes was made from the specifically select case/article/interview for first respondent/article. This collection of record was named set ‘A’. Another set was made for the same case/article/interview, but for the second respondent named ‘B’.



Using SQL minus function, B-A set would then represent the O-codes which are in B and have not been previously repeated in set A. If B-A is null, it would indicate that all the O-codes that appear in B have all been repeated in the earlier responses/interview.

The same process was repeated for each of the respondents in every case study, interview and article with cumulative effect.

For example, set C-(B+A) would represent O-codes that appear in set C but have not been previously repeated either in set A or set B.

For example, set D-(C+B+A) would represent O-codes that appear in set D but have not been previously repeated either in set A or set B or set C.

New respondents were added to the point this cumulative set minus operator became null. This would represent that adequate responses and literature have been reviewed and no new findings are emerging and hence the study has reached its saturation level.
After an entire study was completed for O-codes, the same procedure was adopted for B-codes.

The research articles literature review & case study were continued and more study/inputs articles were added till NULL new O-codes or B-codes were achieved.

4.3 Data Collection

The study utilizes both primary and secondary data.

- In the survey used to assess the opportunities, barriers and risks to the development of hydropower in Uttarakhand: Secondary data collected during a literature review was used to construct a 5-point Likert scale questionnaire. Subsequently, primary data was collected from all relevant stakeholders during the survey.
- For case studies: Secondary data has been collected from Documents and Archival Records from sources such as UJVNL, UPCL, THDC, etc. Primary data has been collected through Interviews.

4.4. Techniques Used for Data Analysis

- Weighted mean scores of risk factors (For survey data) (Risk management of hydropower development in China, Tang et al., 2013, Energy; The diffusion of solar energy use in HK: What are the barriers?, Zhang et al., 2012, Energy Policy)
- Explanation building and Cross-case synthesis (For case study data) (Case Study Research – Design and Methods by Robert K. Yin, Sage Publications, 2014)

4.5 Sample size

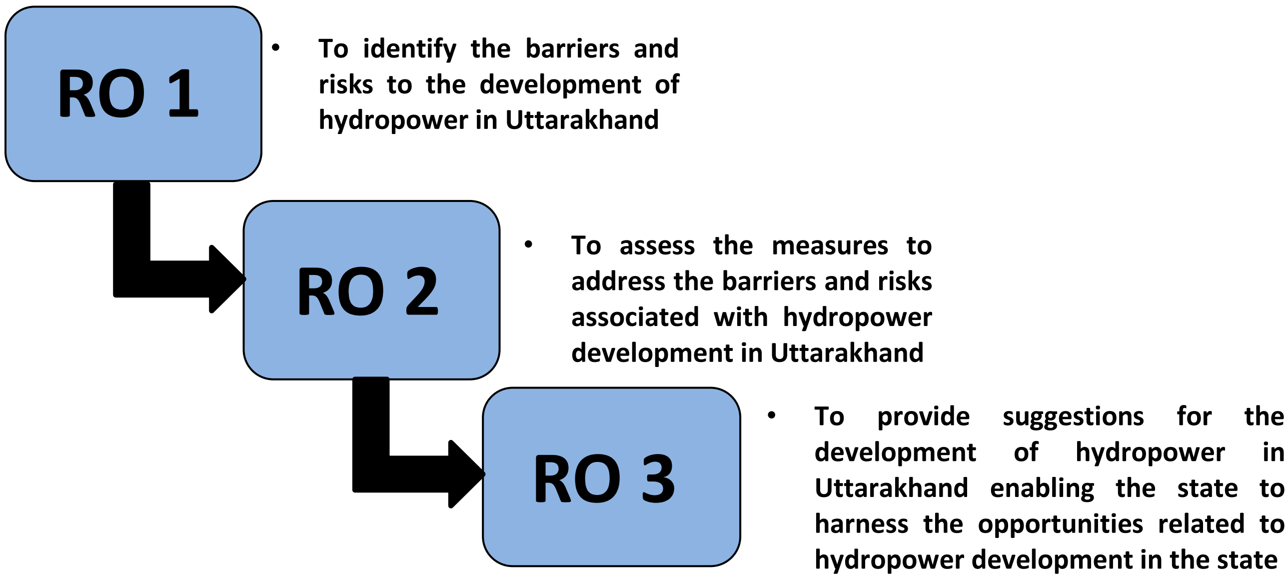
- For personal interviews: 100 stakeholders including client, contractor and policymaker (determined using Yamane's Formula for more than 1,00,000 population, ±10% Precision Level and 95% Confidence Level)
- For Multiple-case study: Sample size is determined by the number of cases required to reach saturation, that is, data collection until no significant new findings are revealed.
    - In this case, the three case studies (one each from central, state and private sector) have been conducted as it reached saturation at that point.

- Within each case study, two comprehensive documents and three in-depth interviews of project officials have been conducted to ascertain triangulation and saturation of data.

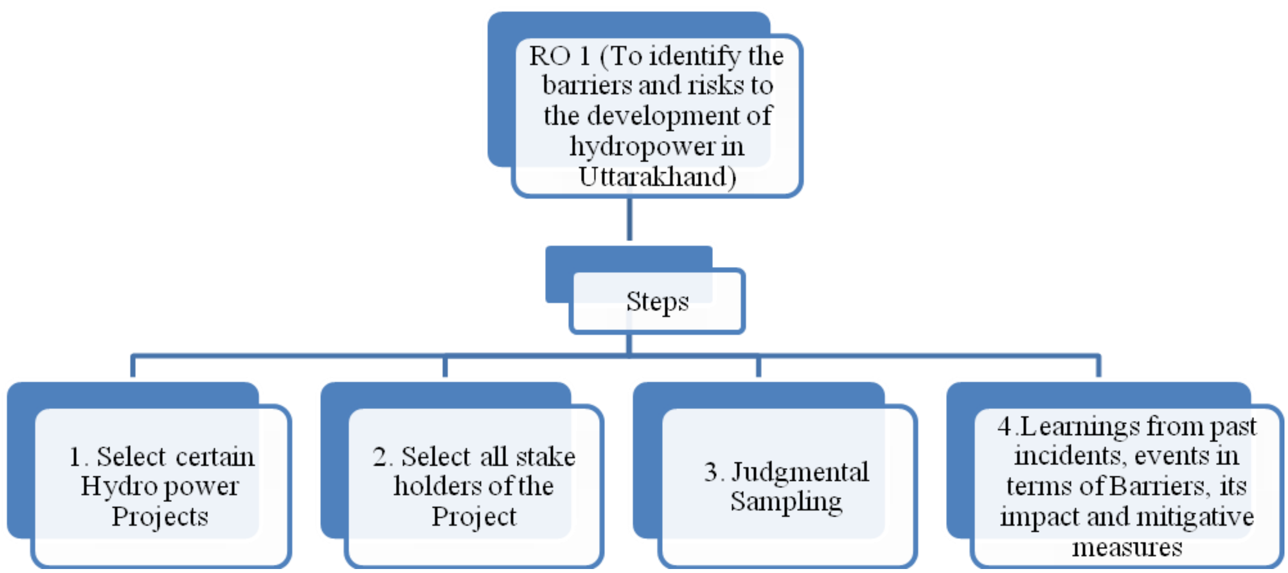
4.6 Objective Wise Research Methodology

OBJECTIVE	STEPS
RO1: To identify the opportunities, barriers and risks to the development of hydropower in Uttarakhand.	As RQ1 is "What are the major opportunities, barriers and risks for development of hydropower in Uttarakhand from the perspective of each stakeholder?" Survey using 5-point Likert Scale 1-Very Low 2-Low 3-Moderate 4-High 5-Very High
RO2: To assess the measures to address the barriers and risks associated with hydropower development in Uttarakhand. RO3: To provide suggestions for the development of hydropower in Uttarakhand enabling the state to harness the opportunities related to hydropower development	1. Why are these barriers and how to address the barriers and risks associated with hydropower development in Uttarakhand? (RQ2) 2. How to develop hydropower projects in the State of Uttarakhand that can address issues of all stakeholders and enable the state to harness the opportunities related to hydropower development? (RQ3) *Case study method has been used to answer "how" or "why" some social phenomenon works with in-depth analysis (Case Study Research – Design and Methods by Robert K. Yin, Sage Publications, 2014).* In this research, mixed method study has been used with the results of a survey being utilized to do in-depth analysis through multiple case studies.

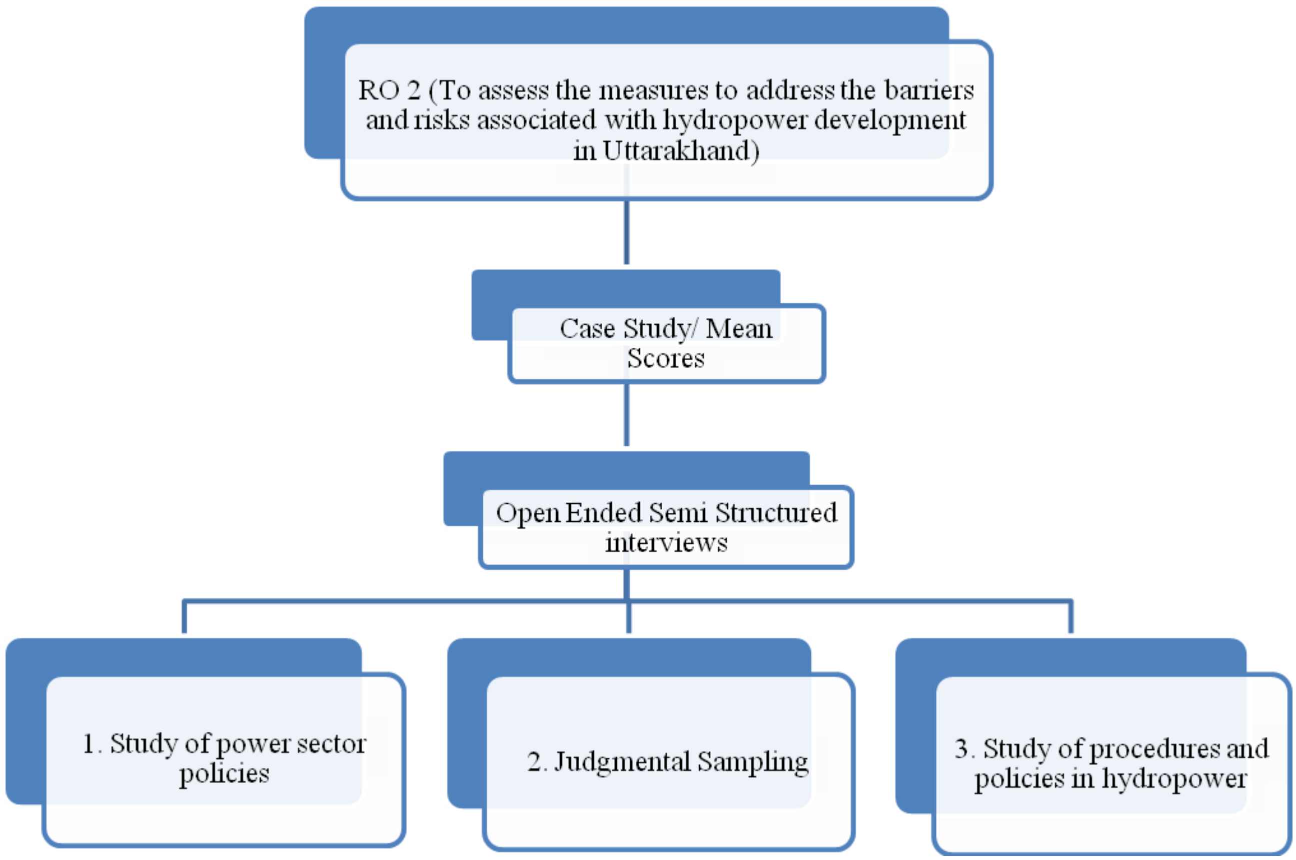
4.7 Research Framework



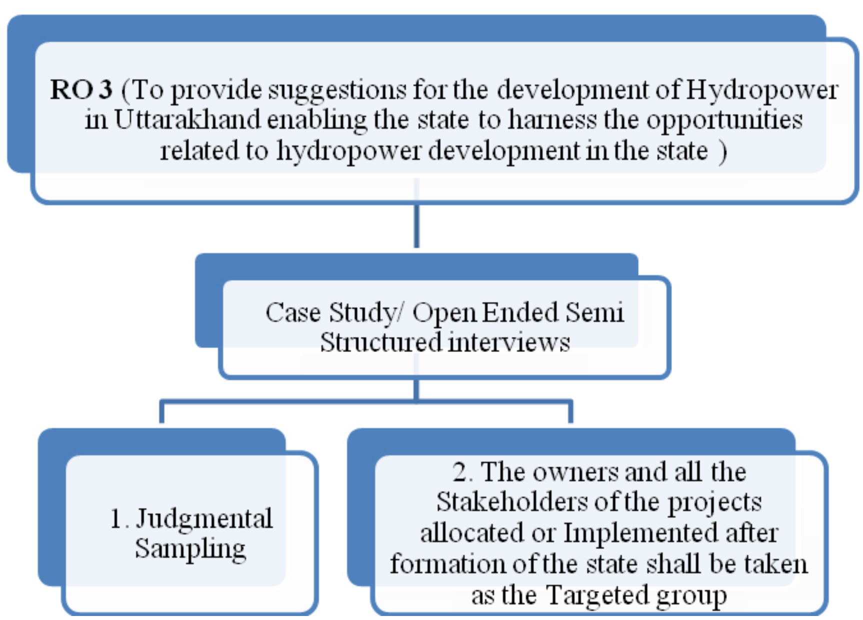
4.8 Process for Research Objective1:



4.9 Process for Research Objective2:



4.10 Process for Research Objective3:



Chapter 5

5.0 Identification of Consequent Risks related to Barriers:

5.1 PESTEL Analysis of Barriers:

Political Risks

1. Uncertainty in government policies
2. Clearances and permits from relevant organizations
3. Inadequate political support and political interferences

Economic Risks

1. Land acquisition
2. Financial constraints
3. Construction cost escalation
4. Construction delay
5. Inadequate planning
6. Logistics and supply of material and equipment
7. Quality of material and equipment
8. Currency exchange rate fluctuation and inflation

Social Risks

1. Safety concerns
2. Shortage of construction labour
3. Inadequate availability of skilled personnel
4. Poor accessibility to the site
5. Lack of coordination among stakeholders
6. Third party delays
7. Non-compliance by the contractor with contractual provisions

Technological Risks

1. Weak (old and inadequate) transmission network
2. Ineffective communication with stakeholders
3. Unrealistic estimates while bidding
4. Quality of construction work
5. The dearth of competent contractors and subcontractors
6. Delay in the tendering process
7. Incorrect estimation of the quantity of material and equipment requirement and subsequent variations
8. Delay in the supply of drawings
9. Inappropriate designs and consequent deviations
10. Obsolete construction method and technology
11. Deviations in the scope of work
12. In-appropriate risk allocation

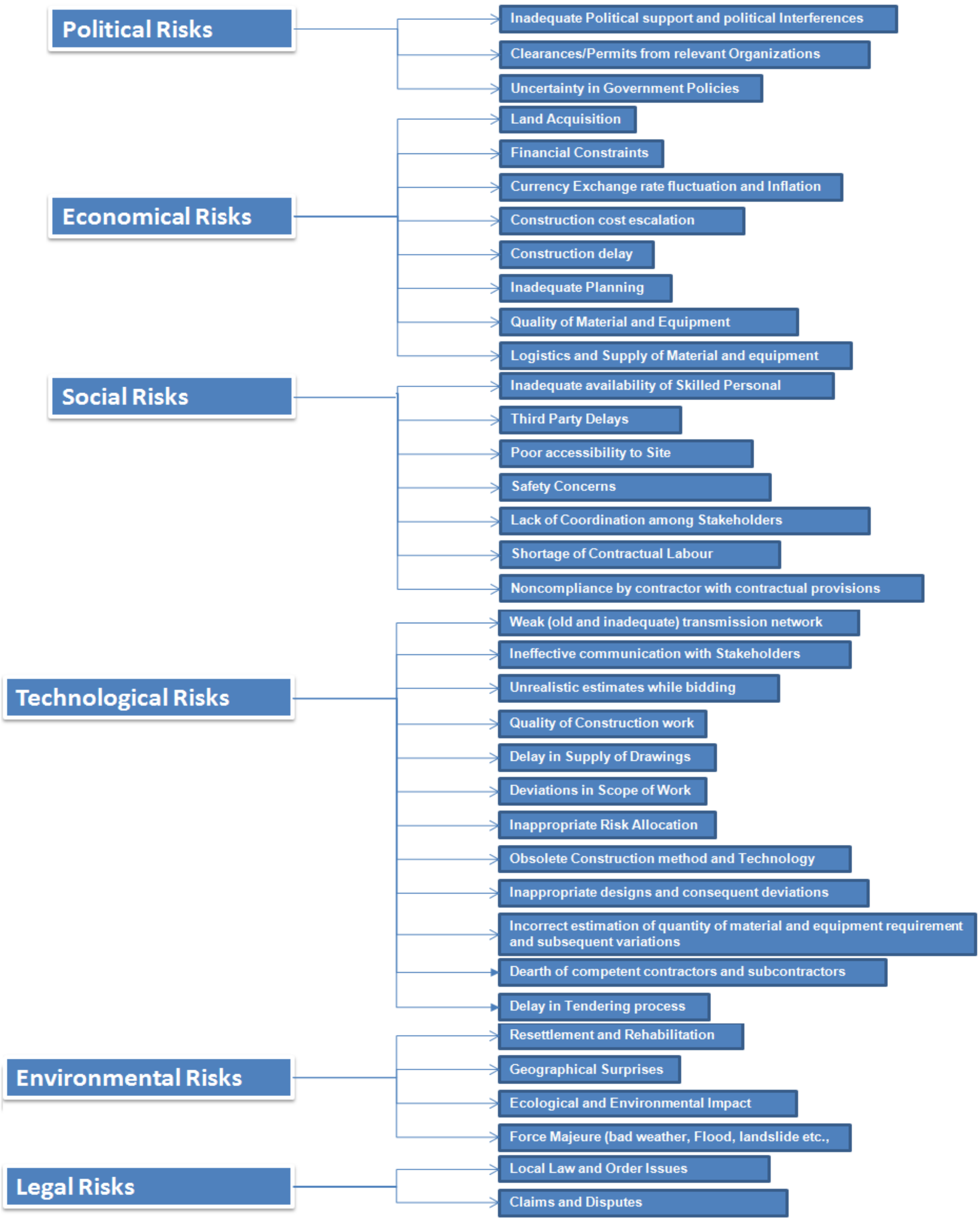
Environmental Risks

1. Resettlement & Rehabilitation
2. Geological surprises
3. Ecological & Environmental impact
4. Force majeure (bad weather, flood, landslide, etc)

Legal Risks

1. Local law and order issues.
2. Claims and disputes

Mapping of Barriers to Risks:



5.2. Risk allocation concerning Barriers for Hydropower Plants:

Financial Risk	1. Tariff Issues 2. Long gestation period cost escalation 3. Valuation of forest land for reducing environmental impact 4. Rehabilitation and Resettlement 5. Lack of private sector investor interest 6. DPR preparation 7. Financial constraints
Business Risks	**Construction Risk** 1. Location of project 2. Quality of construction work 3. Obsolete construction method and technology 4. Construction cost escalation 5. Construction delay **Environmental Risk** 1. Environmental Impact 2. Geographical surprises 3. Ecological & Environmental impact 4. Force majeure (bad weather, flood, landslide, etc) **Political Risk** 1. Inter-state risk (River flow) 2. Public unrest **Manpower Risk** 1. A dearth of good contractors. 2. A dearth of skilled technicians 3. Non-compliance by a contractor with contractual provisions 4. Lack of coordination among stakeholders 5. Inadequate availability of skilled personnel 6. Shortage of construction labour

	Legal Risk 1. Law and order problem 2. Land acquisition problem 3. Regulatory issues 4. Local law and order issues. 5. Claims and disputes **Technological risk** 1. Weak (old and inadequate) transmission network 2. Ineffective communication with stakeholders 3. Unrealistic estimates while bidding 4. Incorrect estimation of the quantity of material and equipment 5. requirement and subsequent variations 6. Delay in the supply of drawings 7. Inappropriate designs and consequent deviations 8. Deviations in the scope of work 9. Inappropriate risk allocation **Economic risk** 1. Land acquisition 2. Inadequate planning 3. Logistics and supply of material and equipment 4. Quality of material and equipment 5. Currency exchange rate fluctuation and inflation **Political analysis** 1. Uncertainty in government policies 2. Clearances/permits from relevant organizations 3. Inadequate political support and political interferences 4. Delay in the tendering process

5.3. Risks in Hydropower (Pre, Operational and Post Risks)

Risks for Hydropower Projects

Pre Project Risks

- Land acquisition
- Local law and order issues
- Uncertainty in government policies
- Resettlement and rehabilitation
- Financial constraints
- Clearances/permits from relevant organizations
- Inadequate political support
- Dearth of competent contractors and subcontractors
- Claims and disputes
- Unrealistic estimates while bidding
- Delay in tendering process
- Inappropriate risk allocation
- Inadequate availability of skilled personnel
- Delay in supply of drawings
- Poor accessibility to site

Operational Risks

- Financial Constraints
- Inadequate political Interference
- Force majeure (bad weather, flood, landslide, etc)
- Geological Surprises
- Construction and Cost-Escalation
- Safety concerns
- Construction delay
- Lack of coordination among stakeholders
- Ecological and environmental impact
- Weak (old and inadequate) transmission network
- Shortage of construction labor
- Third party delays
- Deviations in scope of work
- Incorrect estimation of quantity of material and equipment requirement and subsequent variations
- Inadequate planning
- Non-compliance by contractor with contractual provisions
- Logistics and supply of material and equipment
- Inappropriate designs and consequent deviations
- Obsolete construction method and technology
- Currency exchange rate fluctuation and inflation

Post Project Risks

- Force majeure (bad weather, flood, landslide, etc)
- Safety concerns
- Ineffective communication with stakeholders
- Quality of construction work
- Quality of material and equipment

Chapter 6

6.0 Data Analysis, Results and Discussion

6.1. Survey

Based on literature review, 36 barriers and risk factors were identified (Table 9). A questionnaire consisting of 5-point Likert scale was developed and a pilot study was conducted to seek feedback on the robustness of the questionnaire. Subsequently, the data was collected from 100 relevant stakeholders (client, contractor and policymaker). Cronbach's Alpha value of 0.870 has been obtained that reflects the reliability of the scale used in the study (George and Mallery, 2003). The mean scores of the barriers and risk factors have been estimated using the following equation:

$$\text{Mean score} = \sum_i^j (P_i - R_i)$$

Where mean score was computed as the sum of the product of each rating point (P_i) and the corresponding fractional response to it (R_i) (Tang et al., 2013; Zhang et al., 2012)

The survey results indicate that land acquisition, local law and order issues, uncertainty in government policies, resettlement and rehabilitation, financial constraints, clearances and permits from relevant organizations, inadequate political support and political interferences, dearth of competent contractors and subcontractors, force majeure (bad weather, flood, landslide, etc), and geological surprises are the top 10 barriers and risks hindering the development of hydropower development in Uttarakhand. During the survey, all the relevant stakeholders unanimously expressed the need for enhanced legislative and judiciary support for long-term consistent policies promoting the development of hydropower. Subsequently, with a clear understanding of barriers and risks affecting hydropower projects in Uttarakhand, the study conducts a multiple-case study (three case studies) to assess, in greater depth, the hurdles to the development of hydropower projects in Uttarakhand and the possible suitable measures to address them and harness the opportunities associated with hydropower projects in the state.

Table 9: Barriers and Risk Factors

Barriers	Mean Score	Rank
Land acquisition[6], [17], [42], [54], [56]	4.99	1
Local law and order issues[5], [51], [58], [59], [64]	4.98	2
Uncertainty in government policies[53][28]	4.94	3
Resettlement and rehabilitation[17], [44], [58]	4.92	4
Financial constraints[42][54]	4.86	5
Clearances/permits from relevant organizations[17], [48], [54], [68]	4.74	6
Inadequate political support and political interferences[92], [93]	4.59	7
Dearth of competent contractors and subcontractors[5], [42], [55], [94], [95]	4.43	8
Force majeure (bad weather, flood, landslide, etc)[76]	4.24	9
Geological surprises [17], [20], [51], [58]	4.16	10
Claims and disputes[54], [58], [59]	4.15	11
Construction cost escalation[17], [24], [96]	4.11	12
Safety concerns[46], [76]	4.08	13
Construction delay[76], [96]	4.07	14
Ineffective communication with stakeholders[24], [69], [74]	3.98	15
Lack of coordination among stakeholders[12], [24], [36], [40], [53], [69], [74]	3.86	16
Unrealistic estimates while bidding[97]	3.82	17
Ecological and environmental impact[46], [98], [99]	3.65	18
Weak (old and inadequate) transmission network[14], [45], [46]	3.49	19
Delay in tendering process[100]	3.36	20
Shortage of construction labour[43], [59]	3.33	21
Third party delays[16], [42], [48]	3.22	22
Deviations in scope of work[76], [101], [102]	3.15	23
Inappropriate risk allocation[74], [94]	3.14	24
Quality of construction work[55], [76], [98]	3.10	25
Incorrect estimation of quantity of material and equipment requirement and subsequent variations[36], [69], [76], [97], [98], [103]	3.08	26
Inadequate planning[7], [31], [98], [104]	3.07	27
Non-compliance by contractor with contractual provisions[100]	3.01	28
Inadequate availability of skilled personnel[43], [59]	2.97	29
Delay in supply of drawings[76], [98]	2.91	30
Logistics and supply of material and equipment[41], [76][46], [47], [55], [57], [64], [105]	2.61	31
Inappropriate designs and consequent deviations[98][76], [101], [102], [106]	2.60	32
Poor accessibility to site[13], [67], [75], [107], [108]	2.14	33
Obsolete construction method and technology[12], [41], [53], [60], [97], [98], [109]	2.07	34
Quality of material and equipment[43], [61], [73], [76], [97], [100], [110]	1.99	35
Currency exchange rate fluctuation and inflation[31], [46], [50], [75], [97]	1.58	36

6.2. Case Study

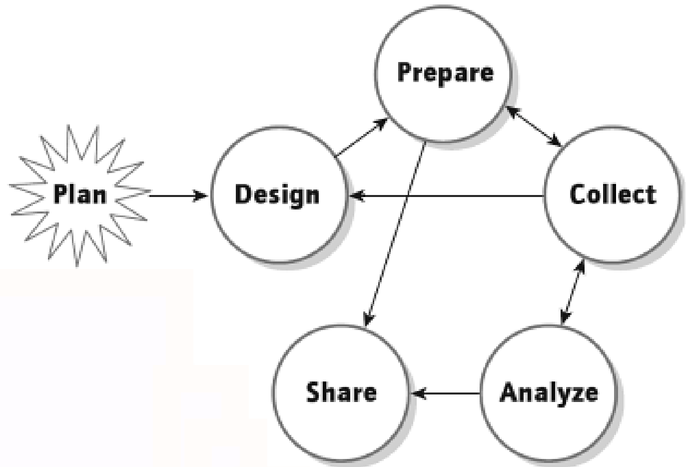


Figure: 5 Case Study Method (Yin)

Four tests have been commonly used to establish the quality of any empirical social research. Because case study research is part of this larger body, the four tests also are relevant to case study research. The case study tactics used in the study for confirming these four tests are:

1. **Construct validity**: identifying correct operational measures for the concepts being studied

2. **Internal validity**: seeking to establish a causal relationship whereby certain conditions are believed to lead to other conditions

3. **External validity**: defining the domain to which a study's findings can be generalized

4. **Reliability**: demonstrating that the operations of a study such as the data collection procedures can be repeated with the same results

The case study protocol used in the study contains the following:

1. Overview of the case study

2. Data collection procedures

3. Data collection questions

4. Information for the case study report

Case Study Research:

Responses of Validators against Initial Protocol

Q.No.	Questions	Respondent 1	Respondent 2
	Introductory		
1.	What is your opinion about Hydropower Projects?	As an introductory question, this is fine.	This question seems good to engage the respondent.
2.	Have you ever been a stakeholder in the development of Hydropower Projects in India?	As the study is about Barriers and Opportunities, no exposure to issues of the project may not help the study. Thus, this question may be deleted.	Engagements as a stakeholder with zero exposure to the Barriers and issues of the project may not help the study. Thus, this question can be deleted.
3.	Have you ever been involved in Hydropower Projects in Uttarakhand? If yes, kindly share your mode of involvement.	Question no. 3 and 4 can be clubbed as they intend to record the response of stakeholders relevant to the study.	As the study intends to record the response of stakeholders with experiences relevant to the study, Question no. 3 and 4 can be clubbed.
4.	Have you ever been affected by Hydropower Projects in Uttarakhand? If yes, kindly share how the project affected you.	Question no. 3 and 4 can be clubbed as they intend to record the response of stakeholders relevant to the study.	As the study intends to record the response of stakeholders with experiences relevant to the study, Question no. 3 and 4 can be clubbed.

5.	What are the advantages and disadvantages of Hydropower Projects?	This question is necessary as it allows the respondents to think about both the pros and cons of Hydropower Projects in Uttarakhand and allows the respondents to provide a balanced view.	It is a good question as it makes the respondents to engage in a balanced way.
	Barriers and Issues		
6.	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?	This is an effective way to take the discussion towards issues associated with Hydropower Projects in Uttarakhand.	This question is necessary.
7.	How do these barriers impact the viability of Hydropower Projects in Uttarakhand?	This is an apt question.	This question may be used to affirm the negative impact of Barriers and Risks on the development of Hydropower Projects in Uttarakhand.
8.	What are the parameters involved in the current framework?	This question can be dropped as question number 9 covers the same subject in a more detailed manner.	The question can be deleted as question number 9 covers the experiences of the stakeholders in a more detailed manner. Moreover, it is quite possible that a few stakeholders may not be aware about the parameters involved in current framework.

9.	Based on your experience, share the impact of Hydropower Projects on the following aspects of PAP: Land Job / Livelihood Home Food security Health Common property Community life Women security Education Any other issue	This question is necessary.	An apt question.
10.	Are the current policies effective enough to address the Barriers and Risks of Hydropower projects in Uttarakhand? If no, comment on the lacunas of the policy.	This question is necessary as it captures the lacunas if any in the current policies.	A relevant question.
	Implementation Issues		
11.	Share your experiences regarding the implementation of several policies and initiatives for the development of hydropower projects in Uttarakhand.	This question is good as it captures the implementation issues and can help accomplish RO2.	This question is related to RO2 and thus must be there.

12.	Which agencies are involved in the implementation of initiatives and policies for development of Hydropower Projects in Uttarakhand and what are your experiences with them?	This question is necessary to understand the implementation framework.	This question is quite relevant.
13.	Is there any gap between current policies and its implementation for Hydropower Projects in Uttarakhand? If yes, share your experiences.	Quite necessary to understand the implementation issues.	This question is necessary and is directly related to RO2.
	Remedial Measures		
14.	Based on your experiences, suggest improvements (if any) in policy associated with Hydropower Projects in Uttarakhand to make it more effective.	This question is related to RO3 and thus necessary.	This question is directly related to RO3 and thus must be there.
15.	Suggest measures to address implementation issues and minimize gaps between policies and implementation	This question is related to RO3 and thus necessary.	This question is relevant to address RO3 and thus necessary.

Responses of Validators against Modified Protocol

Q. No.	Questions	Respondent 1	Respondent 2
	Introductory		
1.	What is your opinion about Hydropower Projects?	Y	Y
2.	Have you ever been involved in and/or affected by Hydropower Projects in Uttarakhand? If yes, kindly share your overall experience.	Y	Y
3.	What are the advantages and disadvantages of Hydropower Projects?	Y	Y
	Barriers and Issues		
4.	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?	Y	Y
5.	How do these barriers impact the viability of Hydropower Projects in Uttarakhand?	Y	Y
6.	Based on your experience, share the impact of Hydropower Projects on the following aspects of PAP: Land; Job/Livelihood; Home; Food security; Health; Common property; Community life; Women security; Education; Any other issue	Y	Y
7.	Are the current policies effective enough to address the Barriers and Risks of Hydropower projects in Uttarakhand? If no, comment on the lacunas of the policy.	Y	Y
	Implementation Issues		
8.	Share your experiences regarding the implementation of several policies and initiatives for development of Hydropower Projects in Uttarakhand.	Y	Y

9.	Which agencies are involved in the implementation of initiatives and policies for development of Hydropower Projects in Uttarakhand and what are your experiences with them?	Y	Y
10.	Is there any gap between current policies and its implementation for Hydropower Projects in Uttarakhand? If yes, share your experiences.	Y	Y
	Remedial Measures		
11.	Based on your experiences, suggest improvements (if any) in policy associated with Hydropower Projects in Uttarakhand to make it more effective.	Y	Y
12.	Suggest measures to address implementation issues and minimize gaps between policies and implementation	Y	Y

Questionnaire Transcripts

Case: 1 Tapovan Vishnugad Hydroelectric Project (NTPC)

Que. no. 1	What is your opinion about Hydropower Projects?
Respondent 1 [c1q1r1]	Hydro Power Projects w.r.t potential – tremendous Benefits – Numerous (Multipurpose) i.e. development of tourism which will result in revolutionary improvement in socio-economic condition.
Keywords	Potential tremendous, Benefits Numerous, Multipurpose, tourism, socio-economic condition,
O Code	01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11
B Code	Nil
Total New O Code	11
Total New B Code	0

Respondent 2 [c1q1r2]	Development of Hydro Projects in Uttarakhand is very slow. NTPC was involved in four projects in Uttarakhand out which 3 have been closed and only one is under construction.
Keywords	Slow, closed, under construction
O Code	Nil
B Code	03, 07, 14, 18
Total New O Code	0
Total New B Code	4

Respondent 3 [c1q1r3]	Very time consuming
Keywords	time consuming,
O Code	Nil

B Code	14
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q1r4]	Hydropower projects promote socio-economic development but involve several barriers and risks that often lead to delay in projects and social conflicts.
Keywords	Hydropower projects, socio-economic development, barriers, risks, delay in projects, social conflicts
O Code	01
B Code	02, 04, 07, 11, 14
Total New O Code	0
Total New B Code	3

Respondent 5 [c1q1r5]	Hydropower projects are beneficial to the local area as they create jobs and income generation activities. However, due to the barriers like R&R issues, location disadvantages and local politics these projects are getting stalled or getting delayed.
Keywords	beneficial, local area, jobs, income generation, barriers, R&R issues, location disadvantages, local politics, stalled and delayed.
O Code	01, 02, 03, 04
B Code	04, 07, 14
Total New O Code	0
Total New B Code	0

Que no. 2	Have you ever been involved in and/or affected by Hydropower Projects in Uttarakhand? If yes, kindly share your overall experience.
Respondent 1 [c1q2r1]	Since 2005, I am in Hydro Sector from NTPC side as Planning & Monitoring HOD. Started from Loharinag-Pala in 2005 till 2010 from Land Acquisition stage and subsequently posted at Tapovan Vishnugad from 2010-2015 and at present at Hydro Region Head Quarter since Aug 2015 till now. I had been entrusted for Scheduling, Budgeting and Monitoring of project Activities including coordination with various agencies. Lata Tapovan HEPP was also being monitored. There were four NTPC projects in Uttarakhand. The 4th one was Rubsiyabagar-Khasiabaara near Munsiyaari.
Keywords	Hydro Sector, NTPC, Planning & Monitoring, Land Acquisition, Tapovan Vishnugad, Scheduling, Budgeting and Monitoring of Project, coordination
O Code	Nil
B Code	01, 16, 22, 25, 31
Total New O Code	1
Total New B Code	5

Respondent 2 [c1q2r2]	As an executive of NTPC, I have been very closely involved in execution of Loharinag-Pala (now closed after NGBRA recommendations), Tapovan-Vishnugad and Lata-Tapovan Hydro Power project. I have been in the executing team in the projects mentioned above.
Keywords	NTPC, execution, recommendations, Vishnugad and Lata-Tapovan Hydro Power project, closed, NGBRA
O Code	Nil
B Code	03, 06, 07, 18
Total New O Code	0
Total New B Code	4

Respondent 3 [c1q2r3]	Development, Implementation and Operation of Bernigad Small Hydro Power Project (22.8 MW) on the River Yamuna in District Uttarkashi on Build-Operate-Transfer (BOT) Basis was awarded to us vide LOA No. 398/I(2)/2010-04(8)-70/2008, Dated. 17th February'2010 by the Government of Uttarakhand.
Keywords	Development, Implementation, Operation, Small Hydro Power Project, Build-Operate-Transfer (BOT), awarded, Government of Uttarakhand
O Code	Nil
B Code	03
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q2r4]	Involved with NTPC (Tapovan Vishnugad Hydro Project) as a part of local administration. R&R issue was the major barrier which a created lot of social conflicts and protests.
Keywords	NTPC, Tapovan Vishnugad Hydro Project, local administration, R&R issue, major barrier, social conflicts, protests
O Code	Nil
B Code	02, 04, 11
Total New O Code	0
Total New B Code	3

Respondent 5 [c1q2r5]	As a Bank Manager, I was a stakeholder in TVHEP. Displacement due to blasting and submergence created a lot of R&R issues that resulted in social conflicts, protests and litigation.

Keywords	CSR, stakeholder, TVHEP, Displacement, blasting, submergence, R&R issues, social conflicts, protests, litigation
O Code	01
B Code	02, 04, 11, 18
Total New O Code	1
Total New B Code	0

Que no. 3	What are the advantages and disadvantages of Hydropower Projects?
Respondent 1 [c1q3r1]	Especially, in case of Uttarakhand – where a resource for revenue generation has its own limitation, hydro projects and tourism are the potential areas from where a lot of perineal revenue could be generated. Hydro projects area could be developed as tourist spots in addition to Power Bank. Remote areas are short of Education & Health facilities. These project complexes could be used appropriately for the development of these facilities.
Keywords	Uttarakhand, Resources, Revenue Generation, Limitation, Hydro Projects, Tourism, Perineal Revenue, Hydro Projects, Tourist Spots, Power Bank, Remote Area, Education, Health Facilities, Project Complexes, Development of These Facilities
O Code	01, 02, 04, 11
B Code	05, 33
Total New O Code	4
Total New B Code	2

Respondent 2 [c1q3r2]	**Advantages** • Hydropower is a green power • Remote area development through hydro projects

	• In the long run, cheaper than other sources of electricity generation. • Flood control. • The only source of generating revenues and jobs for remote places. • Storage of electricity can be done through the storage of water **Disadvantages** • Initially high cost involvement. • Uncertainties involved • Away from social community life • Local agitations • Lot of uncertainties • Lack of infrastructure • Long gestation period • Time consuming due to geological uncertainties
Keywords	Hydropower, Green Power, Remote Area, Hydro Projects, Long Run, Cheaper, Electricity Generation, Flood Control, Revenues, Jobs, Remote Places, Storage, High Cost, Uncertainties, Social Community Life, Local Agitations, Uncertainties, Lack Of Infrastructure, Gestation Period, Time Consuming, Geological Uncertainties
O Code	01, 02, 03, 04, 05, 06, 08
B Code	02, 04, 05, 07, 09, 10, 14, 19, 20, 22, 30, 31, 33
Total New O Code	4
Total New B Code	11

Respondent 3 [c1q3r3]	(i) Green Power/ renewable energy. (ii) Less maintenance cost. (iii) 35 years concessioner period
Keywords	green power, renewable energy, less maintenance cost, 35 years,

O Code	05, 10
B Code	Nil
Total New O Code	1
Total New B Code	0

Respondent 4 [c1q3r4]	Socio-economic development with creation of jobs and income generation activities. Disadvantages: R&R issues
Keywords	socio-economic development, creation of jobs, income generation, R&R issues,
O Code	01, 03, 04
B Code	04
Total New O Code	0
Total New B Code	0

Respondent 5 [c1q3r5]	Socio-economic development with the creation of jobs and income generation activities. Disadvantages: Displacement; Inadequate compensation; R&R issues, social conflicts, protests,
Keywords	Socio-economic development, creation of jobs, income generation, inadequate compensation, R&R issues,
O Code	01, 03, 04
B Code	02, 04, 11
Total New O Code	0
Total New B Code	1

Que no. 4	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?
Respondent 1	Mostly – Forest related, Environment related NGO issues, Locals are being

[c1q4r1]	misguided by these motivated NGOs. Lack of Local Administration support. Poor road conditions for transportation of equipment and materials. Law & Order situation.
Keywords	Forest Related, Environment, Ngo Issues, Locals, Misguided, Motivated, Lack, Local Administration, Support, Poor Road Conditions, Transportation, Equipment, Materials, Law & Order
O Code	Nil
B Code	02, 04, 06, 18, 33
Total New O Code	0
Total New B Code	5

Respondent 2 [c1q4r2]	• Land acquisition problem. • Law & Order issue. • R&R issues. • States are adopting different criterion for allocation of Hydro Projects to Private developers. • Some projects discontinued over fake environmental concerns by Govt./NGO/Environmentalist/Fundamentalist during the construction resulting in a huge national loss.
Keywords	Land acquisition problem, Law & Order issue, R&R issues, different criterion, allocation, private developers, projects discontinued, fake environmental concerns, Govt./NGO/Environmentalist/Fundamentalist, national loss
O Code	01, 02, 03, 05, 07
B Code	01, 02, 03, 04, 05, 06, 07, 18, 6
Total New O Code	5
Total New B Code	5

Respondent 3 [c1q4r3]	Natural resources are still to be harnessed. Time period for approval/ implementation is to be compressed/ minimized
Keywords	Natural resources, harnessed, time period, approval, implementation, compressed, minimized
O Code	Nil
B Code	06
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q4r4]	R&R issues need to be addressed comprehensively to ensure timely completion of hydropower projects, I can tell you that there is lack of comprehensive planning and lack of political will that makes it very difficult for the local administration to address R&R issues and consequent conflicts.
Keywords	Comprehensively, timely completion, hydropower projects, comprehensive, planning, political will, local administration, conflicts
O Code	Nil
B Code	02, 03, 04, 11, 14, 27
Total New O Code	0
Total New B Code	3

Respondent 5 [c1q4r5]	Current R&R policy is inadequate as it leads to inadequate compensation. Implementation of the R&R initiatives also suffers due to bureaucratic and administrative mismanagement by the local administration. There are poor coordination and communication between representatives of local administration implementing R&R initiatives. As a result, the PAP often suffer as they are asked to run from one office to another spread over long distances in the hills of Uttarakhand.

Keywords	R&R policy, inadequate, inadequate compensation, R&R initiatives, bureaucratic, administrative mismanagement,
O Code	Nil
B Code	02, 03, 04, 11
Total New O Code	0
Total New B Code	0

Que no. 5	How do these barriers impact the viability of Hydropower Projects in Uttarakhand?
Respondent 1 [c1q5r1]	All these factor mentions in Que-4 directly affect the project completion schedule. In addition to this during disaster time, the response of state machinery has been inappropriate, which needs to be improved tremendously. Availability/Allotment of the quarry for aggregate, a suitable policy framework needs to be prepared by GoUK especially for Hydro Projects.
Keywords	Factors, project, completion schedule, disaster time, response, state machineries, inappropriate, improved tremendously, availability, allotment of quarry for aggregate, suitable policy framework, GoUK, Hydro Projects.
O Code	Nil
B Code	03, 06, 07, 09, 10, 14
Total New O Code	0
Total New B Code	6

Respondent 2 [c1q5r2]	• Uncertainties and delay in execution. • Increase Project cost.
Keywords	Uncertainties, delay, execution, increase, project cost4
O Code	Nil

B Code	03, 05, 06, 09, 10, 12, 14, 17
Total New O Code	0
Total New B Code	3

Respondent 3 [c1q5r3]	Cost uncertainty due to a long time of implementation
Keywords	Cost uncertainty, long time, implementation
O Code	Nil
B Code	05, 14, 17
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q5r4]	R&R issues associated with hydropower projects in Uttarakhand lead to social conflicts resulting in time delays and cost overruns making them unviable.
Keywords	R&R issues, hydropower projects, Uttarakhand, social conflicts, time delays, cost overruns, unviable.
O Code	Nil
B Code	02, 04, 05, 06, 07, 11, 12, 14
Total New O Code	0
Total New B Code	3

Respondent 5 [c1q5r5]	Due to R&R issues, projects face social conflicts and protests leading to time delays and cost overruns.
Keywords	R&R issues, social conflicts, protests, time delays, cost overruns

O Code	Nil
B Code	02, 04, 05, 06, 07, 11, 12, 14
Total New O Code	0
Total New B Code	0

Que no. 6	Based on your experience, share the impact of Hydropower Projects on the following aspects of PAP: Land; Job/Livelihood; Home; Food security; Health; Common property; Community life; Women security; Education; Any other issue
Respondent1 [c1q6r1]	a) Land – Mostly Forest Land, clearance time is high, private land availability w.r.t rates and other related issues, difficult to resolve. State Govt must finalize suitable rates in advance so that there is no initial delay in acquisition of Private Land. b) Job/Livelihood- Socio-economic condition in most of the project areas are very poor, GoUK must have a policy for employment of land ousters and indirect or direct livelihood provision insistence to developers. c) Home- Very Poor Condition, need to be supported by the developer for improved and sustainable structure. d) Food security- State Government and GoI directives are self sufficient. e) Health- Worst condition of hospitals and non-availability of doctors in even Govt Health Centre is a serious matter of concern. Tele-Health facilities may be developed quickly. f) Common property- No issue g) Community life- Not up to the mark. h) Women security- More or less, not a matter of concern. Cash flow problem effect remote area women life.

	i) Education- Not of good quality. A lot of scope is there to improve upon. Satellite education system could be thought of, for the remote areas. j) Any other issue- Law and Order situation is a matter of concern.
Keywords	Forest land, clearance time, high, private land availability, related issues, resolve, state government suitable rates, initial delay, acquisition of private land, socio-economic condition, very poor, GoUK, policy for employment, land outstees, indirect, direct, livelihood provision, developers, very poor condition, sustainable structure, State Govt., GoI directives, self sufficient, worst condition, hospitals, non-availability of doctors, Govt. Health centre, serious matter, tele-health facilities, developed quickly, no issue, mark, concern, cash flow problem, remote area women life, good quality, scope, improve , satellite education system, law and order, matter of concern
O Code	01
B Code	01, 02, 03, 04, 05, 06, 13, 14, 18
Total New O Code	1
Total New B Code	9

Respondent 2 [c1q6r2]	a) Land Most of the lands are forest land, the executing company deposits CAT plan amount to Govt. for environment support. b) Job/Livelihood There are lot of job opportunities coming up during the construction of a project. c) Home There are no issues regarding the housing of the local population. If that comes in project area agencies provide alternate arrangement or cost of the house.

	d) Food security Yes, this aspect is very well addressed at the time of execution. e) Health Agencies extended medical facilities to locals. f) Any other issue In particularly TVHPP, transmission line has become critical due to no work started by PTCUL in this particular front.
Keywords	executing company, deposits, catchment area treatment, amount, Govt., environment support, job opportunities, develop, construction, project, no issues, home, local population, project area, agencies, alternate arrangement, cost of the house, well addressed space, agencies, extended medical facilities, locals, TVHPP, transmission line, critical, no work, PTCUL
O Code	01, 02, 03, 04, 05, 14
B Code	02, 04, 05, 07, 12, 14, 16, 19
Total New O Code	5
Total New B Code	4

Respondent 3 [c1q6r3]	a) Land b) Job/Livelihood c) Home d) Food security e) Health f) Common Property – Common Property g) Community Life h) Women Security

	i) Education j) Any other issue
Keywords	common property
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q6r4]	Based on my experience, I can say that hydropower projects lead to loss of land, home, livelihood, food security, health, common property (grazing ground and fodder, water source, religious places, playground), community life and women security. In addition, the PAP often complain about inadequate compensation and lack of facilities at resettlement locations.
Keywords	experience, hydropower projects, loss of land, home, livelihood, food security, health, common property, grazing ground, fodder, water source, religious places, playground, community life, women security, complain, inadequate compensation, lack of facilities, resettlement locations.
O Code	Nil
B Code	02, 04, 11
Total New O Code	0
Total New B Code	1

Respondent 5 [c1q6r5]	Hydropower projects cause displacement of PAP. Generally, before displacement, PAP have home, agricultural land and access to common property. Also, before displacement, the PAP are often found to be engaged in agriculture for livelihood and are part of a community along with its distinct culture. Post displacement, at the new location, these PAP feel uprooted as they experience

	loss of land, home, livelihood, food security, health, common property (grazing ground and fodder, water source, religious places, playground, van panchayat land, cremation ground), community life, culture, etc. Often, PAP complain about inadequate compensation and lack of facilities at resettlement locations. In addition, it has been found that if a woman is the head of a joint family of PAP loses her property rights if her sons get the R&R compensation deeply affecting the security of women.
Keywords	Hydropower projects, displacement of PAP, before displacement, home agricultural land, access to common property, agriculture for livelihood, community, distinct culture, new location, loss of land, livelihood, food security, health, grazing ground, fodder,
O Code	Nil
B Code	01, 02, 04, 11
Total New O Code	0
Total New B Code	0

Que no. 7	Are the current policies effective enough to address the Barriers and Risks of Hydropower projects in Uttarakhand? If no, comment on the lacunas of the policy.
Respondent 1 [c1q7r1]	Land Acquisition Forest / Private both delay the projects a lot. R&R Policy need to be revised as suggested at Que-6. Affected people must be compensated on long term basis. Community development must be included in R&R Policy appropriately.
Keywords	Land acquisition forest, private, delay the projects, R&R policy, revised, suggested, affected people, compensated, long term basis, community, appropriately,
O Code	Nil
B Code	03, 04, 11, 14

Total New O Code	0
Total New B Code	4

Respondent 2 [c1q7r2]	• No • Multiple clearances are required which are time-consuming. • Infrastructure should be developed first prior to the allotment of the project. • Once clearance is given to a project, there should be a settled law for not opposing it on any grounds except by respective governments with valid reasons. • Clarity with checklist should be developed for setting up a hydro project. • State Govt. should extend support in law and order at the project area.
Keywords	multiple clearances, time consuming, infrastructure, prior to allotment, project, clearance, law, not opposing, valid reasons, clarity, check list, setting, hydro project, state govt., extended support, law and order, project area,
O Code	Nil
B Code	02, 03, 06, 19, 22, 33
Total New O Code	0
Total New B Code	5

Respondent 3 [c1q7r3]	Single window clearance required / proper coordination with all the concerned departments is required. Which are Department of Energy, UJVNL, PTCUL, UPCL, District/ Local administration etc.,
Keywords	Single window clearance, proper coordination, concerned departments, department of energy, UJVNL, PTCUL, UPCL, District/ Local administration,
O Code	Nil
B Code	02, 06, 15, 27

Total New O Code	0
Total New B Code	2

Respondent 4 [c1q7r4]	No. The current policies are very cumbersome because the state government has to develop the hydro power sector as well as ensure that such development is environmentally and financially sustainable.
Keywords	Policies, cumbersome, state government, development, environmentally, financially sustainable
O Code	Nil
B Code	03, 05, 18
Total New O Code	0
Total New B Code	2

Respondent 5 [c1q7r5]	Hydropower development policies in Uttarakhand are very complex and challenging to implement. The goal post keeps on shifting and lacks clarity. There are policy based surprises even for the most experienced developers. No single window contact system; no clearance timelines, lack of development support makes it difficult to plan, conceive, develop and implement HEP in Uttarakhand.
Keywords	Policies, complex, difficult to implement, shifting, lacks clarity, policy based surprises, no single window, no clearance time lines, lack of development support, plan, conceive, develop, implement
O Code	Nil
B Code	02, 03, 06, 14, 27
Total New O Code	0

Total New B Code	0

Que no. 8	Share your experiences regarding the implementation of several policies and initiatives for development of Hydropower Projects in Uttarakhand.
Respondent 1 [c1q8r1]	Out of four projects allocated to NTPC as mentioned above, only Tapovan Vishnugad HEPP is under construction. Loharinag-Pala was stopped by MoP after NGRBA decision Khasiabaara was declined twice - Forest Clearance LataTapovan – Honourable Supreme Court stopped the construction. The system for monitoring the projects by GoUK and taking time-bound decision by the state is a must. This was being done earlier in 2005-06 for a certain period. However, after that state involvement for project related issued disappeared to a large extent. This needs to be revived like Pragati Review by the Hon'ble Prime Minister.
Keywords	Under construction, stopped, MoP, NGRBA, declined, forest clearance, court, monitoring, GoUK, time bound decision, project related issued, pragati review, Hon'ble PM
O Code	Nil
B Code	02, 03, 06, 07, 18, 27
Total New O Code	0
Total New B Code	6

Respondent 2 [c1q8r2]	Policy for allotment of stone quarry is not in place for hydro projects. Royalty for such projects should be specified and should not change every now and then.

	Issue addressing mechanism should be there.
Keywords	Policy for allotment, stone quarry, hydro projects, royalty, addressing mechanism,
O Code	Nil
B Code	03, 04, 05, 11
Total New O Code	0
Total New B Code	3

Respondent 3 [c1q8r3]	Uttarakhand lacks in initiatives and implementation of hydropower projects. The abundant resources that remain untapped is a testimony to the systemic problem at the policy level. The policy shift from a green aid seeking to an environmentally sustainable and a self-reliant state is an urgent requirement.
Keywords	Initiatives, implementation, abundant resources, untapped, systemic problem policy level, policy shift, green aid seeking, environmentally sustainable, self reliant state
O Code	Nil
B Code	03, 18
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q8r4]	Implementation of policies and initiatives in development fall short of the potential of hydropower in Uttarakhand. The region being environmentally sensitive, the policy keeps on changing making it difficult for projects to comply with these changes.
Keywords	Implementation, initiatives, environmentally sensitive, policy, changing, comply
O Code	Nil

B Code	03, 09, 10, 13, 18
Total New O Code	0
Total New B Code	3

Respondent 5 [c1q8r5]	Policy implementation is very poor in Uttarakhand.
Keywords	Policy, implementation, very poor.
O Code	Nil
B Code	03
Total New O Code	0
Total New B Code	0

Que no. 9	Which agencies are involved in the implementation of initiatives and policies for development of Hydropower Projects in Uttarakhand and what are your experiences with them?
Respondent 1 [c1q9r1]	UPCL, PWD, BRO, Jal Sansthan and Pay Jal Nigam, Forest Department assignment to be monitored closely by the highest level of State. It will be worth mentioning that even after 12 years of deposition of advance amount for Construction Power Lines, it could not be completed, which has resulted in accumulating huge claims by working agencies towards non-availability of Construction Power in case of Tapovan Vishnugad as well as earlier at Loharinag-Pala. Muck disposal areas need to be sufficiently considered for allotment during land acquisition stage. All deposit works entrusted to State Department must be monitored closely.
Keywords	UPCL, PWD, BRO, Jal Sansthan, Pay Jal Nigam, Forest Deptt., assignment, monitored, highest level of State, 12 years, advance amount, construction power

	lines, not be completed, huge claims by working agencies, non-availability of construction power, Tapovan Vishnugad, Loharinag-Pala, Muck disposal area, sufficiently, acquisition, deposit works, entrusted, state deptt, monitored, closely,
O Code	Nil
B Code	01, 05, 06, 11, 13, 19, 33
Total New O Code	0
Total New B Code	7

Respondent 2 [c1q9r2]	State as well as district Administration. No platform available for addressing these issues being faced by developers. Involvement of district administration is minimal while dealing with village Pradhans and local bodies.
Keywords	State, district administration, no platform, addressing, issues, developers, involvement, minimal, dealing, pradhans, local bodies,
O Code	Nil
B Code	02, 07
Total New O Code	0
Total New B Code	2

Respondent 3 [c1q9r3]	State and Central government, UPCL, UERC, UJVNL, UREDA, State Irrigation Department, PWD, Local Administration, District Forest Authority, MoFE. Judiciary system and tribunal authorities also become involved in implementation when disputes arise. These agencies generally hinder rather than facilitate the development of hydropower projects.
Keywords	State, central, government, UPCL, UERC, UJVNL, UREDA, State Irrigation Department, PWD, Local Administration, District, Forest Authority, MoFE, Judiciary, tribunal, implementation, disputes, agencies, hinder

O Code	06
B Code	02, 03, 06, 11, 19, 33
Total New O Code	1
Total New B Code	1

Respondent 4 [c1q9r4]	Government of India, Government of Uttarakhand, state owned generators, State Regulators, Local Administration, Forest Department, UPCL and PTCUL. These departments coordinate together to implement the policies for hydropower project development.
Keywords	Government, State, generators, Regulators, Local Administration, Forest, Department, UPCL, PTCUL, coordinate, implement, policies, development
O Code	Nil
B Code	02, 03, 06, 16, 19
Total New O Code	0
Total New B Code	1

Respondent 5 [c1q9r5]	District Administration is the principle agency for the implementation of policies related to hydropower development in Uttarakhand. Often they are expected to act as a nodal agency but developers themselves have to deal with each agency for project implementation – local police, local politicians, gram pradhan, UPCL officers, Jal Sansthan, forest officers etc. Dealing separately with each of them delays the projects but also results in project time and cost overrun.
Keywords	District, implementation, policies, police, politicians, pradhan, forest
O Code	Nil
B Code	02, 03, 06, 07

Total New O Code	0
Total New B Code	0

Que no. 10	Is there any gap between current policies and its implementation for Hydropower Projects in Uttarakhand? If yes, share your experiences.
Respondent 1 [c1q10r1]	Lack of will by the state government even knowing very well that the delay of projects will hugely impact state revenue. Andhra Pradesh Himachal Pradesh could do, why not Uttarakhand. Political will is needed. PTCUL is constructing Power Evacuation System for TVHPP. Most of the issues are within the control of state government, in spite of that, the Power Evacuation System progress is extremely poor, even forest land transfer proposal could not be submitted. TVHPP project will be commissioned but Lines availability is doubtful.
Keywords	lack of will, state govt., knowing, delay of projects, impact , state revenue, political will, PTCUL, Power Evacuation System, State Govt., progress, extremely poor, forest land transfer, commissioned, lines availability, doubtful
O Code	04
B Code	01, 07, 14, 19, 22
Total New O Code	1
Total New B Code	5

Respondent 2 [c1q10r2]	Even after obtaining all statutory clearances and compliance of all non-conformities, some state authorities/political parties/local leaders create problems over environment concerns during construction of the project and thus time and cost overrun start adding up.
Keywords	statutory clearances, compliance, non conformities, state authorities, political parties, local leaders, create problems, environment concerns, time and cost overrun,

O Code	Nil
B Code	02, 05, 06, 07, 12, 14, 18, 25, 28
Total New O Code	0
Total New B Code	7

Respondent 3 [c1q10r3]	Gaps are huge. The policies are ambiguous and it is difficult to precisely identify the gaps. For example, during a previous state government regime, developers were identified for development of SHPs. After a long and painful process, the projects were allotted to developers only to be cancelled later. For policies to become practically implementable, government should incorporate opinion of the experienced developers. The policies should be clear and firm for all. A mandatory green cover guaranteed compensation; equivalent to two times of the lost green land should be developed within three years of project start date.
Keywords	Huge, ambiguous, difficult, precisely, identify, gaps, allotted, cancelled, policies, practically, implementable, experienced, developers, clear, firm, mandatory, green cover guaranteed
O Code	Nil
B Code	03, 18
Total New O Code	0
Total New B Code	1

Respondent 4 [c1q10r4]	Uttarakhand being vast, rugged and hilly terrain with eco-sensitive Himalayan region it is difficult to have one policy for all. The current policy reasonably addresses and promotes the development of hydropower projects. It also corrects itself based on the inputs and experiences that it receives during the its implementation.

Keywords	vast, rugged, hilly terrain, eco sensitive, difficult, policy, reasonably, promotes, development, experiences, implementation.
O Code	Nil
B Code	03, 18, 33
Total New O Code	0
Total New B Code	1

Respondent 5 [c1q10r5]	Yes. The policy does not look to make the hydropower projects financially viable. Projects developers are forced to quit even after investing huge capital in them.
Keywords	financially viable, developers, forced, quit, investing, capital
O Code	Nil
B Code	05
Total New O Code	0
Total New B Code	0

Que no. 11	Based on your experiences, suggest improvements (if any) in policy associated with Hydropower Projects in Uttarakhand to make it more effective.
Respondent 1 [c1q11r1]	Already spelled out above – for all the areas of concern
Keywords	Nil
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 2 [c1q11r2]	Special task force suggested at secretariat level and local administrative level for the development of hydropower projects may take care of such problems. Single window clearance system should be in place. Forest, environment, mining are the departments which are a cause of constant trouble for developers and once the clearance is granted there should no authority other than the DM, Secretary level for stopping works on petty grounds. R & R policy should have one-time settlement and should be made attractive for local people so that they should support early execution such as ownership share etc from the state govt. Quarry and dumping yard area is always near to the river location. The policies should be in line with the same for construction of crusher, batching plant and other machinery related projects. District administration should be one of the stakeholders answerable for the delay in execution. Any more clearance required during execution stage should be given on priority to the hydro project.
Keywords	special task force, secretariat level, local administrative, development, hydropower projects, single window clearance system, forest, environment, mining, constant trouble, developers, clearance, constant trouble, developers, clearance, DM, secretary level, petty grounds, R&R policy, one time settlement, attractive, local people, support early execution, ownership share, state govt., quarry, dumping yard, policies, in line, construction of crusher, batching plant, project related machineries, district administration,
O Code	Nil
B Code	02, 03, 04, 06, 07, 09, 11, 18, 27
Total New O Code	0
Total New B Code	9

Respondent 3 [c1q11r3]	As suggested above.
Keywords	Nil
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q11r4]	A participative policy making and its amendment process should be followed for incorporating inputs from experts, developers, investors and local population.
Keywords	Participative, policy, amendment, incorporating, experts, developers, investors, local population.
O Code	Nil
B Code	02, 03, 05, 07
Total New O Code	0
Total New B Code	5

Respondent 5 [c1q11r5]	Due to the extreme climatic conditions, frequent natural disasters and the region being environmentally sensitive, the hydropower policy should address the investors risks associated with them. The financial risk cover should be provided to developers during force majeure conditions.
Keywords	Extreme, climatic conditions, frequent, natural disasters, environmentally, sensitive, investors, risks, financial, risk cover force majeure
O Code	Nil
B Code	05, 09, 18

Total New O Code	0
Total New B Code	0

Que no. 12	Suggest measures to address implementation issues and minimize gaps between policies and implementation
Respondent 1 [c1q12r1]	The system for monitoring the projects by GoUK and taking time bound decision by the state is must. This was being done earlier in 2005-06 for certain period. However after that, the state involvement for project related issues disappeared to a large extent. This needs to be revived like Pragati Review by the Hon'ble Prime Minister.
Keywords	Time bound decision, pragati review
O Code	Nil
B Code	3, 14
Total New O Code	0
Total New B Code	0

Respondent 2 [c1q12r2]	There should be fixed check lists and procedures for clearances. Systems for online applications should be in place. Constant meeting of state and district administration with local population should be done to address their and developers issues.
Keywords	Fixed check lists, clearances, meeting, district administration, local population, developers issues
O Code	Nil
B Code	2,3,4,14
Total New O Code	0
Total New B Code	0

Respondent 3 [c1q12r3]	As suggested above processes should be fast with single window provisioning for the project.
Keywords	fast, single window
O Code	Nil
B Code	3,14
Total New O Code	0
Total New B Code	0

Respondent 4 [c1q12r4]	Monitoring mechanism need to be made more elaborate. These mechanism need to be reasonably fair and accommodate the need of the developers and local population. Monitoring power should be decentralized to each regional reforms committee comprising of members of various stakeholder.
Keywords	monitoring, developers, local population, regional reforms committee
O Code	Nil
B Code	3,4,6
Total New O Code	0
Total New B Code	0

Respondent 5 [c1q12r5]	As above
Keywords	Nil
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Case 1: **Summary - Tapovan Vishnugad Hydroelectric Project (TVHEP)**

The Tapovan Vishnugad Hydroelectric Project (TVHEP) is one of the prestigious hydroelectric projects of NTPC. NTPC, though being a thermal power generating company, forayed into hydro generation to balance its portfolio for long term environmental and business sustainability.

The TVHEP is a 520 MW, run of the river Hydro Electric Project (HEP) being constructed on Dhauliganga river and is situated near Joshimath town of Chamoli district of Uttarakhand. Once completed, it is expected to generate approximately 25000 GWh of electricity annually which would work to around Rs. 1020 Crore of electricity @ an average rate of Rs. 4.08 KWh (UPCL's average purchase rate of hydro for FY 2017-18, Detail sheet annexed). The dam has as a concrete type design with 4 x 130 MW pelton turbines. It took the project nearly 27 months for getting all the clearances. The project has been delayed by 88 months now and cost overrun has approximately been 870 crores. The major reason for the delay has been due to geology, flash floods, and termination of civil contracts. Thus project barrier can be attributed to geological surprises, harsh environment and poor contract management.

The respondents in this case are as follows:-

Respondent 1 – He a senior project management level employee of NTPC. He has more than 20 years experience in the hydropower sector.

Respondent 2 – He a senior project management level employee of NTPC and is directly associated with this case study for TVHEP project. He has more than 20 years of experience in the hydropower sector.

Respondent 3 – He a hydropower sector expert with vast experience in Hydropower and Power Transmission. He has 10 years of experience in the hydropower sector specifically in Uttarakhand. Currently he is a Managing Director of a Power Transmission & Projects company.

Respondent 4 – He is a middle level government officer. He has close to 15 years experience in administration and assists the state government in policy making and its enforcement.

Respondent 5 –He is a senior project finance officer working for a private bank. He oversees the technical feasibility for financial lending to various projects, with specialization in project lending. He has more than 20 years experience in financing power sector projects, specifically hydro power projects.

Case Discussion:

In this case study majority of the respondents have highlighted the plight of NTPC projects. As Respondent No. 2 replies to the second question, "*Development of Hydro Projects in Uttarakhand is very slow. NTPC was involved in four projects in Uttarakhand out which three have been closed and only one is under construction*". In reply to the second question the respondent further adds, "*As an executive of NTPC, I have been very closely involved in execution of Loharinag-Pala (now closed after NGBRA recommendations), Tapovan-Vishnugad and Lata-Tapovan Hydropower project".* Respondent 1 in question number 8 comments, "*Out of the four projects allocated to NTPC as mentioned above, only Tapovan Vishnugad HEPP is under construction, while Loharinag-Pala was stopped by MoP after the NGRBA decision. Khasiabaara was declined twice - Forest Clearance, Lata Tapovan – Honourable Supreme Court stopped the construction.*"

The above narration of the respondents is interesting as well as frightening as most of the projects fail to see the light of the day. Environmental aspects have been known to be the reason behind the closure of these projects. The respondent indicates that the future of projects under execution is highly uncertain and this sets an example for the investors to stay away from financing hydro projects in Uttarakhand. However, the exact reason for the closure of the above projects needs to be studied in greater detail.

Respondent number 1 in reply to question number 9 comments, "*It will be worth mentioning that even after 12 years of deposition of advance amount for Construction of Power Lines, it could not be completed, which has resulted in building up huge claims by working agencies towards non- availability of the Construction of Power in case of Tapovan Vishnugad as well as earlier at Loharinag-Pala".* Likewise to question 10 the respondent 1 responds as *"Lack of will by the State Government even knowing very well that delay of the projects will severely impact state revenue. Andhra Pradesh and Himachal Pradesh could do, why not Uttarakhand. Political will is needed. PTCUL is constructing Power Evacuation System for TVHPP. Most of the issues are within the control of the State Government, in spite of this the progress of Power Evacuation System is extremely poor, where even forest land transfer proposal could not be submitted. TVHPP project will be commissioned but lines availability is doubtful*". Similarly in response to question number 6, Respondent number 2 comments, "*Particularly, TVHPP, the transmission line has become critical due to no work started by the PTCUL in this front*". PTCUL is the state grid utility of Uttarakhand. The failure of the state to get the grid line commissioned even after 12 years indicates an indifferent and a collapsed administration. If no administrative and financial provisions are made to safeguard the projects against such delays on the part of other stakeholders, the project will surely suffer and keep the investors at bay.

In question number 8, Respondent number 3 challenges and questions the effort by the policymakers by elaborating, "*Uttarakhand lacks in initiatives and implementation of hydropower projects. The abundant resources that remain untapped is a testimony to the systemic problem at the policy level. A policy shift from a green aid seeking, to an environmentally sustainable and a self-reliant state is an urgent requirement.*"

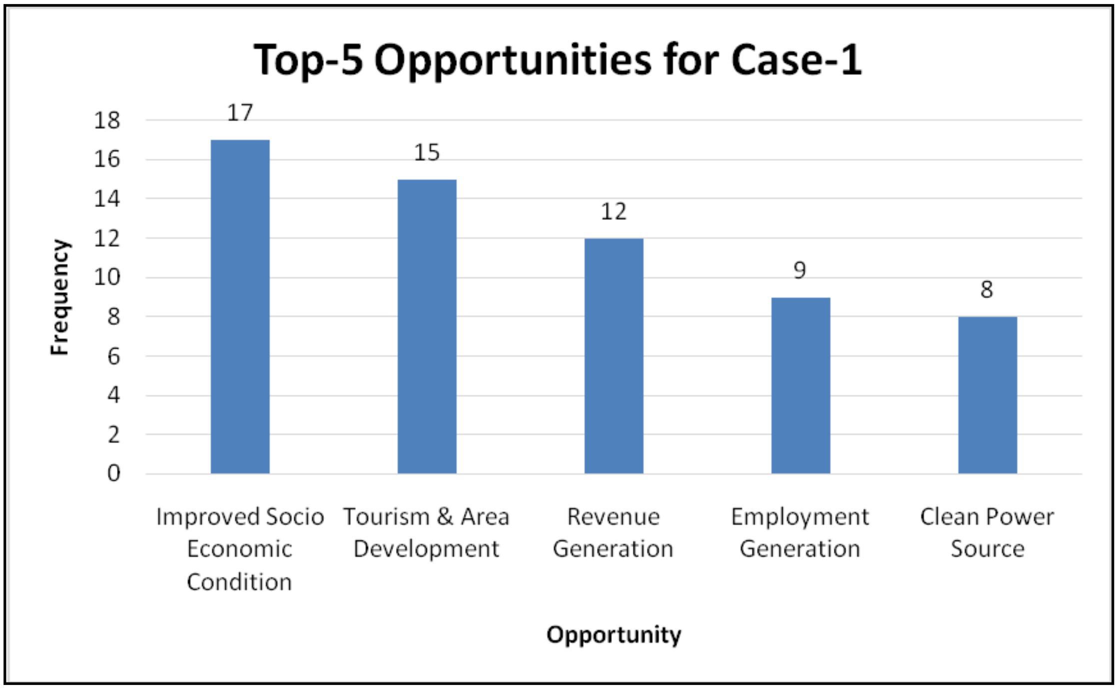
Feedback from the majority of the respondents indicate a need to work at the policy level and its implementation. They also pointed out that the current system of multiple window clearance does not facilitate the ease of doing projects in the state. Respondent number 3 in question number 10 says, "*Gaps are huge. The policies are ambiguous and it is difficult to identify the gaps accurately. For example, during a previous state government regime, developers were identified for the development of SHPs. After a long and painful process, the projects were allotted to the developers only to be cancelled later."*

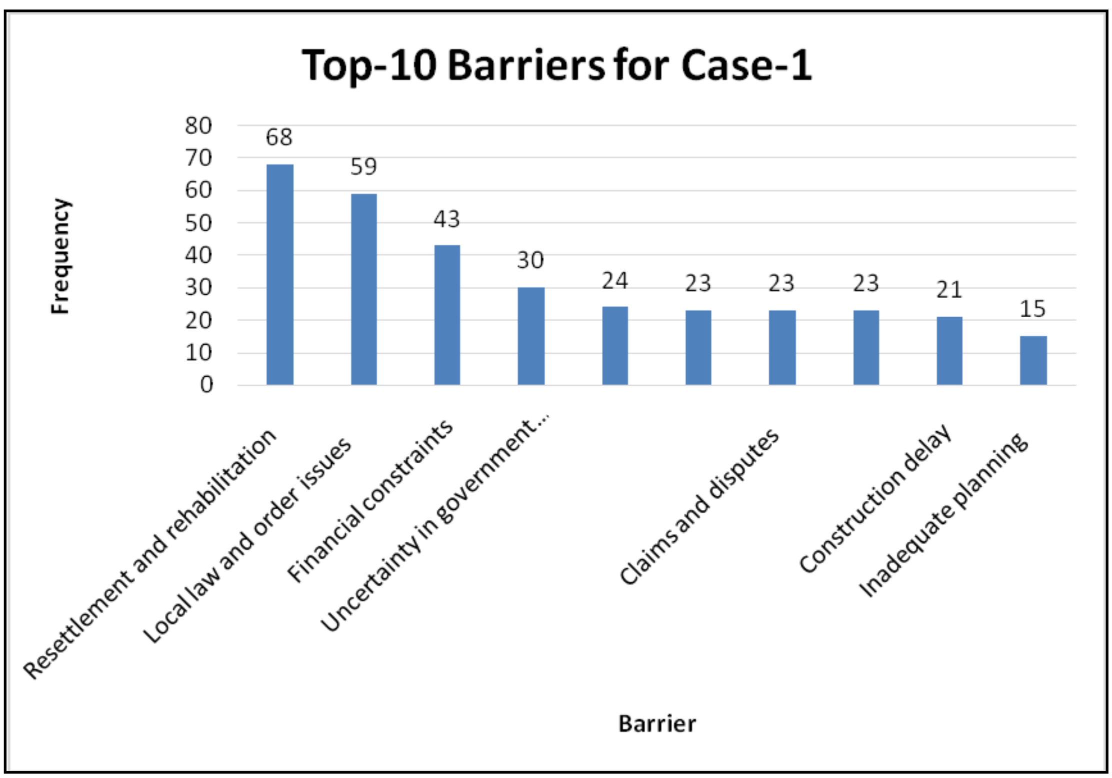
For policies to become practically implementable, the government should incorporate the opinion of the experienced developers. The policies should be clear and firm for all. A mandatory green cover guaranteed compensation that is equivalent to two times of the lost green land should be developed within three years of project start date."

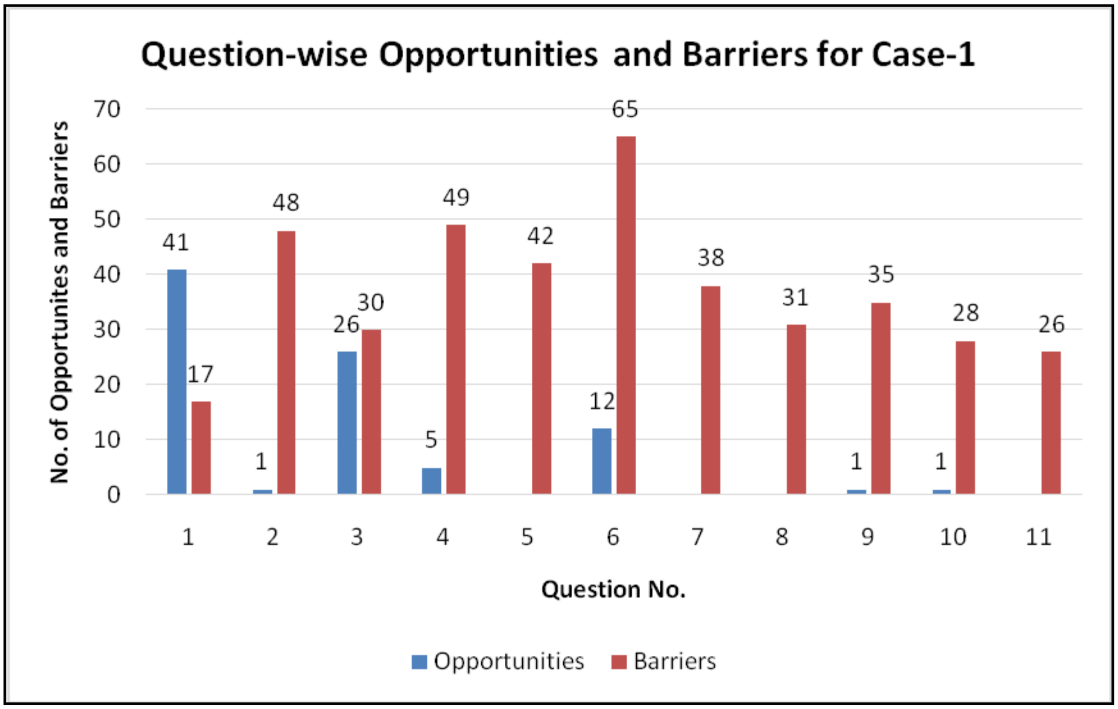
Similarly, Respondent number 2 in reply to question number 11 writes, "*Special task force suggested at secretariat level and local administrative level for the development of hydropower projects may take care of such problems. Single window clearance system should be in place. Forest, Environment and Mining are the departments which are a cause of constant trouble for developers and once the clearance is granted, there should no authority other than the DM, Secretary level for stopping works on petty grounds. R&R policy should offer a one-time settlement that should be made attractive for the local people so that they can support early* *execution such as ownership share ~~etc~~ from the state government. Quarry and dumping yard area is always near to the river location. The policies should be in line with the same for the construction of a crusher, batching plant and other project related machinery. District administration should be one of the stakeholders answerable for the delay in execution. Any more clearance required during execution stage should be given on priority to the hydro project."*

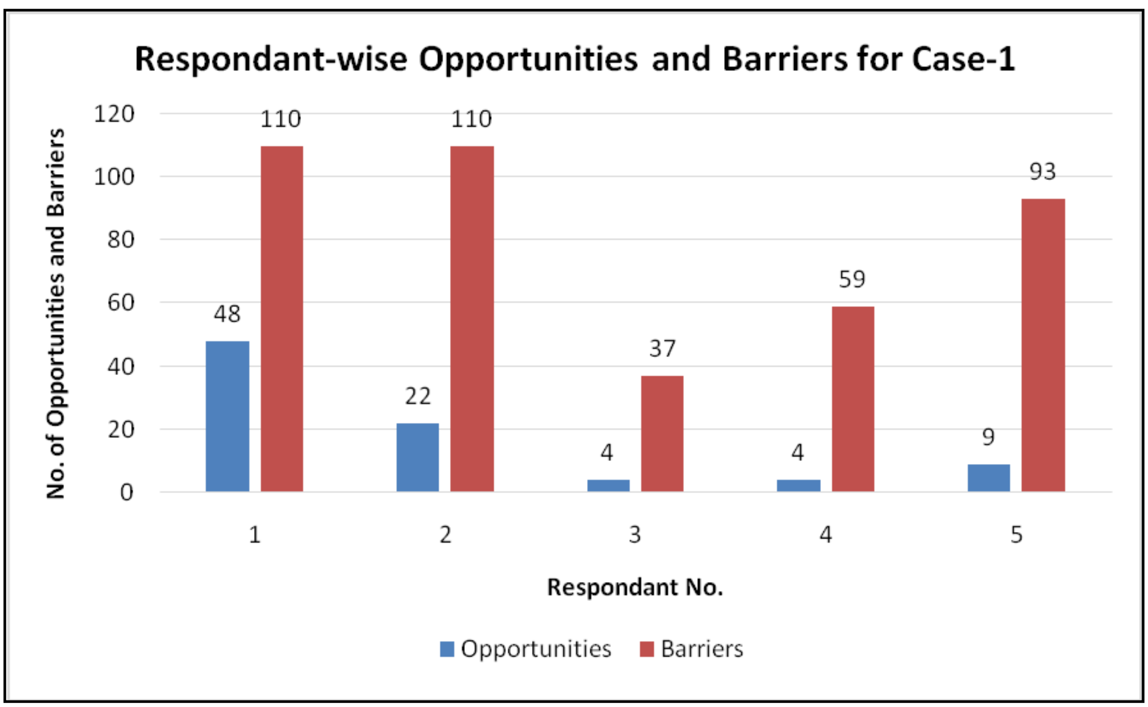
Interestingly, Respondent 1 of question 9 comments, "*Muck disposal areas need to be sufficiently considered for allotment during land acquisition stage. All deposit works entrusted to the State Department must be monitored closely*." Muck disposal has always been highlighted by the environmentalist as it can cause a restriction in the flow of the river. It has also been noted that during the 2013 flash floods, the muck deposits restricted the water flow that caused the waters to rise high. This left a narrow path for the energy to escape making the situation dangerous for the nearby areas and roads.

Case 1 Analysis






Question-wise Opportunities and Barriers for Case-1
No. of Opportunites and Barriers
Question No.
Opportunities
Barriers


Respondant-wise Opportunities and Barriers for Case-1
No. of Opportunities and Barriers
Respondant No.
Opportunities
Barriers

Case 2: Pala Maneri Hydroelectric Project (UJVNL)

Que no. 1	What is your opinion about Hydropower Projects?
Respondent 1 [c2q1r1]	Power is considered to be the backbone for all the nations throughout the world as their development depends on it. The development of hydropower in Uttarakhand, especially in its mountainous regions, has the potential to improve its socio-economic conditions. In Uttarakhand, small hydro projects are also playing a vital role in the development of remote areas which are not connected with main grid. Hence, small hydropower projects that are less than 25 MW, are always welcomed by the local people. The resistance expressed by the people is not against hydropower projects but is aimed at securing their rights in terms of livelihood and proper compensation.
Keywords	Power, major back bone, development, depends, hydropower, mountainous regions, economic condition, very important role, remote areas, not connected, main grid, Small hydropower projects, welcomed, local people, resistance, not against hydropower projects, securing their rights, livelihood, proper compensation
O Code	01, 02, 03, 11
B Code	04, 11, 19
Total New O Code	4
Total New B Code	3

Respondent 2 [c2q1r2]	Uttarakhand has an immense potential for hydropower energy since it has a large network of rivers. Only a fraction of available potential has been harnessed so far. Therefore there is a need to develop this sector urgently.
Keywords	immense potential, hydro power, large network of rivers, fraction, potential, harnessed, develop, urgently
O Code	01, 02, 03, 04
B Code	27

Total New O Code	1
Total New B Code	1

Respondent 3 [c2q1r3]	It is lagging behind the targets fixed during the formation of the state. Required impetus has not been given to the sector which is mostly dependent upon government permissions and support
Keywords	lagging, targets, formation, state, impetus, government permission, support,
O Code	Nil
B Code	06, 07, 27
Total New O Code	0
Total New B Code	2

Respondent 4 [c2q1r4]	Hydropower projects are beneficial to the society as they generate clean, sustainable and affordable power and also lead to the socio-economic development of the local area. However, due to barriers, project delay and cost overrun is quite common.
Keywords	hydropower projects, beneficial, society, generate, clean, sustainable, cheap power,
O Code	01, 05, 08
B Code	Nil
Total New O Code	2
Total New B Code	0

Respondent 5 [c2q1r5]	Hydropower projects are beneficial but they often lead to displacement of local population. The developers often offer inadequate compensation making the project-affected people suffer.

Keywords	hydropower projects, beneficial, displacement, local population, developers, inadequate, compensation, project-affected people suffer
O Code	01
B Code	02, 04, 07, 11
Total New O Code	0
Total New B Code	1

Que no. 2	Have you ever been involved in and/or affected by Hydropower Projects in Uttarakhand? If yes, kindly share your overall experience.
Respondent 1 [c2q2r1]	I am involved in the Development and Construction of Hydropower Power Projects in Uttarakhand, namely Pala Maneri Projects (480 MW), Kaliganga-I SHP (4 MW), Kaliganga-II SHP (6 MW) and Madhyamaheshwar SHP (15 MW). Mode of involvement is as under: **Pala Maneri Project (480 MW)**: I was associated with this project from March, 2005 to June, 2008 i.e. up to the closure of the project. I was involved in Reviewing of Hydrology, Power Potential Study, Design calculation required for DPR i.e. Dam Stability, Flood Routing, Spillway Gate Size including detailed analysis, calculations and estimation and field investigation for Geological study i.e. Drilling, Drifting, Hydrocracks test, Seismic refraction and Seismic reflection. I am also involved with this project in Preparation of Tender Document for Civil Works in different packages for construction of 78 m high Dam, Diversion Tunnel, Intake structure, 3 Nos desilting Chambers & 12.5 km long HRT, 110 m high Surge Tank, 480 MW underground Power House, 1.3 km long TRT including, Technical Specification, Tender drawings & BoQ of Pala Maneri Project for international bidding based on FIDIC guidelines. Further, I was involved with this project for detailed Design Engineering with Consultant M/s SMEC international Pvt. Limited and approximate 20% of the dam

	design works i.e. Stability analysis, River Diversion works, Dam & Energy Dissipation Arrangement was completed. But unfortunately, this project was cancelled by the Government of India due to national level agitation started by certain NGOs. **Small Hydro Projects:** I was involved in the construction of small Hydro Projects namely Pala Maneri Projects (480 MW), Kaliganga-I SHP (4 MW), Kaliganga-II SHP (6 MW) and Madhyamaheshwar SHP (15 MW) along with the full involvement in resolving the local issues i.e. various demands of villagers for securing their rights in terms of livelihood and proper compensation. Out of the aforesaid SHPs, one project, namely Kaliganga-I SHP was commissioned in the month of July 2012 and commercial operation of the powerhouse started on 10th September 2012. Unfortunately, due to unprecedented floods that occurred on 16 and 17 June 2013, major structures such as Diversion weir, Power house etc were washed away and heavily damaged the project area. However, this project is going to reconstruct with a significant amount received from the insurance. At present, more than 60 per cent works of these SHPs completed and these projects may be commissioned in 2019-20 and 2020-21.
Keywords	development, construction, hydropower power, Uttarakhand, closure, reviewing, hydrology, power potential study, design calculation, DPR, Dam Stability, flood routing, spillway gate size, detailed analysis, calculations & estimation, field investigation, geological study, drilling, drifting, hydrocrack, seismic refraction, seismic reflection, tender document, civil works,, high Dam, diversion tunnel, intake structure, desilting chambers, HRT, surge tank, power house, long TRT including, tender drawings, BoQ, international bidding, FIDIC guidelines, design engineering, consultant, stability analysis, river diversion works, dam & energy dissipation arrangement, cancelled, agitation, NGO, Kaliganga-I, 4MW, 6MW, 15MW, demands of villagers, rights, livelihood, proper compensation, commercial operation, flood, heavily damage, project area, reconstruct, insurance, commissioned
O Code	04, 06

B Code	02, 03, 04, 05, 06, 07, 09, 10, 11, 18, 24, 27, 32, 34, 35
Total New O Code	2
Total New B Code	15

Respondent 2 [c2q2r2]	I am working in state genco which is a hydropower generating company, since last the 15 years.
Keywords	state genco, hydropower, company
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 3 [c2q2r3]	We are running two projects namely, Rajwakti 4.4 MW (COD May 2002) and Vanala 15 MW (COD Dec 2009) as IPP. One project Melkhet 24 MW is under implementation.
Keywords	projects, implementation, IPP
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q2r4]	Poor project handling clubbed with weak local administration, law and order issues and uncertainty in government policies result in social conflicts, protests and litigation which further cause project time slippage and cost overrun.

Keywords	Poor project handling, local administration, law and order, uncertainty, government policies, social conflicts, protests, litigation, time slippage, cost overrun, project delays, cost overruns,
O Code	Nil
B Code	02, 03, 04, 05, 11, 12, 14, 24, 27
Total New O Code	0
Total New B Code	2

Respondent 5 [c2q2r5]	Displacement, land loss due to submergence, landslide due to unregulated and excess blasting, and inadequate compensation resulted in social conflicts, protests and litigation.
Keywords	displacement, land loss, submergence, landslide, unregulated, blasting, inadequate compensation, social conflicts, protests, litigation
O Code	Nil
B Code	01, 02, 04, 09, 11, 18
Total New O Code	0
Total New B Code	1

Que no. 3	What are the advantages and disadvantages of Hydropower Projects?
Respondent 1 [c2q3r1]	**Advantages:** ➢ Hydropower is efficient, secure, clean, renewable and a sustainable source of energy, with no reservoir required. ➢ Hydropower contributes to sustainable development by being economically feasible, respecting the environment (avoiding greenhouse gas emissions) and allowing decentralized production for the development of dispersed populations.

	➢ Hydropower is a clean energy source (it does not produce waste in the rivers, or air pollution) and renewable (the fuel for hydropower is water, which is not consumed in the electricity generation process). ➢ Hydropower plants help in Grid Stability that creates a more diversified electricity system, provides electricity in smaller distribution systems when the main grid is disrupted. ➢ Hydropower mobilises financial resources and contributes to the economic development of small dispersed populations, ensuring autonomous and reliable energy for the long term. ➢ Hydropower plants create local jobs for the monitoring the operation of the plant and well hydropower plant to learn the engineering of hydroelectricity. ➢ Hydroelectric power is a domestic source of energy, allowing each village/Tehsil/district to produce their own energy without being reliant on international fuel sources. ➢ Hydropower schemes assist in the maintenance of river basins by allowing the recovery of floating waste from the rivers and the monitoring of hydrological indicators. ➢ Hydropower have high energy payback ratio for each power generation system. The "energy payback" is the ratio of energy produced during its normal life span, divided by the energy required to build, maintain and fuel the generation equipment. **Disadvantages:** ➢ In order to take full advantage of the electrical potential of small streams, a suitable site is difficult to find. ➢ The cost of a hydropower plant, in reality, hinges on the specific site than the cost of the power generation equipment. Initial costs are significantly high

	for construction of small hydropower plant. ➢ Geological instability and cloud bursting are some of the major issues for the SHP, insurance companies and even contractors not being interested to work on remote site. ➢ Road transport and other communication facility are restricted or not available at the SHP site, making it difficult to work on dangerous geological area. ➢ Medical, school, and sports facilities are usually not available at the SHP site, which tends to affect the basic social life of the people working there. ➢ Energy expansion is not possible. The size and flow of small streams may restrict future site expansion as the power demand increases. ➢ Small streams do not provide enough force to generate power, as energy output is dependent on two major factors: the stream flow (how much water runs through the system) and drop (or head), which is the vertical distance the water will fall through the water turbine. ➢ During the summer months, there will likely be less flow and therefore less power output. ➢ Hydropower power development can be cost-intensive to build and maintain. There are some fixed maintenance costs that vary according to site location and material requirements. Local administration does not fully support to resolve the issue with the help of local villagers.
Keywords	hydropower, efficient, secure, clean, renewable, sustainable, resource, energy, no reservoir required, economically feasible, environment, greenhouse gas, decentralized, produce waste, rivers, air pollution, renewable, fuel, water, consumed, generation, grid stability, diversified electricity system, production,

	smaller distribution systems, main grid, disrupted, mobilises, financial resources, economic development, dispersed populations, autonomous, reliable energy, create local jobs , plant, engineering of hydroelectricity, domestic, source of energy, villages, tehsil, district, own energy, reliant, international fuel sources, maintenance, river basins, recovery, floating waste, monitoring , hydrological indicators, high energy payback ratio, potential, small streams, suitable site, specific site, initial costs, significantly high, geological instability, cloud bursting, insurance, not interest, remote site, road transport, communication facility, restricted, dangerous geological, topographical, medical facility, school facility, sports facility, social life, expansion, not possible, small streams, restrict future site expansion, small streams, enough force, stream flow, head, vertical distance, summer months, less flow , less power, cost-intensive, build, maintain, fixed maintenance costs, vary, location, material requirements, local administration, supported,
O Code	01, 02, 03, 04, 05, 07, 08, 09, 10, 11
B Code	02, 04, 05, 07, 09, 10, 13, 27, 31, 33
Total New O Code	10
Total New B Code	10

Respondent 2 [c2q3r2]	Pros • Continuous source of green energy • Can be built on small scale • Low operating cost & little maintenance • No fuel cost • Energy can be stored in pumped store plant • Longer life span

	Cons • Rehabilitation issues • Long gestation period • Environmental issues • Frequent delay in project commissioning • Earthquake vulnerable
Keywords	continuous, green energy, small scale, low operating cost, little maintenance, no fuel cost, pumped store plant, longer life span, rehabilitation issues, long gestation period, environmental issues, frequent delay, project commissioning, earthquake vulnerable
O Code	05, 09, 10, 11, 12
B Code	04, 06, 07, 09, 14, 18, 20, 21, 22, 23, 27, 29, 30, 31, 32, 33, 34, 39
Total New O Code	1
Total New B Code	12

Respondent 3 [c2q3r3]	Hydropower is a renewable source of energy. The construction of the project is tough, but once constructed it gives reliable and predictable power which other renewable sources of energy cannot provide. The cost of power may be high in the initial years but in the long run of 15 years when the rate of power of other sources rise exponentially, it will still be able to provide/ supply power at the initial rate which is very competitive. Hydropower provides employment in the remote area of Uttarakhand where no other industry can be established. It acts as an economic booster in the area as a whole as the economic activity by way of continuous expenditure incurred on the project is absorbed in the area itself. We have seen exponential growth of the economic activity in the surrounding villages.

Keywords	renewable, construction, project, very difficult, reliable, predictable power, high, initial years, long run, rise exponentially, initial rate, competitive, employment, remote area, economic booster, continuous expenditure, economic activity
O Code	01, 03, 05, 08, 11, 12
B Code	05, 14
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q3r4]	Advantages: Cheap and green power source, socio-economic development with creation of jobs and income generation activities. Disadvantages: Displacement due to blasting and submergence leading to loss of livelihood, home, land and community life. Inadequate compensation results in social conflicts, protests and litigation.
Keywords	Cheap, green power source, Socio-economic, development, creation of jobs, income generation, Displacement, blasting, submergence, loss of livelihood, home, land, community life, Inadequate compensation, social conflicts, protests, litigation
O Code	01, 03, 04, 05, 08
B Code	01, 02, 04, 11, 18
Total New O Code	0
Total New B Code	2

Respondent 5 [c2q3r5]	Sustainable power, spot beautification, minimal socio-economic and road network development in the region. Dust and air pollution due to project construction, R&R issues, social conflicts, protests, jobs to people from outside the region, non-local labour employed without

	police verification and crime due to non-local labour.
Keywords	Sustainable power, Spot beautification, socio-economic, Road network development, Dust, air pollution, project construction, R&R issues, social conflicts, protests, jobs to people from outside the region, non-local labour, police verification, crime.
O Code	01, 02, 03, 05
B Code	02, 04, 11, 13, 18
Total New O Code	0
Total New B Code	0

Que no. 4	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?
Respondent 1 [c2q4r1]	There has been an unthoughtful rush to build hydroelectric power projects in Uttarakhand without assessing the ecological, social or economic costs of their implementation. The government is not even sure of how many projects have been planned and of what capacity. A barrier to the development of hydropower may be defined as a factor that negatively affects its adoption and subsequent utilization which hampers its widespread diffusion. Due to frequent damage of transmission lines, lack of availability of skilled labour in the remote areas, inaccessible locations are some of the factors that make an extremely unfavourable condition for the development of hydropower in the state. Identified barriers for the development of hydropower in India are as follows: **1. Longer gestation period and allocation of fund** Hydropower projects entail long gestation periods, due to unavailability of geological, seismological and hydrological records, delays in land acquisitions, resettlement and rehabilitation issues, law and order problems and poor

connectivity. Whereas thermal projects have a short gestation period and get priority in fund allotments with a view to get early benefits.

2. **Land acquisition problems**

Due to land acquisition problem, many of the hydropower projects faced prolonged project implementation and schedule delays. This problem can be minimized with the co-operation of concerned state governments.

3. **Geological Surprises**

As the hydropower projects are site-specific, they rely on geography, geology and hydrology at the site. A geological survey should be done and analysed before starting any project. Even with a proper geological survey with technical advancements, a component of vulnerability stays in the sub-surface geography and the topographical amazements amid positive development can't be precluded. These, in turn, prolong the time and cost leading to constructional risks.

4. Hydrological Challenges

River discharge observations are made available to the developers on the pretext of confidentiality to the concerned government department only after the approval of the Ministry of Water Resources, GoI. Considerable time is lost in getting the approvals and the data.

5. **Location Disadvantage**

The hydropower projects are site-specific Majority of the hydropower projects are constructed in remote locations and at high altitudes. Proper connectivity to the site, transportation of machinery, lack of power evacuation infrastructure and adverse weather conditions, construction of these projects get delayed.

6. **Lack of Political Commitment**

   In theory, India is endowed with economically exploitable and viable hydro-potential assessed to be about 1, 48, 700MW at 60 per cent load factor. This potential cannot be exploited without clear political vision with efficient scientific and technological support. Political instability, government intervention in domestic markets, corruption and lack of civil society are major barriers.

7. **Lack of Public Awareness**

   There is a negative perception in the public regarding safety and environmental damage due to hydropower projects. Not only that, there is inadequate public involvement during the project planning stage as well. Also, no effort is taken to gain public acceptance through their involvement and transparency by the government agencies.

8. **Environmental and Forest Clearances**

   Due to several concerns on deforestation, submergence, monuments, seismicity, ecology, flora, fauna, wildlife protection and catchment area treatment getting environmental and forest clearances became a major issue in the development of hydropower projects. Tehri is the best example of this issue as it took more than 36 years to start after conceptualization of the project, this has delayed the project and in turn realization of energy.

9. **DPR Preparation**

   There is a lengthy and time consuming process for the preparation of DPR and clearances having an uncertainty of the timeline and shortage of people with clearing agencies e.g. forest and wild life clearances, environmental clearances, availability of land and hydrology records etc.

	10. **Resettlement and Rehabilitation Issues** As this is public related and a sensitive issue, implementation of resettlement and rehabilitation for the project affected people is difficult. It is one of the main reasons for the delay in the project execution, resulting in time and cost overruns. Several projects like Tehri, Sardar Sarovar, Indirasagar are affected due to R&R issues, where the opposition came from the environmentalists and the surrounding people. Hydroelectric power projects in India's mountainous north and northeast regions have been slowed down by rehabilitation controversies, coupled with political interventions and public interest litigations. **11. Regulatory and Policy Issues** Frequent changes in policy and norms by the central and state government, delay in getting environmental and forest clearances and NOC from local village level institutions and government departments. It is a major barrier because the projects can be developed or operated only if there is a proper regulatory and permitting frameworks. **12. Tariff** Tariff of hydropower projects are higher in the initial years as compared to other sources due to lack of incentives like tax concessions, financing cost and construction of projects in remote areas with inadequate infrastructure. Due to present tariff formulation norms for hydropower projects, (based on a cost plus approach) with no premium for peaking services and the provision for 12 per cent free power to the distressed states from the initial years are also proving to be an obstacle.
Keywords	unthoughtful, without assessing, ecological, social, economic costs, government, not even sure, planned, capacity, negatively, adoption, utilization , hampers, widespread diffusion, frequent damage, transmission lines, lack of availability of skilled labour, remote area, inaccessible locations, extremely unfavourable, longer

	gestation, allocation of funds, unavailability, geological, seismological, hydrological records, delays, land acquisitions, resettlement, rehabilitation issues, law and order, poor connectivity, land acquisition problems, schedule delays, co-operation, state governments, geological surprises, hydrology, geological survey, vulnerability, sub-surface geography, prolong, time and cost, constructional risks, hydrological challenges, confidentiality, time is lost, approvals and data, location disadvantage, remote locations, high altitudes, proper connectivity to the site, transportation of machinery, lack of power evacuation infrastructure, adverse weather conditions, projects get delayed, lack of political commitment, clear political vision, scientific, technological support, political instability, government intervention, domestic markets, corruption, civil society, public awareness, safety, environmental, damage, inadequate, public involvement, planning stage, no effort, public acceptance, public involvement, transparency, government agencies, environmental, forest clearances, deforestation, submergence, monuments, seismicity, ecology, flora, fauna, wildlife protection and catchment area treatment delayed, dpr preparation, lengthy time consuming clearances , uncertainty , time line, shortage of people, clearing agencies, forest, wild life clearances, environmental, availability of land, hydrology records, resettlement, rehabilitation issues, sensitive issue, resettlement and rehabilitation, delay, time and cost overruns, R&R issues, environmentalists, surrounding people, rehabilitation controversies, political interventions, public interest litigations, regulatory, policy issues, policy, norms, central government, state government, delay, environmental, forest clearances, NOC, proper regulatory, permitting frameworks, tariffs higher, initial years, lack of incentives, tax concessions, financing cost, construction of projects, inadequate infrastructure, premium peaking services, free power, obstacle,
O Code	Nil
B Code	01, 02, 03, 04, 05, 06, 07, 09, 10, 11, 12, 13, 14, 16, 18, 19, 22, 24, 27, 29, 31, 32, 33, 39
Total New O Code	0
Total New B Code	24

Respondent 2 [c2q4r2]	Uttarakhand despite being a hydro rich state could not harness its potential because of environmental and rehabilitation issues and lack of public awareness.
Keywords	harness, environmental, rehabilitation, public awareness,
O Code	Nil
B Code	04, 18
Total New O Code	0
Total New B Code	0

Respondent 3 [c2q4r3]	It is a very long topic and may need a paper itself. There are many barriers some of which are listed below: 1. Government sanctions and the policy 2. Lack of support from the government 3. Forest and other land transfer 4. Regulatory 5. Difficulty if construction of project being located in remote place without any infrastructure like roads, schools, medical facilities etc. 6. Natural calamities. 7. Geological surprises and risk 8. Financing 9. Local issues 10. Manpower availability and attrition 11. Technological
Keywords	Government sanctions, lack of support, government, forest, land transfer, regulatory, remote place, infrastructure, roads, schools, medical facilities, natural calamities, geological surprises, risk, financing, local issues, manpower availability, attrition, technological,
O Code	Nil

B Code	01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 13, 21, 29, 33, 34
Total New O Code	0
Total New B Code	3

Respondent 4 [c2q4r4]	In my experience, it is clear that lack of political will and frequent changes in the policy make it difficult to maintain the financial viability of the hydroelectric projects. Overhyped environmental issues, R&R issues, bureaucratic and administrative mismanagement by the local administration and poor coordination and communication between representatives of local administration escalate various issues and hinder the development of hydropower projects in Uttarakhand. Time slippages have an exponential spiral impact directly on the financial inflow and outflow of the projects. The risks at times have such severe impact that discontinuing the projects, even after huge capital investment, becomes the only viable option.
Keywords	political will, frequent changes, policy, financial viability, hyped, environmental issues, R&R issues, Bureaucratic, administrative mismanagement, local administration, poor coordination and communication, escalate, hinder, development, time slippages, exponential, inflow, outflow, discontinuing, capital investment, viable option
O Code	05
B Code	02, 03, 04, 05, 07, 12, 14, 15, 27
Total New O Code	1
Total New B Code	1

Respondent 5 [c2q4r5]	Current R&R policy is inadequate as it leads to inadequate compensation. Implementation of the R&R initiatives also suffers due to bureaucratic and administrative mismanagement by local administration. Large hydro projects lead to displacement resulting in loss of home, land, livelihood, water source, religious places, van panchayat land, grazing ground and fodder, cremation ground, community life, culture, health and hygiene. Poor support by local administration results in delayed and inadequate compensation leading to social conflicts and protests. There is a need to make R&R policy more comprehensive and to ensure effective implementation.
Keywords	R&R policy, inadequate, compensation, bureaucratic, administrative mismanagement, local administration, displacement, home, land, livelihood, water source, religious places, van panchayat land, grazing, ground, fodder, cremation ground, community life, culture, health, hygiene, poor support, local administration, delay, inadequate compensation, social conflicts, protests, R&R policy, comprehensive, effective implementation,
O Code	Nil
B Code	01, 02, 03, 04, 07, 11, 13, 14, 22, 27
Total New O Code	0
Total New B Code	0

Que no. 5	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?
Respondent 1 [c2q5r1]	Policy makers are promoting sustainable development to counter the challenges of climate change and energy security. Hydropower is a clean source of energy and is a desirable constituent of power generation mix of a country resulting in energy security and sustainable development. Hydropower plant also helps in flood control, irrigation and water supply. Despite several advantages of hydropower generation, its development is facing several barriers and risks. Longer gestation

	period, environmental and rehabilitation issues, land acquisition problems, geological surprises, location disadvantages, financial constraints, and lack of public awareness etc., are the major barriers to the development of hydropower. This paper should be the basis for future studies in creating a framework for reducing bottlenecks in the industry and to promote hydroelectricity.
Keywords	policy makers, sustainable development, climate change, energy security, clean source, flood control, irrigation, water supply, longer gestation period, environmental, rehabilitation issues, land acquisition, geological surprises, location disadvantages, financial constraints, public awareness,
O Code	05, 06, 11
B Code	01, 03, 04, 05, 08, 10, 12, 17, 18, 21, 22, 29, 33, 39
Total New O Code	3
Total New B Code	14

Respondent 2 [c2q5r2]	Due to unsettled rehabilitation issues, environmental issues and in the absence of adequate policies, projects are getting delayed which lead to cost overrun making the project unviable.
Keywords	rehabilitation issue, environmental issues, adequate policies, cost overrun, unviable,
O Code	Nil
B Code	03, 04, 05, 12, 18
Total New O Code	0
Total New B Code	0

Respondent 3 [c2q5r3]	It is a very long topic and may not be possible to cover in this questionnaire.
Keywords	Nil

O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q5r4]	I believe that the huge capital investment required and uncertainity in the forest, environment & state hydro policy and natural disasters pose a significant risk for development of Uttarakhand as a Hydro power rich state. Financers see this as the major barrier in investing in hydro power projects in the state. The plight of few prestigious hydroprojects has been historically seen in the past in Uttarakhand and is keeping the investors at bay.
Keywords	huge capital investment, uncertainty, environment, state hydro policy, natural disasters
O Code	Nil
B Code	03, 05, 06, 09, 18
Total New O Code	0
Total New B Code	2

Respondent 5 [c2q5r5]	Opportunities are insignificant as compared to the impact which the hydropower plants have on the local people around. People are forcefully displaced and inadequate compensation is given. Farming cycles have been adversely affected which include soil erosion and landslides. Local people have no options but to work as project labour, taxi drivers, or to vacate and migrate to major cities. The local culture, local farming has vanished in these areas. Because social issues are not resolved, projects face social conflicts, protests, work stoppage and litigation leading to time delays and increase in cost.
Keywords	Opportunities insignificant, forcefully displaced, inadequate compensation, Farming cycles, soil erosion, landslides, project labour, taxi drivers, migrate, local

	culture, local farming, vanished, social conflicts, protests, work stoppage, litigation, time delays, cost
O Code	03, 06
B Code	02, 04, 05, 09, 11, 12, 14, 18, 22
Total New O Code	1
Total New B Code	3

Que no. 6	Based on your experience, share the impact of Hydropower Projects on the following aspects of PAP: Land; Job/Livelihood; Home; Food security; Health; Common property; Community life; Women security; Education; Any other issue
Respondent 1 [c2q6r1]	a) **Land:** The size of the reservoir created by a hydroelectric project can vary widely, depending largely on the size of the hydroelectric generators and the topography of the land. Hydroelectric plants in flat areas tend to require much more land than those in the hilly areas or canyons where deeper reservoirs can hold more volume of water in a smaller space. The construction of hydroelectricity projects caused changes in land use, involving mainly conversion of agricultural land and forests to roads, tunnels, buildings, or other components of the projects. b) **Job/Livelihood:** Agricultural land and forests are valuable rural assets for villagers who practiced farming as their main livelihood activity. Farming consisted of cultivation of cereals and vegetables on terraced farmlands and of cardamom on steeper slopes. Agricultural fields in villages that had been affected by construction work for hydroelectricity projects were damaged to various degree and adversely affected their livelihood. However, employment has accrued to the rural community from these economic development projects. Younger and more educated people in particular withdrew from agriculture and took up employment with the companies, because they felt this was a better livelihood option. One

interviewee said, ‘‘These days, people don’t like to work on farms as it’s easier to work for the company—you get a steady income”.

c) **Home:** The hydroelectric projects, being large engineering undertakings, also resulted in immigration of workers from outside to the project townships and into residential colonies around the project sites. This provided opportunities for some local people to engage in business and trade of various kinds.

d) **Food security:** In hydropower projects, displacement and resettlement are acute. Development of local road, transportation facility results in increase in per capita income due to local business. Food has often become more readily available compared to the previous situation where they could find it difficult to obtain food from various sources. As a result, the quantity and quality of the main meals of the population have increased, especially as a result of better availability of meal products.

e) **Health:** Connectivity with the metropolitan and main cities is generally very poor. Due to the establishment of the hydropower project, transportation and medical facility might improve. Generally, at regular intervals of time, the project authority may provide medical vans and free medical check-up camps.

f) **Common property:** Poor farmers, particularly those without assets, suffer a loss of access to the common property goods belonging to communities that are relocated (e.g., loss of access to forests, water bodies, grazing lands, etc.). This represents a form of income loss and livelihood deterioration that is typically overlooked by planners and therefore uncompensated. Hydropower projects also have extraordinary positive social impacts, direct and indirect. Their many multiplier effects have to be measured better and made known wider.

g) **Community life:** When facing the climate adaptation challenge, hydropower plants can make a precious resource to manage water, prevent damages from extreme weather and regulate irrigation system. Hydroelectric facilities have

		many characteristics that favour developing new projects and upgrading existing power plants: Hydroelectric power plants do not use up limited non-renewable resources to make electricity. They do not cause air, land, or water pollution and have low failure rates, low operating costs, and are reliable. They can provide start-up power in the event of a system wide power failure. As an added benefit, reservoirs have scenic and recreation value for campers, fishermen, and water sports enthusiasts. The water is a home for fish and wildlife as well. Dams add to domestic water supplies, control water quality, provide irrigation for agriculture, and avert flooding. Dams can actually improve downstream conditions by allowing mud and other debris to settle out. Considering above hydropower plants improve community life drastically.
	h)	**Women security:** The role of women in rural environmental protection is becoming an issue worthy of attention in the communities affected by hydropower projects. Gender equality through empowerment and safety of women is also crucial and fundamental. The hydropower afforded women new opportunities and at the same time exposed them to new dangers. Generally, women who worked in the industry did so out of necessity as working for them was a matter of survival. In the wake of increasing incidents of violence and atrocities against women, safety of women in our society and at the work places play a vital role. All organizations need to have a system in place to monitor their activities on gender sensitization and security and safety issues as well as On-line basic security awareness training shall be provided where women employees are guided on how to act when faced with sexual harassment.
	i)	**Education:** To evaluate the post-construction impacts from hydropower development on local socio-economic conditions, variables such as income, education, longevity, the percentage of public access to electricity and piped water, population density, HIV cases, and teenage pregnancy rates etc. to

	characterize the socio-economic dimensions of each county. j) **Any other issue:** The project has taken equal care in protecting the fragile Himalayan environment. Construction debris was disposed of in a manner that did not scar the mountainside or obstruct the river's natural flow; it was also reused in new construction. Disposal sites are now being planted with trees. To ensure the river's continued flow, trees have been planted in the catchment area; and, a minimum flow of water is being ensured at all times to preserve the river's delicate aquatic balance.
Keywords	reservoir, topography, more land, hilly, smaller space, land use, agricultural lands, forests, roads, tunnels, buildings, practiced farming, livelihood, cultivation, employment, economic development, easier to work, steady income, immigration of workers, business, trade, displacement, resettlement, transportation, increase in per capita income, local business, food, meal, connectivity, poor condition, medical facility, medical van, medical check-up camp, farmers, loss of access, relocated, forests, water bodies, grazing lands, income loss, livelihood deterioration, uncompensated, social impacts, climate adaptation, precious resource, manage water, prevent damages, extreme weather, regulate irrigation, pollution, low failure rates, operating costs, reliable, start-up power, power failure, scenic, recreation, sports, fish, wildlife, water quality, irrigation, agriculture, avert, flooding, exposed, incidents, violence, atrocities, gender sensitization, sexual harassment, public access, electricity, piped water, fragile, environment, disposal sites, planted, catchment area, preserve, aquatic balance, land, hilly areas, smaller space, job, livelihood, farming, steady income, home, food security,
O Code	01, 02, 03, 04, 05, 06, 10, 11, 13, 14
B Code	01, 02, 04, 11, 33
Total New O Code	10
Total New B Code	5

Respondent 2 [c2q6r2]	a. Land – b. Job/ Livelihood – Job Opportunity has improved c. Home – Improved d. Food Security – Improved e. Health – Improved f. Common property g. Community Life – Improved h. Women security – Improved i. Education – Improved j. Any other issue
Keywords	Job opportunity, improved
O Code	03
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 3 [c2q6r3]	a) Land There is no impact b) Job/Livelihood Substantial improvement in the jobs in the hinterland c) Home No Effect d) Food security No effect e) Health No effect f) Common property No Effect g) Community life Improved h) Women security No effect i) Education No effect j) Any other issue
Keywords	no impact, substantial, improvement, jobs, no effect, improved
O Code	01, 03

B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q6r4]	a) Land - Land cost rise, soil erosion and landslide reduce cultivable land. b) Job/Livelihood - Livelihood increase and better job prospects for the local educated youth. c) Home - Homes close to project submergence area are at a higher risk and are vacated. No impact on homes which are at a safe distance. d) Food security - Lesser farming increases dependence on food supply from the market. e) Health - Improved due to project medical camps act as first aid. f) Common property - People lose access to few areas of the forest which were earlier easily accessible for them. g) Community life – With street lights, and visitors, road development and sports in and around the project will lead to an improvement in the overall community life. h) Women security – Lighting in and around the project area will increase women safety, but due to the inflow of non-local construction labourers, women security is at times compromised. i) Education No significant impact j) Any other issue
Keywords	Land cost rises, soil erosion, landslide, reduce cultivable land, job prospects, submergence, lesser farming, food supply from the market, project medical, lose access, street lights, visitors, road development, sports, increase women safety, non-local construction labourers, women security is at times compromised.

O Code	01, 02, 03, 14
B Code	01, 02, 04, 09, 13
Total New O Code	0
Total New B Code	2

Respondent 5 [c2q6r5]	Because of displacement due to hydropower projects, at the new location PAP feel uprooted as they experience loss of land, home, livelihood, food security, health, common property (grazing ground and fodder, water source, religious places, playground, van panchayat land, cremation ground), community life, culture, etc. Often, PAP complains about inadequate compensation and lack of facilities at resettlement locations. Frequent changes in policy coupled with bureaucratic and administrative mismanagement aggravate the loss to PAP.
Keywords	displacement, land, home, livelihood, food security, health, common property, grazing ground, fodder, water, religious places, playground, panchayat land, inadequate compensation, lack of facilities, resettlement location, bureaucratic, mismanagement,
O Code	Nil
B Code	01, 02, 03, 04, 11
Total New O Code	
Total New B Code	1

Que no. 7	Are the current policies effective enough to address the Barriers and Risks of Hydropower projects in Uttarakhand? If no, comment on the lacunas of the policy.
Respondent 1 [c2q7r1]	To make current policies effective enough to address the Barriers and Risks of hydropower projects in Uttarakhand, regular consultative and review meetings are being held with the Central and State Nodal Departments & Developers. The Ministry of Power has to resolve the issues responsible for retarding the pace of implementation of the hydro projects. This Ministry of Power should also be in

	touch with the Ministry of Environment, Forests and Climate Change for solving issues related to forest clearances for hydro projects and also with the state governments to ease the process of obtaining statutory clearances.
Keywords	nodal departments, developers, retarding, implementation, climate change, forests, clearances, governments, statutory, barriers, risks, hydropower projects, Uttarakhand, consultative, review meetings,
O Code	Nil
B Code	03, 06, 27
Total New O Code	0
Total New B Code	3

Respondent 2 [c2q7r2]	Environmental policies are not clear. Some projects like Lohari Nagpala, Pala Maneri & Bhairon Chati were stopped in between after a heavy investment on these projects. These kind of indecisive policies make the hydropower projects very risky.
Keywords	policies, not clear, stopped, heavy investment, indecisive, risky
O Code	Nil
B Code	03, 05, 07, 18
Total New O Code	0
Total New B Code	3

Respondent 3 [c2q7r3]	I do not think policies alone can make any change in the scenario until the time comes where the implementation of such policies in letter and spirit is ensured and the mindset of the people responsible for implementing such policies is changed. The IPP is seen as competitor to the government. Even today nobody in the government or otherwise supports the hydropower

	projects though it is the stated policy of the government.
Keywords	policies, implementation, IPP, competitor, government,
O Code	Nil
B Code	03, 07
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q7r4]	Policies are unipolar. They address only one aspect while fail to hedge the risk of investors, developers and financers. Environment and green cover concerns only hinder hydropower development, and policies looks at it as a part of the problem with no solution. Developers and state government obligations towards green cover renewal and forest replenishment and social concerns are either ignored or are impractical.
Keywords	policies, unipolar, hedge, risk, investors, developers, financers, environment, green cover, hinder, development, government, obligations, green cover renewal, forest replenishment, social concerns, ignored, impractical
O Code	Nil
B Code	03, 04, 05, 07, 18
Total New O Code	0
Total New B Code	1

Respondent 5 [c2q7r5]	Existing policies have been made to benefit only the project developers. Employment of the local population and resettlement of project affected people have been overlooked.
Keywords	policies, developers, employment, local population, resettlement, overlooked
O Code	Nil
B Code	02, 04
Total New O	0

Code	
Total New B Code	1

Que no. 8	Share your experiences regarding the implementation of several policies and initiatives for development of Hydropower Projects in Uttarakhand.
Respondent 1 [c2q8r1]	The decision of implementing hydro projects rests with the Central and State Governments. Both large and small hydro projects have their own advantages. In order to encourage small hydropower projects, the government is giving financial support to the state government to set up projects and also for the identification of new potential sites including survey and preparation of DPRs. Small hydro projects are difficult to construct as they are normally located in remote and hilly areas. The gestation period is relatively long and the projects usually take 4 to 5 years in completion. Water being a state subject, the projects are allotted by the states and all clearances are given by them. Sometimes the allotment, physical possession of land, forest clearance etc. takes two to three years. The Ministry has a very limited catalytic role in the exploitation of this potential. It facilitates by way of guiding the states, providing subsidy to the projects to improve their economic viability and create technical support services. However, the Ministry stepped up substantially its efforts towards close monitoring of the projects, interaction with potential States and private developers. A series of meetings and visits were held at the level of the Minister and Secretary, MNRE with the states to monitor the ongoing projects and take up new potential sites.
Keywords	Central, State, financial support, State Government, survey and preparation of DPR, difficult to construct, gestation period, long, states, clearances, physical possession, land, forest, projects, interaction, States, private, developers, Minister and Secretary, MNRE
O Code	05
B Code	01, 06, 33, 39
Total New O Code	1
Total New B Code	4

Respondent 2 [c2q8r2]	Inadequate policies resulted in inefficient development.
Keywords	Inadequate policies, inefficient development,
O Code	Nil
B Code	03
Total New O Code	0
Total New B Code	1

Respondent 3 [c2q8r3]	No comments
Keywords	Nil
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q8r4]	The hydropower projects being implemented by the central government are reasonably large projects and are managed fairly well. Relatively the small hydropower projects being developed by the state government or the IPP are not properly managed. The policies are neither clear nor practical and are totally silent on some aspects. Hence it causes hindrance for some projects while facilitating the others.
Keywords	implemented, government, large projects, managed fairly well, government, IPP, properly managed, clear, practical, totally silent, hindrance
O Code	Nil
B Code	03, 07
Total New O Code	0
Total New B Code	1

Respondent 5 [c2q8r5]	Actual implementation on ground totally differs from the policies on paper. The developers divert more than approved quantity of intake water, forces the river to change it course for its own benefit. The developers ignore all social welfare and environmental impact for profits.
Keywords	implementation, policies, developers, divert, ignore, social welfare, environmental impact, profits
O Code	Nil
B Code	03, 04, 18
Total New O Code	0
Total New B Code	2

Que no. 9	Which agencies are involved in the implementation of initiatives and policies for development of Hydropower Projects in Uttarakhand and what are your experiences with them?
Respondent 1 [c2q9r1]	Uttarakhand has a hydropower potential of the order of 25000 MW against which only 3164 MW has been harnessed so far. Keeping in mind the national objective of increasing power generation through environmentally appropriate means, and the target of 3000 MW for the hydropower sector in the 11th Plan period, the Government of Uttarakhand (GoU) has framed a hydropower policy. The objectives of this policy are to attract investors for the development of the state's water resources in an environment-friendly manner, and to generate revenues for the State from development of its hydel resources while ensuring project viability. **(I) Based on the generating capacity**, projects will be grouped into the following three categories: a) Micro Projects with capacity up to 100 kW, b) Mini Projects with capacity above 100 kW and up to 5 MW,

	c) Small Projects with capacity above 5 MW and up to 25 MW. d) Large Hydro Projects above 25 MW **(II) On the basis of the mode for identification**: a) **Self Identified Projects:** Developers may identify the micro and mini projects, prepare the DPR and ask for allotment; b) **State Identified Projects:** The state or state sponsored agencies may identify projects of any size, prepare the DPR and allot it in the manner prescribed below. **Eligibility criteria for allotment of self identified projects:** **For Micro projects** (i) Individuals who are domiciles of Uttarakhand, (ii) Gram Panchayats of Uttarakhand in the vicinity of the site, (iii) Societies of Uttarakhand registered under the Society Registration Act, 1860/UP Cooperative Society Act 1965 would be eligible for allotment. **For Mini projects** (i) Individuals who are domiciles of Uttarakhand, (ii) Gram Panchayats of Uttarakhand in the vicinity of the site, (iii) Societies of Uttarakhand registered under the Society Registration Act, 1860/UP Cooperative Society Act 1965, (iv) Firms registered under the Company Act 1956 and having their manufacturing units located in Uttarakhand would be given preference for allotment of project. **For Small Projects** (SHP) These would be open to all and there would be no reservations. For this, the premium will be decided later. **For LHP (Policy for >25 MW)**: This policy shall be in operation from the date of its publication as notified by Government Order. All hydropower

	projects/stations estimated to have an installed capacity of 25 MW and more, that will be eligible under this policy. Uttarakhand invites any qualified, non-Uttarakhand state government agency to bid for identified projects for the development of this sector. These will be termed as Independent Power Producers (IPP). This would include any Private Sector Entities, Central Power Utilities, State Governments or any other Government entities and their Joint Ventures. The Government shall be advertising and inviting participation for developing these projects in lots through sequence of RFQs and RFPs. GOU shall have all powers to amend the provisions under the policy.
Keywords	national objective, increasing power generation, environmentally, government, attract investors, water resources, environmental-friendly, generate revenues, project viability, micro projects, mini projects, small projects, large hydro projects, self identified projects, state identified projects, domiciles of Uttarakhand, Gram Panchayats, Societies of Uttarakhand, Cooperative Society, independent power producers (IPP),
O Code	04, 05
B Code	05
Total New O Code	2
Total New B Code	1

Respondent 2 [c2q9r2]	UERC, UPCL, PTCUL, UJVNL, State Govt., CEA etc
Keywords	UERC, UPCL, PTCUL, UJVNL, State Govt., CEA
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 3 [c2q9r3]	The state government through UERC plays a pivotal role in the implementation of policies.
Keywords	state government, UERC
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q9r4]	State Government, UPCL, PTCUL, UJVNL, Central Government, SERC, CERC, CEA, PGCIL, NTPC, NHPC
Keywords	State Government, UPCL, PTCUL, UJVNL, Central Government, SERC, CERC, CEA, PGCIL, NTPC, NHPC
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 5 [c2q9r5]	Government, independent developers, local bodies, NGO, local people and societies, UPCL. The government agencies favour the developers. They do very less for the sacrifice of the local people.
Keywords	Government, developers, local bodies, NGO, local people, societies, agencies
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Que no. 10	Is there any gap between current policies and its implementation for Hydropower Projects in Uttarakhand? If yes, share your experiences.
Respondent 1 [c2q10r1]	State Governments need to review procedures for land acquisition and other approvals and clearances for speedy implementation of hydroelectric projects. Proper implementation of National Policy on Rehabilitation and Resettlement (R&R) would be essential in this regard to ensure that the concerns of project-affected families are addressed adequately. Local Area Development Fund Government of Uttarakhand is working on a policy to provide direct benefits to people living near project sites. Money received from the revenue of 12 per cent free energy to the state government as matching share from the State Government. The developer shall deposit the money received as revenue of 1 per cent of total electricity generated to this fund which is termed as additional free electricity. Money shall be deposited on yearly basis. The total money received from the developer and bank interest will be used for the development of the project affected area in the chairmanship of the District Magistrate. Money received in LADF will be utilized for the benefit of people residing in PAA, PAZ and nearby areas.
Keywords	State Governments, land acquisition, approvals, clearances, speedy implementation, national policy, R&R, project-affected families, direct benefits, revenue, free energy, LADF (Local Area Development Fund)
O Code	01, 02, 04
B Code	01, 04, 06, 07, 11
Total New O Code	3
Total New B Code	5

Respondent 2 [c2q10r2]	Inadequate maintenance of transmission lines, lack of availability of proper infrastructure like road, communication, law and order problems and poor power evacuation system. All the above gaps are making hydropower development in Uttarakhand very difficult.
Keywords	Inadequate maintenance, transmission, proper infrastructure, road, law & order, power evacuation,
O Code	Nil
B Code	02, 19, 27, 31, 33
Total New O Code	0
Total New B Code	5

Respondent 3 [c2q10r3]	The problem of grid connectivity and power evacuation has not been adequately addressed in the policy. Developers put in a lot of capital, develop the last mile transmission line for grid connectivity, only to find that they are not able to generate electricity because of frequent grid failures. Deemed generation is also being manipulated by the distribution or transmission utility as per their convenience under the garb of natural disaster and force majeure.
Keywords	grid connectivity, power evacuation, transmission, grid connectivity, grid failures, deemed generation, garb, natural disaster, force majeure
O Code	Nil
B Code	05, 07, 19
Total New O Code	0
Total New B Code	1

Respondent 4 [c2q10r4]	Current policies ignore the various risk of the developers and financers. They fail to protect the developers from such risks. The developers find it difficult to arrange for capital funds and even if they manage to get the investment, the interest on capital is too high which increase the payback time. Increase in payback time exposes the projects to risk of natural disasters for a longer time, specifically for small hydro projects.
Keywords	capital, investment, payback, natural disasters
O Code	Nil
B Code	05, 13
Total New O Code	0
Total New B Code	1

Respondent 5 [c2q10r5]	Not Answered.
Keywords	
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Que no. 11	Based on your experiences, suggest improvements (if any) in policy associated with Hydropower Projects in Uttarakhand to make it more effective.
Respondent 1 [c2q11r1]	The growth in the SHP sector is relatively slow. The main reason for the slow progress can be attributed to the difficult locations where SHP projects are normally set up, short working season in hilly areas and involvement of private and forest land in setting up of SHP projects. The risks due to natural calamities in setting up SHP

	projects are high and sometimes the developers face resistance from local residents. This apart, time taken in allotment of sites and obtaining statutory clearances in the states, adds up to the overall time in construction of SHP projects. The main constraints in setting up SHP projects are: a) The SHP projects are governed by the state policies and the potential sites are allotted by the state governments to private developers. b) Time consuming process for allotment of sites by the states and statutory clearances including land acquisition, forest clearance, irrigation clearance etc. c) Relatively longer gestation period in completing the projects due to difficult terrain and limited working season. d) Inadequate evacuation facilities for power generated from projects. Increase in project cost due to HFL consideration and inflation in the prices of steel and cement and other construction materials.
Keywords	growth, SHP sector, slow, difficult locations, short working season, forest land, natural calamities, resistance from local residents, state policies, inadequate evacuation, HFL, inflation, prices of steel and cement, construction materials,
O Code	Nil
B Code	01, 02, 03, 04, 06, 09, 12, 19, 31, 33, 36
Total New O Code	0
Total New B Code	11

Respondent 2 [c2q11r2]	Government should take consideration of all the issues before allotting a project. Once started it should not be stopped for any of these reasons.
Keywords	government, issues, allotting, stopped,
O Code	Nil
B Code	03, 07, 18, 27
Total New O Code	0
Total New B Code	3

Respondent 3 [c2q11r3]	As stated earlier the policies alone shall not make any change until the government as a whole is committed to the development of the sector. The hydropower projects need to deal with almost all government departments including district administration and until everybody supports the projects, it may not get the required push. We have been talking of a single window clearance for a long time but so far, nothing has materialized. The single window may not be for the permissions alone but all other problems faced by the IPP.
Keywords	government, committed, administration, single window clearance, permissions, other problems, IPP
O Code	Nil
B Code	03, 06, 07
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q11r4]	The approval process should be fast and transparent with fixed timeline. Policy should focus on financial and environmental sustainability. Quick cost recovery should be allowed to the developers with preferential tariff during the initial years.
Keywords	fast, transparent, fixed timeline, financial, environmental, sustainability, cost recovery, preferential tariff
O Code	Nil
B Code	03, 05, 06, 07, 12, 18
Total New O Code	0
Total New B Code	1

Respondent 5 [c2q11r5]	Not Answered.
Keywords	
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Que no. 12	Suggest measures to address implementation issues and minimize gaps between policies and implementation
Respondent 1 [c2q12r1]	There is an urgent need to develop this promising sector of renewable energy in all developing countries as only a fraction of available potential has been harnessed so far. The policy mentioned below has to be implemented positively to develop the hydropower. 1. A substantial hydel power potential has remained locked up and many mega hydel projects could not be taken up for implementation, even when these projects are well recognised as attractive and viable, because of unresolved inter-state issues. 2. CPSUs and the private sector would need to play a greater role in hydro development. The immediate requirement would be to transfer the clearances already accorded to non-started hydro projects in the state sector in favour of CPSU/IPP/Joint Venture of IPP and CPSU. The government should evolve a simple procedure so that the transfer of CEA's techno-economic clearance would be futile as only updating of the project estimate would be examined by the CEA. In the case of environment and forest clearances, these could be transferred to CPSU/IPP etc. within a prescribed time limit on acceptance of conditionality stipulated in the MOEF clearance accorded for execution in the State sector by the above executing agencies. 3. The tariff formulation and norms for hydro projects as per existing the

	government notification are viewed by CPSUs and IPPs as unfavourable compared to those for thermal projects and the IPPs tend to prefer thermal projects for investment. There is a need to reformulate the principles based on the tariff determined for hydel generation. The objective is to fix a rate which will be reasonable to the consumer, to ensure adequate internal resources to repay the loan and also to provide a reasonable rate of return on investment.
Keywords	renewable energy, harnessed, mega hydel projects, attractive, viable, unresolved, inter-state issues, CPSUs, private sector, greater role, clearances, CPSU, IPP, Joint Venture of IPP, techno economic clearance, project estimate, environment, forest clearances, time limit, MOEF clearance, tariff formulation, government notification, reformulated, principles, tariff,
O Code	05
B Code	05, 06, 07, 22, 27
Total New O Code	1
Total New B Code	5

Respondent 2 [c2q12r2]	Clear and adequate rehabilitation, environmental and land acquisition policies. Adequate infrastructure for projects like approach roads, power evacuation infrastructure, good communication facility etc. Clear policy on interstate issues. Better financing options and regulatory framework.
Keywords	clear, adequate rehabilitation, environmental, land acquisition policies, approach roads, power evacuation, good communication facility, interstate issues, financing options, regulatory framework.
O Code	Nil
B Code	01, 03, 04, 05, 07, 18, 27, 33
Total New O Code	0
Total New B Code	5

Respondent 3 [c2q12r3]	Discussed already in previous responses.
Keywords	Nil
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c2q12r4]	If a project is abandoned due to reasons which are not under the control of the developers, then the investment recovery assurance mechanism should be a part of the policy. Only then will the developers and financer be interested in investing and developing hydro projects in Uttarakhand.
Keywords	Abandoned, developers, investment recovery, assurance mechanism, policy, interested
O Code	Nil
B Code	03, 05, 13, 15, 18
Total New O Code	0
Total New B Code	2

Respondent 5 [c2q12r5]	Implementation has to be done with complete involvement of the local population. The policy has to be inclusive of all the stakeholders. Local population should not be considered as anti project. There requirements and needs should be addressed and protected adequately in the policy.
Keywords	local population, anti project, requirements, protected, policy
O Code	Nil
B Code	02, 04
Total New O Code	0
Total New B Code	1

Case 2: Summary – Pala Maneri Hydro Electric Project

The Pala Maneri Hydro Electric Project is a run of the river (ROTR) project which utilizes the flow of Bhagirathi River to harness the head available between the proposed head work located near Pala village and the reservoir of Maneri Bhali Stage-I in Uttarkashi district, of Uttarakhand. The project has a proposed installation capacity of 480 MW (4x120 MW) envisaged to generate an annual energy generation of 1993 million units (MU). The gravity designed dam is 78 meter high and head race tunnel is 12.5 KM long with 7.2 KM circular diameter. The turbine used arc Francis and the project land used is 1217.18 hector. The project has been discontinued by GoI on 01/11/2010 based on the recommendation of the National Ganga River Basin Authority.

The case study of the project was conducted through a questionnaire and interview of the stakeholders. The respondents of the questionnaire are as follows:-

Respondent 1 – He is a General Manager at UJVNL, which is a state government undertaking responsible for hydropower generation in Uttarakhand. He has vast project management and operation experience of more than 35 years in the hydropower sector. He has been associated with the Pala Maneri Project until June, 2008 when the project was finally closed.

Respondent 2 – She is currently working as an Executive Engineer in UJVNL. She has more than 16 years of experience in design and development of hydropower projects in UJVNL.

Respondent 3 – He is an expert with a vast experience in Hydropower and Power Transmission. He has more than 33 years of experience in hydropower sector specifically in Uttarakhand. Currently, he is a Managing Director of a hydropower company in Uttarakhand. He has been an active member of the hydropower association, where he has been involved in various policy making processes and providing his inputs for the hydropower roadmap of the state.

Respondent 4 – He is a senior financial analyst with an international bank. He has more than 25 years of experience in financing the energy sector projects in the India. He is a native of the state and is thus well aware of the difficult topology, local and administrative issues. His vast experience in project investment through co-financing, lending and capital syndicating makes his financial acumen unquestioned.

Respondent 5 – This respondent runs an NGO that raises various social issues caused due to environmental changes in the region. He is a well know environmentalist and is also one of the project affected persons who has been directly affected by the development of the Pala Maneri Project. He has been instrumental in raising social concern with the government and resolving various issues of the PAP.

Case Discussion

The Pala Maneri hydro project was discontinued on the recommendation of the National Ganga River Basin Authority owing to environmental issues. Being a state government project, it was discontinued even after a sunken expenditure of Rs 120 crore. This makes the project an interesting and befitting case for an elaborate study.

Respondent number 1 while responding to question 2 said, "*Out of aforesaid SHPs, one project, namely Kaliganga-I SHP was commissioned in the month of July 2012 and the commercial operation of the powerhouse started on 10th September 2012. However, unfortunately, due to the unprecedented flood that occurred on 16 and 17June 2013, a major structure like Diversion weir, Power house etc were washed away, leaving the project area heavily damaged. However, this project is going to reconstruct with the major amount received from insurance. At present, more than 60 per cent works of these SHPs completed and these projects may be commissioned in 2019-20 and 2020-21."* The above comment by Respondent number 1 highlights the adverse impact of the inclement weather and flash floods that is unprecedented. Obviously the insurance cost for such projects should be relatively higher. These impacts can make the projects economically unviable.

Respondent number 1 in his answer to question number 3 of this case study has mentioned on the "*Grid Stability*" aspects of hydropower plants. He comments "*Hydropower plants helps in Grid Stability which create a more diversified electricity system by providing the production of electricity in smaller distribution systems when the main grid is disrupted."*

Another important aspect discussed by the respondent which challenges the usual conception of the hydro electric projects is the ability of the HEP to clean rivers by means of collecting floating waste stuck in the trash racks. Respondent number 1 responds to ~~in~~ question number 3 of this case study that has also highlighted on the "*recovery of floating waste from rivers*". He comments, *"Hydropower schemes assist in the maintenance of river basins by allowing the recovery of floating waste from the rivers, the monitoring of hydrological indicators."* This aspect of recovery of blocking of floating waste stuck on the trash rack is an interesting fact highlighted by the participant. However, the procedure for proper disposal of the floating waste recovered from the trash racks has to be studied before concluding that this has a positive impact on the quality of the water flow.

The respondents also mentioned of the provisions for 12 per cent free power for the initial years that are proving to be an obstacle in the development of hydropower projects in Uttarakhand. Respondent number 1 in response to question number 4 commented, "*The tariffs from the hydropower projects are higher in the initial years as compared to other sources due to lack of incentives like tax concessions, financing cost and construction of projects in remote areas with inadequate infrastructure. Due to the present tariff formulation norms for hydropower projects (based on a cost plus approach) with no premium for peaking services and the provision for 12 per cent free power to the distressed states from the initial years are also proving to be an obstacle.*" The higher tariff in initial years makes it difficult for the hydro projects to sell electricity through open access or through power exchange.

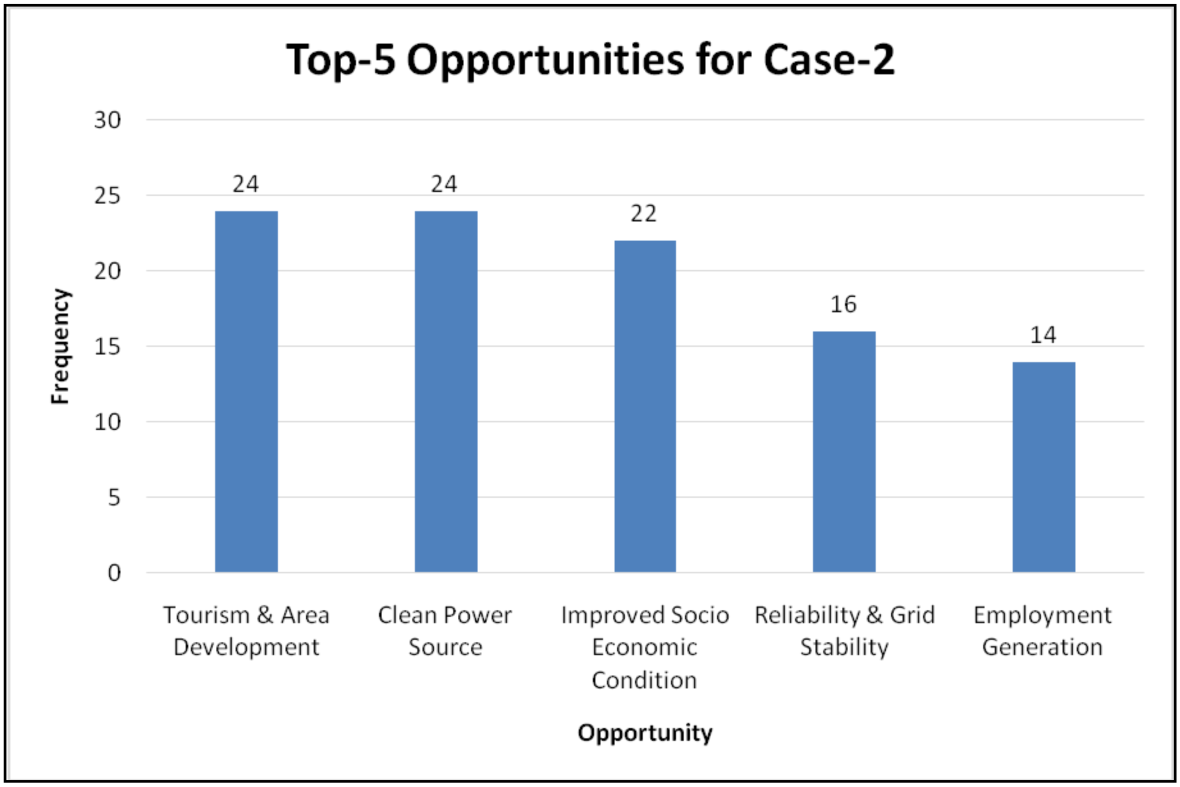
During an interview it was also observed that the state generators are not allowed to trade the energy openly in the exchange market. The utility monopoly and the frequent breakdown of the transmission tie line to the grid also make it difficult for the IPPs to increase the plant availability factor. The state generators are expected to supply the power to the only state distribution utility, i.e. UPCL, at prices which have been fixed by the regulatory commission. Although open access policy allows for free trading of power, state generators are obligated to supply only to state discom, whereas state generators can earn a lot revenue if they trade the electricity through power exchange. This could in turn make the HEP financially unviable in the long term.

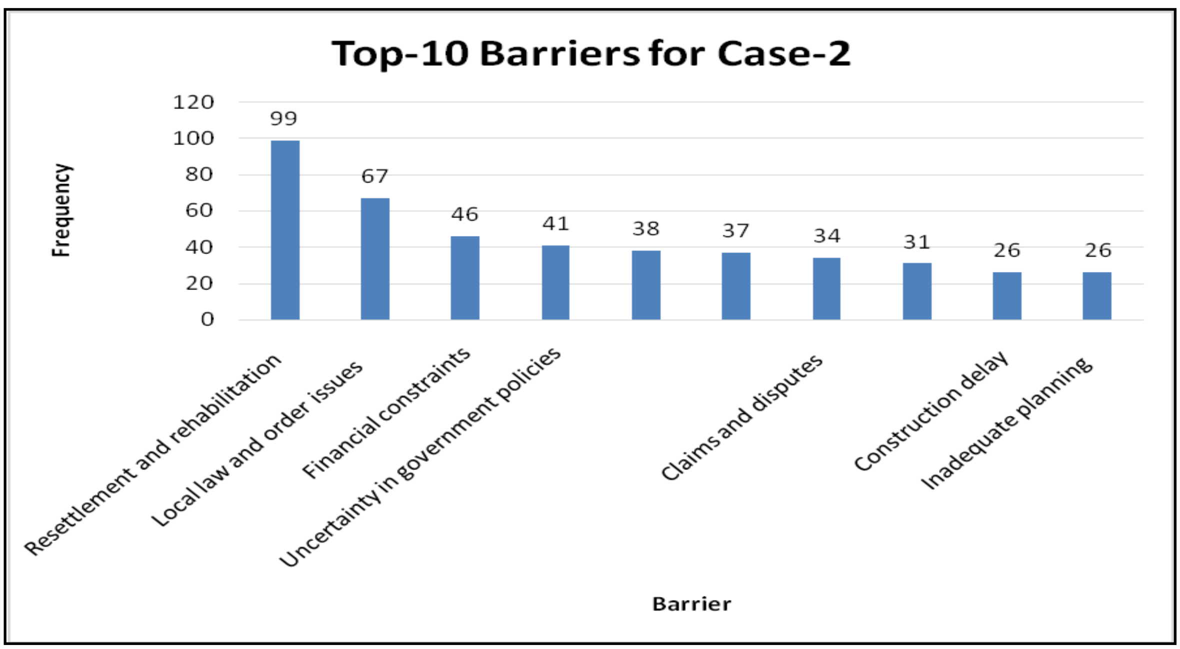
Respondent number 4 has mixed comments on women safety in question number 6. He writes, "*Women security – Lighting in and around the project area increase women safety, but due to inflow of non-local construction labourers the security of women is at times compromised.*"

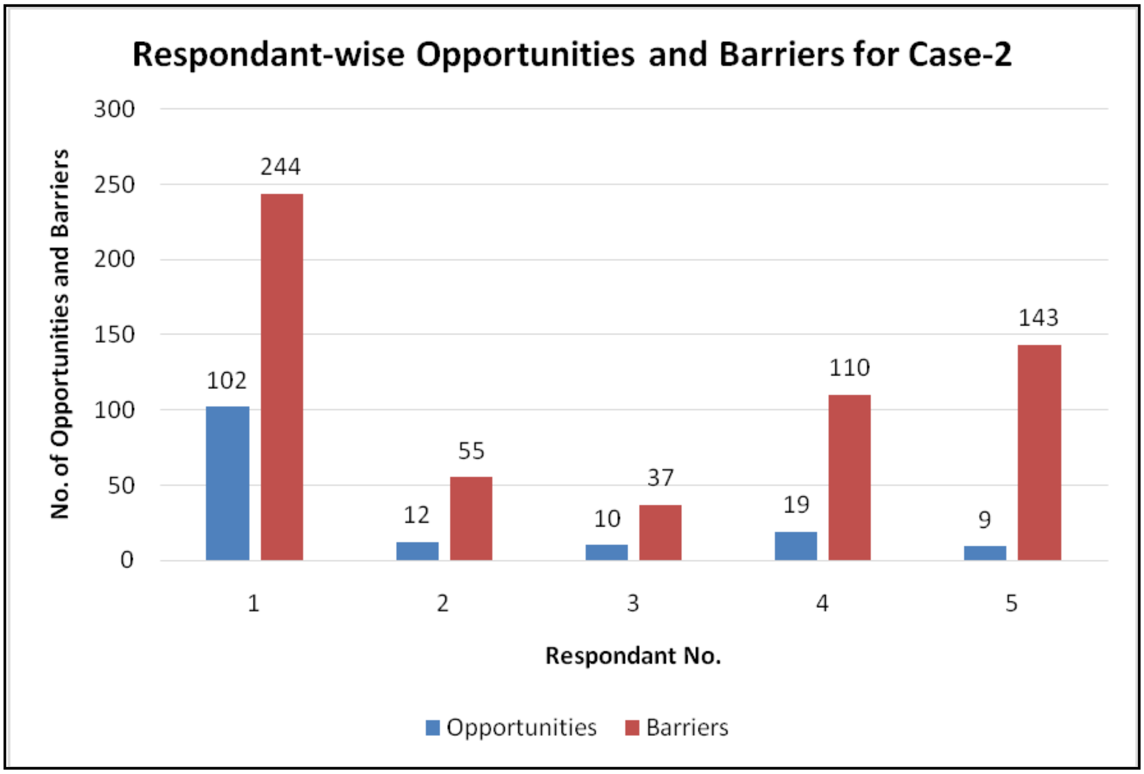
Respondent number 2 in response to question number 10 says "*Inadequate maintenance of transmission lines, lack of availability of proper infrastructure like road, communication, etc. law and order problems, poor power evacuation system. All the above gaps are making hydropower development in Uttarakhand very difficult".* In question number 11 she also highlights that "*Government should take consideration of all these issues before allotting a project. Once started it should not be stopped for any of these reasons*"

Respondent number 3 in question number 11 draws attention towards the need of single window clearance mechanism. He writes "*We have been talking of single window clearance for long time now but so far, nothing has materialized. The single window may not be for the permissions alone but all other problems faced by the IPP*"

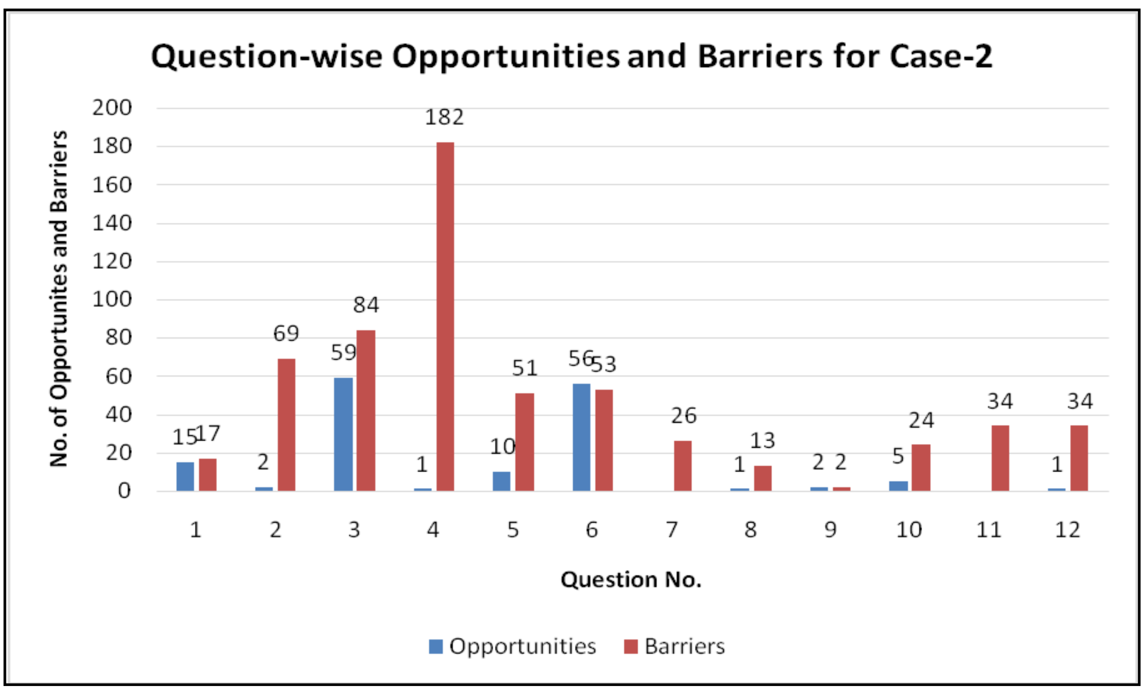
Case -2 Analysis







Respondant-wise Opportunities and Barriers for Case-2
No. of Opportunities and Barriers
300
250
200
150
100
50
0
102
244
12
55
10
37
19
110
9
143
1
2
3
4
5
Respondant No.
Opportunities
Barriers



Question-wise Opportunities and Barriers for Case-2
No. of Opportunites and Barriers
200
180
160
140
120
100
80
60
40
20
0
15
17
2
69
59
84
1
182
10
51
56
53
26
1
13
2
2
5
24
34
1
34
1
2
3
4
5
6
7
8
9
10
11
12
Question No.
Opportunities
Barriers

Case 3: Singoli Bhatwari Hydroelectric Project (LnT)

Que no. 1	What is your opinion about Hydropower Projects?
Respondent 1 [c3q1r1]	Uttarakhand is a rich state in terms of water resources. The mountainous terrain offers many ideal locations for hydropower development. The state is also successful in pursuing its aggressive industrial policy and as a result, has been able to achieve rapid growth of industrialization since its creation in 2000. The availability of cheap hydroelectric power potential and a large industrial customer base provides a golden opportunity for the state and its people towards economic prosperity. At the time of formation of the state, hydropower and tourism were projected as main thrust areas for the economic development of the state. In the following years, the government of Uttarakhand was supporting and promoting new hydropower projects. Much thrust was given on implementation of hydropower projects. At the same time, in the 2000s, hydropower was also being promoted by the central government. However, the development of new hydropower projects proved to be slow, with planned projects facing environmental opposition, corruption allegations and socio-political issues. As such, the growth in hydropower capacity in the state slowed down and did not match the growth in demand following industrialisation.
Keywords	water resources, ideal locations, aggressive industrial policy, industrialization, golden opportunity, economic prosperity, tourism, slow, planned projects, environmental opposition, corruption allegations, social-political issues,
O Code	01, 02, 06
B Code	02, 04, 07, 18, 27
Total New O Code	3
Total New B Code	5

Respondent 2 [c3q1r2]	Hydropower potential in Uttarakhand is good. The cost of implementation in Uttarakhand is very high due to relatively low heads and high quantity of water in season; as a result, the civil structure cost is very high. The quantity of water is very high during the monsoon for two to three months and the rest of the months it is very low (less than $1/5^{th}$), that causes the PLFs to be low as well. Tariff fixation is based on the Caps on Capital Cost i.e. cost per MW which will not cover ROI on real investment. As the days pass on the implementation of hydro projects is becoming tough due to tough policies of the forest land acquisition and private land acquisition. Local issues and exploitation are increasing as the awareness is growing. Environmental issues have become more strict with each passing day making. Private investments in Hydro Project Development very risky.
Keywords	cost of implementation, very high, low heads, high quantity, quantity of water, PLFs are low, tariff fixation, capital cost, ROI, real investment, implementation, tough, forest land acquisition, private land acquisition, local issues, exploitation, private investment, very risky,
O Code	Nil
B Code	01, 02, 04, 05, 06, 12, 26
Total New O Code	0
Total New B Code	5

Respondent 3 [c3q1r3]	There is large potential.
Keywords	large potential,
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c3q1r4]	Hydro projects generate clean and cheap energy. It is a huge opportunity loss if we are unable to develop Hydro Projects in Uttarakhand.
Keywords	clean, cheap, opportunity loss
O Code	01, 02, 03, 04, 05, 08
B Code	Nil
Total New O Code	4
Total New B Code	0

Respondent 5 [c3q1r5]	Hydropower projects are beneficial but due to several barriers and risks, the potential remain unutilized.
Keywords	beneficial, potential, unutilized, hydropower projects, barriers, risks, un-utilized,
O Code	01, 02, 03, 04, 05
B Code	Nil
Total New O Code	0
Total New B Code	0

Que no. 2	Have you ever been involved in and/or affected by Hydropower Projects in Uttarakhand? If yes, kindly share your overall experience.
Respondent 1 [c3q2r1]	L&T is involved as a developer in Uttarakhand since 2008. We are developing the Singoli-Bhatwari Hydro Electric Power Project (99 MW) in the Mandakini river basin. L&T was also involved in the construction of Srinagar HE Project (330 MW) on Alaknanda river.
Keywords	developer, river basin, construction,

O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 2 [c3q2r2]	We have implemented Debal SHP (5 MW) in Chamoli District. We started the construction in the year 2005 and completed the project by September 2007. Our project was affected in the 2013 floods and was stopped for nearly six months for reconstruction. We had to spend nearly ₹ 3 crores for the reconstruction (this expenditure is not covered in the tariff fixation norms) and loan repayment by the FI rescheduled by another four years. In 2012, we started the construction of two more projects Bhyunderganga SHP (24.3 MW) and Khiraoganga SHP (4 MW) in Chamoli District. The constructions of our projects were stopped by the Hon'ble Supreme Court in May 2014 due to a PIL filed by NGOs on environmental grounds. We have all the permissions and clearances from the government and yet our project construction was stayed by the Hon'ble Court to date. If there is any change in the government policies, it should be implemented for the new projects, but not for the projects already cleared and under implementation. Our investment is struck in both the projects for the last four years.
Keywords	SHP, Stopped, Tariff fixation, loan, court, environmental issues, permissions, clearances, government policies, investment, struck, reconstruction, PIL, NGOs,
O Code	Nil
B Code	02, 03, 05, 06, 07, 09, 11, 12, 14, 18
Total New O Code	0
Total New B Code	10

Respondent 3 [c3q2r3]	Yes. The process involves mapping, scheduling, evacuation network planning, design and ADB funding.
Keywords	evacuation, network planning, process mapping, scheduling, evacuation network planning, design, ADB funding,
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c3q2r4]	Yes, I was a part of the local administration during the flash floods of 2013. The flood hit the project construction. The administration had its own set of law and order issues to resolve. Due to the floods, despite being willing to assist the project, we were not in a position to offer any substantial support. The flash floods I believe has been one of the major setbacks for the project.
Keywords	local administration, flash floods, law and order, practically, support, set back
O Code	Nil
B Code	02, 07, 09, 12, 14, 15, 16
Total New O Code	0
Total New B Code	2

Respondent 5 [c3q2r5]	The project faced flash floods in 2013 that damaged the coffer dam of this project. After the devastation by the flash floods, reconstruction caused time and cost overruns.
Keywords	flash floods, damaged, devastation, time, cost, overruns,
O Code	Nil
B Code	05, 09, 12, 13, 14
Total New O Code	0
Total New B Code	1

Que no. 3	What are the advantages and disadvantages of Hydropower Projects?
Respondent 1 [c3q3r1]	**Advantages of Hydropower Projects:** Hydropower is a clean source of energy. Water being its fuel, it does not pollute the air like power plants that burn fossil fuels like coal or natural gas. Hydropower is a renewable source of energy. The International Energy Agency defines renewable energy as "energy that is derived from natural processes that are replenished at a higher rate than they are consumed. Solar, wind, geothermal, hydropower, bio-energy and ocean power are sources of renewable energy". The Ministry of Power, Government of India's website states, "Hydropower is called a renewable source of energy because it uses and not consumes the water for generation of electricity and hydropower leaves this vital resource available for other uses". Being a renewable power source, it is a more reliable and affordable source than fossil fuels that are rapidly being depleted. Compared to solar and wind, the variability of the water cycle is such that it makes hydropower more reliable and efficient. Solar power generation works best when the sun is at its peak, which generally happens during the middle of the day. After the sun sets, solar power systems have no more energy to draw from. Storms and clouds can also impact solar power production. Wind power works well in stormy conditions, but its predictability is location-specific. Hydropower facilities can quickly go from zero power to maximum output i.e. they can generate and provide power to the grid immediately which is very essential during major electricity outages or disruptions. Even otherwise, this high degree of flexibility is very important when it comes to meeting real-time energy demands. When high or low volumes of electricity are required, operators of a hydroelectric dam can alter the water intake to increase or decrease the flow of water into the dam thus generating the right level of electricity. This alteration can be completed in a very short space of time when compared to traditional thermal power stations.

	Hydroelectric power is a domestic source of energy, allowing each country and state to produce their own energy without being reliant on international fuel sources; provided there exists an adequate supply of water, hydroelectricity production can be constant and some countries have been successful in producing a large proportion of their total electricity capacity from it. Paraguay has been able to produce almost 100 per cent of its electricity supply from hydroelectric power. Moreover, hydropower allows countries to become less reliant on external supplies of fossil fuels such as coal, oil and natural gas which can become disrupted in situations of conflict, supply and demand and state of the economy. Hydroelectric power is economical to produce once the initial hydroelectric plant has been constructed. Hydroelectric plants have very low operating and maintenance costs when compared to those of the more traditional power stations. Tied in with the economic advantages is the fact that hydroelectric power isn't vulnerable to the fluctuating cost of fossil fuels, thereby helping to provide a more stable economy with predictable energy prices. Hydropower creates reservoirs that offer a variety of recreational opportunities, notably fishing, swimming, and boating. These reservoirs enhance the aesthetic beauty of nature unlike solar and wind farms and the smoke-filled thermal power plants. The larger, more noticeable hydroelectric dams can become landmarks for a country or a region helping to bring in large volumes of tourists each year providing a boost to the local economy. A reservoir can sometimes provide unintended benefits too, apart from the water reservoir acting as a buffer in times of drought. In connection with the June 2013 Uttarakhand floods, it has been reported by CEA and CWC that in the absence of the Tehri dam, the flood peak at Haridwar would have been about 21500 cumecs in place of actual observed about 14500 cumecs. Hence, due to the Tehri dam, the flood at Haridwar was mitigated by about 7000 cumecs.

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In addition to electricity, some hydropower facilities produce a number of other benefits, such as flood control, irrigation, and water supply as well.
<u>Disadvantages of Hydropower Projects:</u>

Despite producing a non-polluting and clean form of energy, the environmental fall-out of hydropower projects is significant. The damming of a river affects all form of life, including human beings. Changes in river levels, flow patterns and water temperature all contribute to how severe this impact will be. Sometimes, villages and even small towns may have to relocate to make way for a reservoir. The altered bio-environment is not acceptable to everybody.
Hydroelectric plants are expensive to build. Lots of planning, engineering and construction is required before a dam can start producing power to start paying for itself. This process takes several years and results in a long payback period and a low return on investment.
The long gestation period associated with hydropower projects is often a dampener. Policies, regulations, too many technical and administrative clearances together have contributed to the lengthening of the gestation period making hydropower projects unattractive for the investors. All these factors also result in higher tariffs compared to the other forms of energy.
Sometimes, the stored water can pose a significant danger to the downstream inhabitants. As recently as on 23rd July, a saddle dam of the under-construction Xe Pian Xe Namnoy Hydroelectric Power Project in Laos collapsed due to incessant rain and reportedly poor quality of construction. The incident has caused a massive flood disaster for the country requiring large scale rescue and evacuation operations and international aid to cope with the crisis.

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<td>Keywords</td>
<td>clean source, energy, water, fuel, not pollute, fossil fuels, coal, natural gas, renewable source, replenished, solar, wind, geothermal, hydropower, bioenergy, reliable, affordable, depleted, predictability, provide power, grid immediately,</td>
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	outages, disruptions, flexibility, meeting real time energy demands, alter the water intake, alteration, domestic source, international fuel sources, adequate supply, constant external supplies, coal, oil, natural gas, conflict, very economical, operating and maintenance costs, vulnerable, fluctuating cost, stable economy, predictable energy prices, recreational opportunities, notable fishing, swimming, boating, aesthetic beauty, tourists, boost to the local economy, buffer in times of drought, flood event, mitigated, flood control, irrigation, water supply, non-polluting, clean, environmental, river levels, flow patterns, water temperature, relocate, bio-environment, not acceptable, expensive to build, long payback period, low return on investment, long gestation period, policies, regulations, technical and administrative clearances, unattractive, investors, higher tariffs, stored water, great danger, downstream inhabitants, collapsed due to incessant rain, poor quality of construction,
O Code	01, 02, 03, 04, 05, 06, 08, 09, 10, 11
B Code	02, 03, 04, 05, 06, 09, 13, 18, 24, 25, 35, 39
Total New O Code	10
Total New B Code	12

Respondent 2 [c3q3r2]	Advantages: 1. Environmental friendly as compared to other conventional power projects 2. Ease of operation, i.e. easy starting and stopping 3. Good to operate as peaking power 4. Low O&M cost as there is no fuel cost 5. Though the cost is high initially, the cost will come down after recovering the capital

	Disadvantages 1. High capital cost. 2. Long gestation period 3. Project safety at stake due to unpredictable weather conditions
Keywords	environmental friendly, ease of operation, good to operate, peaking power, low O&M cost, no fuel cost, cost is high initially, high capital cost, long gestation period, project safety, unpredictable weather conditions, conventional
O Code	05, 07, 09, 10, 11
B Code	05, 09, 13, 39
Total New O Code	1
Total New B Code	0

Respondent 3 [c3q3r3]	Advantages a. Quick ramp-up and ramp down-aid grid stability. b. Can inject reactive power-aid grid stability c. Renewable, non-polluting d. Low operational cost e. No need to spend foreign exchange on fuel Disadvantages a. High capital cost b. Desilting is difficult due to various constraints
Keywords	quick ramp-up, ramp down-aid , grid stability, inject reactive power-aid, grid stability, renewable, non-polluting, low operational cost, no need to spend foreign exchange on fuel, high capital, various constraints,
O Code	05, 08, 09, 10

B Code	05, 11
Total New O Code	0
Total New B Code	1

Respondent 4 [c3q3r4]	Area development, increase in job prospects and employment for locals, economic growth, illumination and beautification of the project surrounding area. Hydro development is also a clean source of power and can also be used for flood control and irrigation purposes. Social conflicts and land acquisition disputes, rehabilitation issues are well known disadvantages of the hydro projects.
Keywords	development, job prospects, employment, economic, growth, illumination, beautification, clean, flood control, irrigation, social conflicts, land acquisition disputes, rehabilitation
O Code	01, 02, 03, 04, 05, 06
B Code	01, 02, 04, 11
Total New O Code	0
Total New B Code	1

Respondent 5 [c3q3r5]	Advantages: Socio-economic development with creation of jobs. Disadvantages: Blasting and submergence leading to displacement, loss of livelihood, home, land, community life. Inadequate compensation results in social conflicts, protests and litigation.
Keywords	socio-economic development, jobs, blasting, submergence, displacement, loss of

	livelihood, home, land, community life, inadequate compensation, social conflicts protests, litigation
O Code	01, 03
B Code	02, 04, 11, 13, 18
Total New O Code	0
Total New B Code	0

Que no. 4	What is your take on the Barriers and Opportunities associated with Hydropower Projects in Uttarakhand?
Respondent 1 [c3q4r1]	The antagonistic stand of the environmental lobby against hydropower is the the most significant barrier associated with its development in Uttarakhand. Following the 2013 disaster on August 13, 2013, the Supreme Court of India directed the government to set up a committee to review the role of existing and under construction hydropower projects in the disaster. The multi-disciplinary committee headed by Ravi Chopra set up by the Union Ministry of Environment and Forests (MoEF) took the view that the construction and operation of hydropower projects had increased the proportions of the disaster. In August 2016, the National Green Tribunal slapped an order on the company operating the 330 MW Srinagar Hydropower project to pay ₹9.26 crore compensation to the people who were affected due to the project. Subsequently, the Ravi Chopra committee recommendations saw some dilution leaving the issue to only 24 hydropower projects. These projects were asked to be scrapped by the report of Government of India’s Wildlife Institute of India that was published way before the June 2013 disaster. In spite of efforts being made for re-starting of the projects, contradictions between changing stands of the Judiciary, MoEF and MoWR have created a situation that these projects are still stalled. There is huge negative perception in the public about hydropower projects. Although there may be many other reasons for environmental degradation, air and

water pollutions, hydropower projects are opined to be the main reason behind these. Local residents often resisted and are suspicious about hydropower projects. Many a times works in the projects were suspended due to local and political issues, resulting in delay in construction or clearances. This has gained much ground post June 2013 floods mainly due to the stand taken by environmental lobby against hydropower projects.

Another major barrier associated with hydropower development in Uttarakhand is political instability and allegations of corruption. Although endowed with huge potential, historically a lack of political will and political instability has not been favourable for the development of the state’s true potential in this sector. The cumulative effect of all these political instability and allegations of corruption did not augur well for the hydropower sector.

Apart from the above major barriers, the other barriers of hydropower development like delay in government support, long forest and environmental clearance process including frequent changes in the norms, delay in private land acquisition, remote locations, high cost of roads and bridges due to the inaccessible mountainous terrain, geological surprises commonly faced in the Himalayan region are also associated with hydropower development in Uttarakhand.

Private sector participation has been declining and there are not many private players operating in the state and fewer still are forthcoming. In addition to aforesaid constraints, regulatory and socio-political issues, high cost of implementation, mandatory royalty energy, unfavourable market for hydropower as there is much focus on renewable energy like solar/wind/biomass etc, uncertainty in getting PPA at viable tariff, difficulty in achieving financial closure, R&R issues etc. have resulted in waning of interest of the private players.

Being a Himalayan state, Uttarakhand has an enormous potential for cheap hydropower capacity. Its rapid growth in the industry over the last 17 years since its formation in 2000 has delivered a large paying customer base to the state’s

	public discom. This golden combination of availability of supply and demand is its biggest opportunity. Uttarakhand is blessed with precipitation almost throughout the year. Geographically, the state lies within the domain of both the monsoon and western disturbances. The terrain is also ideal for hydropower development. As the prospect of solar and wind power is comparatively less due to its location and topography, there is an active thrust on renewable energy at a national and a global level. Not only that, the availability of abundant hydropower potential in Uttarakhand emerges as a big opportunity to tap. The identified potential of small hydropower projects in Uttarakhand is about 1500 MW, out of which about 170 MW has been developed. Although there are many challenges like remote location, vulnerability to natural calamities like flash floods, cloud bursts and landslides, lack of reliable transmission system, high specific cost, lower load factor SHPs are less vulnerable to the controversies associated with large HEPs. The controversies due to large hydropower projects are, that these projects physically transforms rivers, impact valuable ecosystems, involve relocation of population, impact the water quality and contribute to a decline in the fish population and other life-sustaining animals in the region. In the backdrop of growing resistance from the local people who gets displaced from inundated areas, focus is being put into the development of SHPs in some states. SHPs are considered environmentally not damaging, particularly when compared to large and medium hydro plants with storage reservoirs. As of now, SHP is exempted from the Environment Impact Assessment in India. In the backdrop of sluggish growth of large and medium hydropower projects in the state, focussing on the development of SHP may also be considered.
Keywords	environmental lobby, biggest barrier, construction and operation of hydropower projects had increased the proportions of the disaster, compensation, scrapped, re-starting, changing stands, judiciary, MoEF, MoWR, still stalled, negative perception, hydropower projects, environmental degradation, air pollutions, water pollutions, hydro projects, resisted, suspicious, local, political issues, in delay in

	construction, clearances, political instability, allegations of corruptions, lack of political will, political, support of the government, long forest, environmental clearances process, frequent changes in the norms, delay in private land acquisition, remote locations, high cost of roads and bridges, inaccessible mountainous terrain, geological surprises, private sector, participation has been declining, regulatory, socio-political issues, cost of implementation, mandatory royalty energy, unfavourable market for hydropower, solar, wind, biomass, viable tariff, difficulty, financial closure, R&R issues, waning of interest, cheap hydropower, rapid growth in industry, opportunity, precipitation, renewable energy nationally and globally, remote location, vulnerability of natural calamities, flash floods, cloud bursts, land slide, lack of reliable transmission system, high specific cost, lower load factor, relocation of populations, water quality, decline in the fish population, life sustaining animals, environment impact assessment, sluggish growth of large and medium hydropower projects in the state, focusing on development of SHP,
O Code	04, 05, 08
B Code	01, 02, 03, 04, 05, 06, 07, 09, 10, 11, 12, 14, 15, 16, 17, 18, 19, 31, 33
Total New O Code	3
Total New B Code	19

Respondent 2 [c3q4r2]	Land acquisition is becoming tougher due to change in government policies. Getting environmental clearances is also becoming very tough as there is a continuous change in government policies. There are instances that the government stopped the projects under construction which have incurred huge expenditure in construction after taking all clearances in the name of environmental issues.
Keywords	land acquisition is becoming tougher, change in government policies, environmental clearances is also become very tough, government stopped the projects under construction which have incurred huge expenditure,

O Code	Nil
B Code	01, 03, 06, 07, 14, 18
Total New O Code	0
Total New B Code	0

Respondent 3 [c3q4r3]	Barrier a. Know-how for social and environmental compliances needs to be readily available with entrepreneurs Opportunities b. Encourages entrepreneurship c. Can encourage Eco-tourism
Keywords	social and environmental compliances, entrepreneurs, encourages entrepreneurship, eco-tourism,
O Code	02, 04
B Code	06, 18, 28
Total New O Code	1
Total New B Code	1

Respondent 4 [c3q4r4]	Uttarakhand’s terrains pose more barriers than opportunities to the hydropower development. Reducing glaciers and river waters, old stressed infrastructure of roads and bridges, weather unpredictability and variations, geological limitations, grid reliability offer significant challenges in terms of seeking funding and investments. Due to severe cold and huge precipitation for more than six months in

	a year, the civil construction and curing works are very slow and difficult. The administration does not have much control on these conditions that hamper the hydropower development in the region. Opportunities for SHP projects are slightly better as compared to large hydropower projects.
Keywords	Uttarakhand, reducing glaciers and river water, stressed infrastructure, roads, bridges, weather unpredictability, geological limitation, grid reliability, funding, investments, severe cold, precipitation, civil construction, curing, difficult, Administration, hamper, Opportunities
O Code	Nil
B Code	05, 09, 10, 12, 14, 19, 31, 33, 37
Total New O Code	0
Total New B Code	1

Respondent 5 [c3q4r5]	Blasting and submergence leads to displacement resulting in loss of home, land, livelihood, water source and religious place. Poor support by local administration results in delay and inadequate compensation leading to social conflicts and protests.
Keywords	Blasting, submergence, displacement, loss of home, land, livelihood, water source, religious place, local administration, delay, inadequate compensation, social conflicts, protests
O Code	Nil
B Code	02, 04, 07, 11, 14, 18
Total New O Code	0
Total New B Code	0

Que no. 5	How do these barriers impact the viability of Hydropower Projects in Uttarakhand?
Respondent 1 [c3q5r1]	Following the state's creation, Uttarakhand inherited 3700 million units (MU) of hydropower capacity from Uttar Pradesh. Coupled with this inherited situation, in 2003 the Government of India passed a package of incentives for the industry to

	set up in Uttarakhand, and in the years following 2002 the state government actively encouraged the same. The result of this was that a large part of the industry moved to the state en masse. By 2014-2015 the industry made up 55.40 per cent of electricity sales. Benefiting from cheap hydropower and the arrival of industrial consumers, the aggregate technical and commercial (AT&C) losses declined from 54.56 per cent in 2001-2002 to 18.82 per cent in 2014-2015. As a result, the Uttarakhand Power Corporation Limited (UPCL) has not required annual government subsidies. Despite this desirable situation, the fact is that Uttarakhand currently buys short-term power from central exchanges during periods of seasonal deficit as there has been a failure to develop sufficient new hydro power capacity. This is the direct fallout of the barriers acting against hydropower development in the state. In recent years, agreements to buy gas and renewables have been made, which are more expensive sources of energy, and if rates for short-term power rise, this will eventually put pressure on the government's financial position. The general effect of the normal barriers of hydropower development such as delay in providing support by the government, delay in private land acquisition, high cost of roads and bridges due to the inaccessible mountainous terrain, geological surprises commonly faced in the Himalayan region all add to the high cost of generation due to time and cost over-runs.
Keywords	short-term power from central exchanges, seasonal deficit, failure to develop sufficient new hydro power capacity, barriers acting against hydropower development, gas and renewable, more expensive sources of energy, rate for short-term power rise, government's financial position, delay in private land acquisition, high cost of roads, bridges, mountainous terrain, geological surprises, high cost of generation, time, cost over-runs,
O Code	08, 09, 10
B Code	01, 02, 05, 07, 10, 12, 14, 27, 31, 33
Total New O Code	3
Total New B	10

Code	

Respondent 2 [c3q5r2]	Barriers will delay the project implementation due to which there will be huge cost escalation which will impact the viability of the project.
Keywords	delay the project implementation, huge cost escalation, viability of the project,
O Code	Nil
B Code	05, 12, 14
Total New O Code	0
Total New B Code	0

Respondent 3 [c3q5r3]	Delay in assessing and managing the social or environmental impact can hold up the project and cause cost and time overruns
Keywords	assessing and managing the social, environmental impact, project, cost and time overruns,
O Code	Nil
B Code	02, 04, 05, 11, 12, 14, 18, 22, 24, 27
Total New O Code	0
Total New B Code	5

Respondent 4 [c3q5r4]	Recently the natural disasters have become one of the major project barriers. The under-construction Singoli-Bhatwari project was severely affected by the June 2013 floods. Out-flanking of the river at the Singoli-Bhatwari barrage site by the high-velocity flowing waters, and complete filling of the then excavated power house pit by the river-borne sediments, were two important damaging consequences of the incident. The passage of flood was an one-off incident lasting

	for a couple of hours, but the morphological changes in the river course, particularly the aggradations of river bed due to the left-over sediments may take time to flow down, as it may take years for the river to attain the pre-flood regime conditions. This poses severe ramifications in the context of the project's economic life.
Keywords	natural disasters, under-construction, flood, out-flanking, barrage, high-velocity, filling, excavated, house pit, river-borne sediments, damaging consequences, morphological, river course, aggradations, river bed, serious, economic life
O Code	Nil
B Code	05, 09, 12, 14, 18
Total New O Code	0
Total New B Code	1

Respondent 5 [c3q5r5]	R&R issues including displacement and inadequate compensation lead to social conflicts, protests, work stoppage and litigation, leading to time delays and cost overruns and consequently making the hydropower projects in Uttarakhand unviable.
Keywords	R&R issues, inadequate, compensation, social conflicts, protests, work stoppage, litigation, time delays, cost overruns, hydropower, Uttarakhand, unviable,
O Code	Nil
B Code	02, 04, 05, 11, 12, 14
Total New O Code	0
Total New B Code	0

Que no. 6	Based on your experience, share the impact of Hydropower Projects on the following aspects of PAP: Land; Jobs and Livelihood; Home; Food security; Health; Common property; Community life; Women security; Education; Any other issue
Respondent 1	**Land**– The extent of land depends on the size of the reservoir created by a

[c3q6r1]	hydroelectric project and the topography of the land. In case of a storage type project, the land requirement would be more compared to run-of-the-river (ROTR) type. Hydroelectric plants in flat areas tend to require more land than those in hilly areas where deeper reservoirs can hold more volume of water in a smaller space. In case of the project being developed by L&T, which is ROTR type, land acquired is less than 39 ha for 99MW plant. Of this about 34 ha is forest land and remaining is private land. There is no R&R issues involved as there was no displacement. While 11 ha of this land is being used for muck dumping purposes that would be returned after restoration, the remaining forest land is used for project components and roads. Hence, there is a land-use change for balance land as the same is used for permanent project components like barrage, poundage area, powerhouse, head race tunnel, surge shaft and approach roads. **Jobs and Livelihood** – In the backdrop of migration of population from villages in Uttarakhand (more than 1000 villages officially or unofficially declared as "ghost village"), development of hydropower projects would offer the people jobs and livelihood to local population. In the project being developed by L&T, a significant number of the local population has been employed at various levels. Although, as inherent to hydropower projects, major engagement of workers is during the construction phase only and skill acquired would be an advantage in finding jobs in similar nature of work. As such the project has provided an opportunity in this regard. **Home** - Hydropower facilities can have large environmental impacts by changing the environment and affecting land use, homes, and natural habitats in the dam area. Most hydroelectric power plants have a dam and a reservoir. However, in the project being developed by L&T, there is no dam and the small storage is diurnal. The water is diverted for the generation of power at the barrage and released back into the river below the powerhouse. Mandated minimum release of water from the barrage would be maintained for sustaining life and habitat in the river stretch between the barrage and the powerhouse.

	As the project involves no resettlement of population, human habitat of the population have not been impacted. **Food security**– It may be appreciated that the trade-offs among hydropower production and food security is complex, and developing an integrated resource management plan is not an easy task. In case of the project being developed by L&T, prima facie, there has been no threat to food security of the region being adversely impacted that could be identified. The pondage area of the project is very small and not located in any agricultural land, other components being located in forest areas, the project being ROTR type and not impacting any irrigation scheme, the head works being a barrage where water is not stored for long duration, the project is not likely to impact food security in the area. **Health**– The World Health Organization (WHO) has reported that the reservoirs created behind dams are often breeding grounds for water-borne illnesses (such as schistosomiasis, malaria, and cholera) and other potentially toxic bacteria. Compulsory resettlement is also stressful because of the way in which people are uprooted from homes and occupation and brought to question their own values. In the project being developed by L&T, neither any large reservoir would be created nor does the project involve any resettlement. Hence, there are no instances of any increase in vector borne diseases due to project. The area where the project is located, no major health issues were observed. However, dispensaries established in the project to provide the health care services to the local population as well as construction workers and staff have been found to be beneficial to the local population. The area also comes under the Hindu pilgrimage hence medical facilities to the tourists coming from different parts of the country are also being provided from time to time. As on date, three free medical camps for pilgrims have been arranged and so far about 2600 devotees benefitted from the camp. Periodic medical and health awareness camps are being organized for the local people, including the workers and the staff. Presently, eight

	medical and health awareness camps has been organized and about 4200 people have benefitted from this facility. A safety officer has been appointed for effective implementation of occupational health and security measures. **Common property**– The project being developed by L&T is located in an area, where minimum infrastructures like roads, bridges, water supply, schools and markets are available. The area is located mostly along a National Highway and is en-route the Chardham Yatra path. With the project being implemented, some arterial roads in the area have been improved. After the devastating floods of 2013, the project got involved in restoration and rebuilding of various approach roads in and around the project area. **Community life -** With the implementation of various schemes under the CSR programme the standard of community life likely to improve. Some the significant CSR work carried out so far includes - water supply schemes in few villages, construction and repair of rooms, toilets in schools, construction of pathways, village roads, pedestrian bridges, cremation sheds, Gul (Irrigation Channel) coaching centres, computer centres, old age (men and women) and widow Pension etc. **Women security** – Although a lot of workers were engaged in the project, there has been no incident so far which may give rise to any concern about the security of women. **Education** – The area where the project is located has schools and colleges in the vicinity. L&T has been providing supports to various schools and colleges through its CSR programme.
Keywords	size of the reservoir, more volume of water in a smaller space, no R&R issues, permanent project components, ghost village, job, livelihood, employed, environmental impacts, land use, homes, natural habitats, reservoir, mandated minimum release of water, sustaining life, habitat, no resettlement, integrated resource management plan is not an easy task, no threat to food security, breeding

	grounds for water-borne illnesses, schistosomiasis, malaria, cholera, increase in vector borne diseases, no major health issues, health care services, Hindu pilgrimage, free medical camps, health awareness camps, safety officer, occupational health & safety, minimum infrastructures, already available, en-route the Chardham Yatra, arterial roads, restoration and rebuilding of various approach roads, CSR programme the standard of community life likely to improve, supply schemes, construction, repair of rooms, toilets in schools, construction of pathways, village roads, pedestrian bridges, cremation sheds, irrigation channel, coaching centers, computer center, old age, widow pension, no incident, schools, colleges in the vicinity, supports to various schools and colleges, CSR programme,
O Code	01, 02, 03, 05, 06, 13, 14
B Code	04, 11, 13, 18, 27
Total New O Code	7
Total New B Code	5

Respondent 2 [c3q6r2]	a) Land = Getting land acquisition is highly impacted due to change in. government policies b) Jobs and livelihood = will improve in remote areas c) Home = not impacted d) Food security = not impacted e) Health = Health care facilities will improve with the big projects implementation. f) Common property = infra structure will improve and property values may go up g) Community life = will improve h) Women security = will improve i) Education = Educational facilities will improve in the remote areas as well j) Any other issue = Roads and communication facilities will improve in the

	project areas
Keywords	land acquisition, change in Govt. Policies, improve, remote areas, not impacted, health care facilities, will improve, property values,
O Code	01, 02, 03, 04, 14
B Code	01, 03
Total New O Code	1
Total New B Code	2

Respondent 3 [c3q6r3]	a) Land = depends on impact management b) Jobs and livelihood = depends on impact management c) Home = depends on impact management d) Food security = very positive e) Health = positive f) Common property = depends on impact management g) Community life = depends on impact management h) Women security = positive i) Education = positive j) Any other issue
Keywords	impact management, very positive, will improve,
O Code	01, 02, 03, 14
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c3q6r4]	a) Land – Better irrigation system leads barren lands towards farms. b) Job/ Livelihood – Positive impact. c) Home - Conditions improve and home are now converted to home stays. d) Food security – Positive impact and increased house hold farming. e) Health – Better health services due to project health centres. f) Common property - depends on impact management. g) Community life - Improves significantly. h) Women security – Project law and order concerns improves women safety. i) Education – Improves since it is a common issue for the families of employees at the project. j) Any other issue – No.
Keywords	irrigation, barren lands, farms, positive impact, improve, home, home stays, impact, health services, health centres, significantly, law and order, women safety, common issue, employee, family
O Code	01, 02, 04, 06, 14
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 5 [c3q6r5]	Hydropower projects make the displaced PAP feel uprooted as they experience loss of land, home, livelihood, food security, health, common property (grazing ground and fodder, water source, religious places, playground, van panchayat land, cremation ground), community life, culture, etc. Often, PAP complains about inadequate compensation and lack of facilities at resettlement locations. Frequent changes in policy coupled with bureaucratic and administrative mismanagement aggravate the loss to PAP as they are made to run from one office to another to claim the compensation that are often found to be inadequate in comparison with the loss to the PAP.

Keywords	PAP feel, land, home, livelihood, food security, health, common property, grazing ground, fodder, water source, religious places, playground, van panchayat, cremation ground, community life, culture, inadequate, compensation, lack of facilities, resettlement, frequent changes, policy, bureaucratic, administrative, mismanagement
O Code	Nil
B Code	02, 03, 04, 11, 27
Total New O Code	0
Total New B Code	1

Que no. 7	Are the current policies effective enough to address the Barriers and Risks of Hydropower projects in Uttarakhand? If no, comment on the lacunas of the policy.
Respondent 1 [c3q7r1]	The following may be listed as major barriers for development of hydropower: 1. Commercial non-viability 2. Long gestation period 3. Geological risks 4. Capital requirements 5. Environmental and forest issues 6. Land acquisition and rehabilitation 7. Infrastructure limitations, lack of transport infrastructure 8. Local policy issues 9. Lack of public awareness The hydro policy [POLICY ON HYDROPOWER DEVELOPMENT BY THE PRIVATE SECTOR IN UTTARAKHAND (25 MW & ABOVE)] has not addressed the above issues adequately. Although some clauses (clause 4.8.2, 4.8.3, 4.11.1, 4.11.2) addressing commercial

	viability are incorporated in the policy, but in the present circumstances, these clauses call for a review. Clauses related to deferment of free power for some time, sharing of evacuation and cost of infrastructure development need to be reviewed as clarity on eligibility is not adequate. In the post GST regime, the clause exempting Entry Tax needs to be reviewed. Although open access and sale of power to any consumers (inter-state) are allowed, adequate evacuation systems with viable transmission charges remains an issue. Downstream release from the headworks has been creating issues concerning aquatic life. Suitable clauses need to be incorporated in the policy on maintaining downstream flow in the diversion reach. The project being developed by L&T faced a major setback, along with some other projects, in the June 2013 floods. The project was at an advanced stage of construction and suffered a major loss. Although as per the policy, in case of force majeure conditions such as floods, the developer may surrender the allotment to the Government of Uttarakhand subject to the acceptance by the Nodal Agency; but at a stage when substantial investments have been made, surrendering the project was not a favourable option. A need was also felt to contribute to the re-development of the region. Extension of time for COD was allowed to L&T, however, for mitigating the time and cost overrun impact, provisions including the deferment or waiver of royalty energy, procurement of energy at CERC tariff. may also be considered to be included in the policy in cases of such extra ordinary situations.
Keywords	commercial non-viability, long gestation, geological risks, capital requirement, environmental and forest issues, land acquisition and rehabilitation, infrastructure limitations, lack of transport infrastructure, local policy issues, lack of public awareness, deferment of free power, sharing of evacuation and cost of

	infrastructure development, post GST regime, Entry Tax needed to be reviewed, open access, sale of power, inter-state are allowed, adequate evacuation systems, viable transmission charges, aquatic life downstream, force majeure conditions, substantial investments, surrendering the project was not a favourable option, mitigating the time and cost overrun, deferment or waiver of royalty energy, procurement of energy at CERC tariff etc.
O Code	Nil
B Code	01, 02, 03, 04, 05, 06, 07, 09, 10, 12, 14, 15, 16, 18, 19, 31, 33, 39
Total New O Code	0
Total New B Code	18

Respondent 2 [c3q7r2]	The present policies are not effective. Government has to give priority to the hydro sector as it is a renewable energy. Frequent changes in government policies are creating more barriers than easing the situation. The government should allot the project to developers along with land sanctioned and all other clearances. Local people and their issues are becoming risky for the projects. As the projects are located in remote areas, locals are resorting to extortion and local government administration is not concerned in resolving the issues due to political reasons. Government intervention is very important in solving extortion by locals.
Keywords	policies are not effective, priority to the hydro sector, change in Government policies, clearances, local people, becoming more risky for the projects, locals are resorting to extortion, extortion by locals,
O Code	05
B Code	02, 03, 04, 06, 07, 11, 15, 16
Total New O Code	1
Total New B Code	1

Respondent 3 [c3q7r3]	More awareness and Skills are required
Keywords	awareness, skills,
O Code	Nil
B Code	08, 15, 16, 29
Total New O Code	0
Total New B Code	2

Respondent 4 [c3q7r4]	Kedarnath Valley in the Rudraprayag District, was hit by flash floods triggered by very heavy rainfall and cloudburst on 16th and 17th June 2013. A confluence of very heavy rainfall, cloudbursts, floods and landslips devastated the roads, bridges and other infrastructure in the way. The flash flood caused heavy damages in the Kaliganga-I SHP and Kaliganga-II SHP Project. The SHP in other areas have been similarly washed away or damaged. However, it was told by a prominent scientific officer that "Blaming hydropower projects for the recent floods in Uttarakhand is a misconception and is a result of inadequate awareness and understanding of natural and man-made phenomena; some are based on belief and not on scientific reasoning". He further added, "It appears that the floods were primarily a result of cloud burst and landslides in the glacial area above Kedarnath which, besides carrying a lot of water and sediment, also caused a breach in the Gandhi Sarovar (Chorabari Tal) at an elevation of 3500 metre. The nearest hydropower project is at an elevation of 1610 metre and thereafter at an elevation of 540 metre. The small hydropower is run-of-the-river schemes with small catchments and have nothing to do with the glacial, atmospheric and landslide activities". Policies have since then given over emphasis to environmental conservation, and have been influenced by the general public sentiments and opinions. Sure environmental protection is the basis of human survival, but policies have to be more rational and scientific in its approach in order for it to be more effective.

Keywords	Floods, heavy rainfall, cloudburst, confluence, landslips, roads, bridges, scientific officer, glacial area, catchment, run-of-the-river, glacial, atmospheric, landslide, environmental, public sentiments, opinions, human survival, policies, rational, scientific, effective
O Code	Nil
B Code	03, 09, 15, 16, 17, 18, 26
Total New O Code	0
Total New B Code	2

Respondent 5 [c3q7r5]	No. The government should take care of the existing projects while allotting new ones. The example of Debal SHP (5MW) on Kaliganga River (a tributary of Pinder River) in Chamoli District of Uttarakhand reflects the effectiveness of the current policies. The power house of Debal SHP is located on the right bank of Kaliganga river near the confluence with Pinder river. Without any planning and thought the Government allotted Devasari HEP (252MW) on the downstream of the Pinder river. The DAM is proposed to be constructed at about 1.75km downstream of the Debal SHP with a proposed DAM height of 35meters. If completed, this will completely submerge the Debal SHP powerhouse on the upstream of the much bigger Devsari HEP. The very existence of Debal has been left in complete jeopardy. If again the Devasari HEP dam height is readjusted for Debal SHP, the Devasari HEP may not remain feasible at all. Similar case happened with two big projects the THDC and Maneri Bhali –II project of the central and state generators respectively. The impact of big projects on other projects and on SHPs has to be properly accessed before project allotment.
Keywords	Government, planning, existence, jeopardy, readjusted, feasible, big projects, accessed, allotment
O Code	Nil
B Code	03, 05, 06, 27

Total New O Code	0
Total New B Code	1

Que no. 8	Share your experiences regarding the implementation of several policies and initiatives for development of Hydropower Projects in Uttarakhand.
Respondent 1 [c3q8r1]	Uttarakhand aspires to be a leading hydropower generator in the country. This necessarily requires active private sector participation; which clearly implies that the "Ease of doing Business" in the hydropower sector needs to be of a very high order in the state. Regrettably, the sector is saddled with issues ranging from inadequate policy, an underdeveloped road and bridge infrastructure, lack of viable PPAs and consequently low to very low rate of returns for a private investor. Other factors include - financing issues with leading banks and financial institutions reluctant to lend to hydropower projects, lack of power evacuation, a hostile local community, legal interventions, and a system generally geared to maintain status quo rather. As a result, instead of pushing the envelope, investors choose to look for other avenues in which to deploy the capital.
Keywords	active private sector participation, ease of doing business, inadequate policy, under-developed road, bridge infrastructure, lack of viable PPAs, very low rate of returns for a private investor, financing issues with leading banks, financial institutions reluctant to lend, lack of power evacuation, hostile local community, legal interventions, other avenues,
O Code	Nil
B Code	02, 03, 05, 07, 19, 31, 33
Total New O Code	0
Total New B Code	7

Respondent 2 [c3q8r2]	Land acquisition policies should be made easier. Any subsidy should be made available upfront which is very useful for implementation of the projects. Subsidy eligibility conditions should be made easier so that all implemented projects will get subsidy without fail.
Keywords	land acquisition policies, subsidy should be made available upfront, subsidy eligibility conditions should be made easier,
O Code	Nil
B Code	01, 03, 05
Total New O Code	0
Total New B Code	1

Respondent 3 [c3q8r3]	Policies have evolved and improved with time
Keywords	polices, improved with time,
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c3q8r4]	The government has taken several steps to develop the hydropower sector in Uttarakhand. However, it is also true that several big hydropower projects have been closed or abandoned and could never see the light of the day. Social and environmental issues, I believe are not as big of an issue as it had been made to be in the public. The projects which have been initiated should be continued and should not be stopped at all. We should look at finding a solution to the project

	problem and not eliminating the project itself. Closure of the projects at various stages, due to several reasons, indicates either improper planning or inadequate political and government support.
Keywords	Government, abandoned, social, environmental, stopped, solution, eliminating, closure, improper planning, inadequate political, government support
O Code	01, 05
B Code	02, 03, 07, 13, 18, 27
Total New O Code	2
Total New B Code	3

Respondent 5 [c3q8r5]	My experiences on poor policy implementation have been shared in previous questions.
Keywords	Poor, policy, implementation, shared
O Code	Nil
B Code	02, 03, 07
Total New O Code	0
Total New B Code	0

Que no. 9	Which agencies are involved in the implementation of initiatives and policies for development of Hydropower Projects in Uttarakhand and what are your experiences with them?
Respondent 1 [c3q9r1]	Uttarakhand Jal Vidyut Nigam Limited (UJVNL), has been designated as the nodal agency for hydropower development involving Independent Power Producers (IPPs). It is responsible for the implementation of policies and directions given by the government from time to time.

	Uttarakhand Environment Protection and Pollution Control Board (UEPPCB), constituted in 2002, have been entrusted with the responsibility of enforcing various Environmental Acts and Rules including the use of water resources for hydropower generation. Further, PTCUL is the agencies for implementation of transmission of power related issues. Various other agencies like Forest, Mining, PCB and District Administration are involved in regulatory roles related to implementation of the project. UPCL is the state's discom and the Urja Cell is the state's nodal monitoring agency. Our experiences have been mixed over the past decade of our association with the state, however we do see a definite trend of increasing sensitivity towards the sector on part of the above agencies and the state government, especially in recent times. However, frequent transfer of senior personnel at the government departments and agencies has probably resulted in a situation where key decisions requiring approvals are stalled for an extended period of time.
Keywords	UJVNL, UEPPCB, water resources, PTCUL, transmission of power related issues, forest, mining, PCB, district administration, UPCL, urja cell, definite trend of increasing sensitivity towards the sector, frequent transfer, extended period of time,
O Code	Nil
B Code	06
Total New O Code	0
Total New B Code	1

Respondent 2 [c3q9r2]	Main agencies involved are GoUK, Urja Cell, UJVNL, as a Nodal agency, UPCL, UERC
Keywords	GoUK, Urja Cell, UJVNL, UPCL, UERC

O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 3 [c3q9r3]	Various PSUs and entrepreneurs, Mostly positive
Keywords	PSUs, entrepreneurs, Mostly positive,
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 4 [c3q9r4]	The central and state government and its ancillary departments. State regulators, Ministry of Environment, Forest and Climate Change, Ministry of Water Resources, River Development and Ganga Rejuvenation, UPCL, UJVNL, UREDA and other supporting state departments.
Keywords	Government, ancillary, departments, regulators, Ministry of Environment, forest, Ministry of Water Resources, River Development, Ganga Rejuvenation, UPCL, UJVNL, UREDA
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Respondent 5 [c3q9r5]	UERC, CERC, Jal Vidhut, Hydel, Police & District Administration, Forest, PWD, Irrigation etc.
Keywords	UERC, CERC, Jal Vidhut, Hydel, Police, District Administration, Forest, PWD, Irrigation
O Code	Nil
B Code	Nil
Total New O Code	0
Total New B Code	0

Que no. 10	Is there any gap between current policies and its implementation for Hydropower Projects in Uttarakhand? If yes, share your experiences.
Respondent 1 [c3q10r1]	Perhaps the biggest gap is the lack of awareness. This can be a vital area for the state's own development and consequently needs to be studied in depth from the perspective of an investor on the ease of doing business. The issues faced by the private sector generators range from financial, commercial and regulatory parameters, to lack of an assurance on part of the government and regulatory bodies in securing a viable tariff. Any sector that aspires to be in the ease of doing business rankings also needs to be easy to enter and exit for an investor.
Keywords	lack of awareness, vital area, investor, on ease of doing business, financial, commercial, regulatory parameters, lack of an assurance, viable tariff, easy to enter and exit, investor
O Code	Nil
B Code	03, 05, 06, 07, 15
Total New O Code	0
Total New B Code	5

Respondent 2 [c3q10r2]	The government should make their policies very clear. For example, there is lot of uncertainty whether the projects are required in Alaknanda, Bhagirathi and Ganga Basins. If the government wants to maintain these basins as pristine, they should make it clear and should not allot any projects. Once having given permissions, the government should see that they are implemented even if there is any policy change.
Keywords	Government, policies, clear, uncertainty, allot, permissions, implemented, policy
O Code	Nil
B Code	03, 27
Total New O Code	0
Total New B Code	1

Respondent 3 [c3q10r3]	The current policy claims to be environmentally balanced, however I have experienced that the during hydropower implementation, the environmental norms are flouted with impunity. With no control, transparency and supervision mechanism being practised, the developers find easy ways to escape the environmental norms. We need to understand that being developed is essential but protecting the environment and co-existing with it is a question of survival.
Keywords	Policy, environmentally balanced, implementation, flouted, no control, transparency, supervision, mechanism, practiced, protecting, co-existing, survival
O Code	Nil
B Code	02, 03, 18, 28
Total New O Code	0
Total New B Code	3

Respondent 4 [c3q10r4]	No policy can provide impetus to the hydropower sector unless the project itself makes considerable business sense. Preferential tariffs, differential cost protection, fixed purchase commitments and other mechanism require to be incorporated in the hydro power policies.
Keywords	Policy, impetus, business, preferential tariffs, cost protection, purchase commitments, mechanism, incorporated, policies
O Code	Nil
B Code	03, 05
Total New O Code	0
Total New B Code	0

Respondent 5 [c3q10r5]	Financial and environmental aspects of hydro power development, though opposing are also key drivers of the projects. The policy tries to balance one aspect at the cost of the other. Making and implementing such policies is not only tough but also requires a continuous effort towards improvement.
Keywords	Financial, environmental key drivers, policies
O Code	Nil
B Code	05, 18
Total New O Code	0
Total New B Code	0

Que no. 11	Based on your experiences, suggest improvements (if any) in policy associated with Hydropower Projects in Uttarakhand to make it more effective.

Respondent 1 [c3q11r1]	Hydropower development, in general, is very sluggish across the country and Uttarakhand is no exception. Thus any modification or inclusion in the National Hydro Policy should also be applicable broadly to Uttarakhand as well. Commercial viability, an unhindered and assured revenue stream, a reasonable IRR and ROE and a healthy cash flow, are the prime factors in going ahead with any business. Regrettably, the hydropower sector needs a great deal of catching up to do on these aspects. Pumped storage projects are now being looked at in various parts of the world, and by a few States in India. This could be one area for the state to consider. PPP models have generally met with mixed success. BOOT projects (a form of PPP) have also failed to elicit investor interest given the long gestation periods and high risks associated with HEPs. One area that could be explored is a Hybrid Annuity Model as was implemented to revive the roads sector at the centre.
Keywords	very sluggish, national hydro policy, commercial viability, unhindered, assured revenue steam, IRR, ROE, healthy cash flow, pumped storage projects, PPP models, mixed success, BOOT projects, investor interest, long gestation periods, high risks associated, explored, hybrid annuity model.
O Code	04
B Code	03, 05, 07, 09, 39
Total New O Code	1
Total New B Code	5

Respondent 2 [c3q11r2]	The government should appoint a Shadow Officer for every project to get the problem solved and to implement the project smoothly.
Keywords	Appoint, shadow officer, implement
O Code	Nil

B Code	07, 15, 16
Total New O Code	0
Total New B Code	2

Respondent 3 [c3q11r3]	The policy cannot be forward looking with ageing infrastructure, adverse environmental impact and reducing river discharge. These aspects have not been properly taken care of in the policy. The policy decisions on any of these aspects are contained only in the papers and not in reality. Policies are to be practiced, applied and prosecuted.
Keywords	Policy, forward looking, ageing infrastructure, environmental, reducing river discharge, reality, practiced, applied, prosecuted
O Code	Nil
B Code	18, 19, 24, 27, 31, 33, 37
Total New O Code	0
Total New B Code	7

Respondent 4 [c3q11r4]	The state government and administration which is involved in the policy making are at times limited in their knowledge. The opinion of suitable industry experts and consultants shall assist the government in decision making.
Keywords	Government, administration, policy, limited, knowledge, opinion, industry experts, consultants, decision making
O Code	Nil
B Code	27, 29
Total New O Code	0
Total New B Code	1

Respondent 5 [c3q11r5]	The solar generation policies have received much attention in the state, the hydropower policies are still lacking and need to be modelled in a similar way. Small hydro projects for the development by IPP with lesser capital and preferential cost recover mechanism need to be incorporated in the policy.
Keywords	Solar generation, lacking, modelled, IPP, lesser capital, preferential, cost recover mechanism
O Code	Nil
B Code	03, 05
Total New O Code	0
Total New B Code	0

Que no. 12	Suggest measures to address implementation issues and minimize gaps between policies and implementation
Respondent 1 [c3q12r1]	During construction, hydropower projects have to encounter various conditions which could not be reasonably foreseen during the planning and DPR stages. Unprecedented floods, earthquake, major landslide, adverse geological conditions necessitate implementing remedial measures, which sometime call for additional regulatory clearances; such situations are very common to HEPs. On the other hand, the aggressive development of any sector is usually best done in a top down manner with a careful selection of partners, marketing the sector aggressively to attract investment, rigorous monitoring of investments with timely decision making.
Keywords	reasonably foreseen, planning, DPR stage, unprecedented floods, earthquake, major landslide, adverse geological, remedial measures, regulatory clearances, aggressive development, careful selection, marketing, aggressively, attract investment, rigorous monitoring, investments, timely decision making,
O Code	Nil

B Code	05, 06, 09, 10, 12, 14, 27
Total New O Code	0
Total New B Code	7

Respondent 2 [c3q12r2]	For implementing the projects, the government should allot the projects along with the required forest and private land and all other clearances.
Keywords	implementing, government, allot, forest, private land, clearances
O Code	Nil
B Code	01, 06
Total New O Code	0
Total New B Code	1

Respondent 3 [c3q12r3]	Better training would enable faster development
Keywords	training, faster development,
O Code	Nil
B Code	29
Total New O Code	0
Total New B Code	1

Respondent 4 [c3q12r4]	Policies have to periodically realign to adjust and accommodate the changes that are happening across the country and the globe. To minimize the policy and its implementation gaps, the policies amendments must be thoughtful of the

	implementation issues that would surface due to its realignment and must address them suitably.
Keywords	Policies, periodically, realign, adjust, accommodate, amendments, implementation issues, realignment
O Code	Nil
B Code	27
Total New O Code	0
Total New B Code	0

Respondent 5 [c3q12r5]	The enforcement wing for policy implementation is missing. Only the project developers are expected to self enforce and abide by the policy guidelines. Guidance, support and implementation assistance need to be provided by the government to the project developers once the projects are sanctioned, especially to the independent power producers.
Keywords	enforcement, policy, implementation, self enforce, abide, guidelines, guidance, support, government, project developers, sanctioned
O Code	Nil
B Code	02, 07, 27, 28
Total New O Code	0
Total New B Code	3

Case 3: **Summary - Singoli Bhatwari Hydro Power Project**

The Singoli Bhatwari hydropower project is a 99MW, run of the river project located on the River Mandakini, in Rudraprayag District. The project involves design and construction of a 22 meter high and 80 meter long barrage, a 11.26 KM long headrace tunnel of 4.9 meter diameter , an orifice type surge tank, surface powerhouse, substation and a 12 Km long 132 KV transmission line. Three Francis turbines of 33 MW each were used to generate 472.18 MU of energy.

The case study of the project was conducted through a questionnaire and interview of the stakeholders. The respondents of the questionnaire are as follows:-

Respondent 1 – He is heading the project management division of L&T in Uttarakhand. He has been closely associated with the Singoli Bhatwari hydropower project for more than five years. He has vast project management experience in handling hydropower projects.

Respondent 2 – He is an experienced civil work contractor involved in the construction of various projects in Chamoli District. He has also been a consultant for the Singoli Bhatwari hydropower project. He is inspecting and supervising the quality of the project works related to civil and mechanical erection. He has more than 21 years of experience in the construction and development of various hydropower projects in Uttarakhand.

Respondent 3 – He is a respected environmentalist and a social activist. He has worked in various areas for more than 25 years, before turning into an environmentalist. He holds an electrical engineering degree and has travelled far and wide in the hills of Uttarakhand. He has garnered a lot of support from the local people. He has been active in apprising the government about any norm violations being done by the hydropower developers during the construction of the project.

Respondent 4 – He is a member of the state administration. He is also amongst the people directly affected by the Singoli Bhatwari hydropower project. He is a native of the state and is thus well aware of the remote terrain, difficult geology, local and the administrative issues involved in the development of hydropower projects. During his tenure, he has been directly involved in resolving R&R issues related due to implementation of the Singoli Bhatwari hydropower as a part of the local administration team.

Respondent 5 – This respondent is a hydropower specialist engaged as a project consultant for the Singoli Bhatwari hydropower project by L&T. He directly monitors and reports the progress to the top most authority of the L&T management.

Case Discussion

Some interesting points emerged during this case study. Surprisingly, respondent number 1 in his response to question number 6 of the questionnaire mentioned that no significant R&R issues were involved in this project. He responded, "*In case of the project being developed by L&T, which is ROTR type, land acquired is less than 39 ha for 99MW plant. Out of this, about 34 ha is forest land and remaining is private land. There is no R&R issues involved as there was no displacement. Almost 11 ha of this land is being used for muck dumping purpose and would be returned after restoration.*" Most of the land was uninhibited and hence did not experience any major rehabilitation issues. This specific case demonstrates that R&R may not be a significant issue for the ROTR type project since they are confined to only a limited area which is mostly remote and uninhibited. There has been a lot of hype and the ROTR based hydroprojects have also been projected as causing lot of R&R issues. This general perception may not actually be true.

Respondent number 4 of question 4 has also discussed on the effect of cold weather on the delay in civil construction. He was a part of local administration and has highlighted, "*Due to severe cold and huge precipitation for more than six months in a year, the civil* *construction and curing works are very slow and difficult*". This also increases the gestation period for the project completion and exposes the project to other indirect risks.

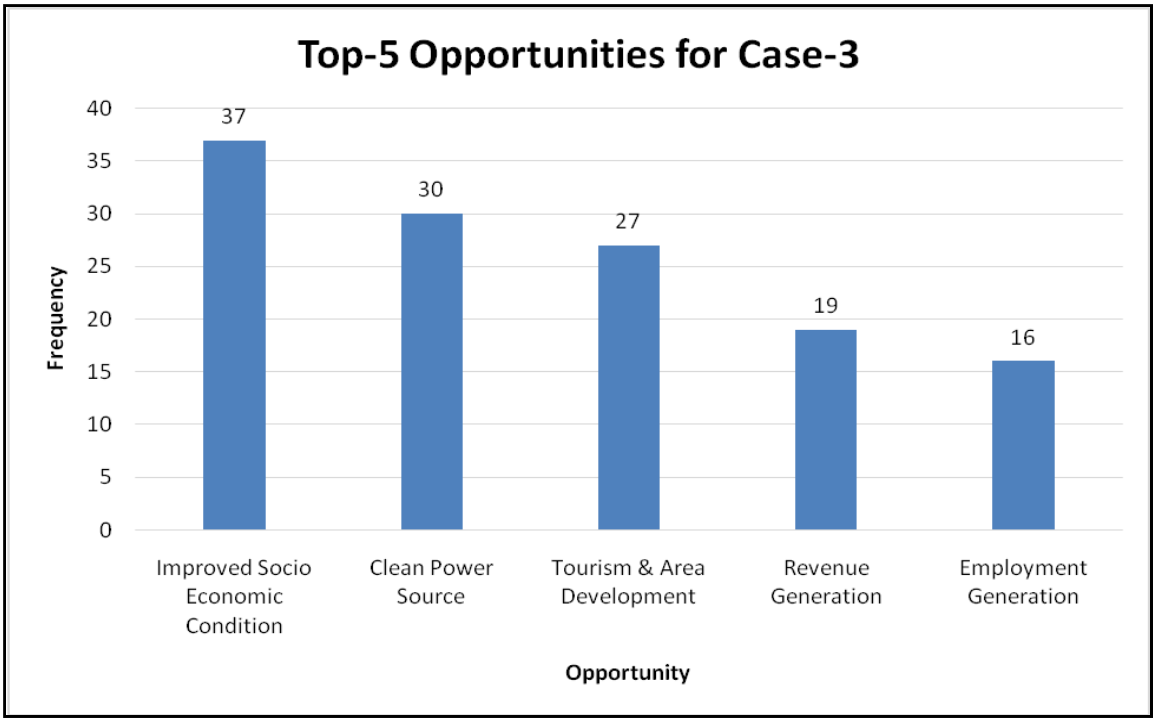
Respondent number 4 of question 7 mentions how flash floods and frequent natural disasters have established a general perception non-scientific basis the adverse impact of HEPs on the environment. He mentioned that "*Policies have since then given over emphasis to environmental conservation, and have been influenced by the general public sentiments and opinions. Sure environmental protection is the basis of human survival, but policies have to be more rational and scientific in its approach in order for it to be more effective*"

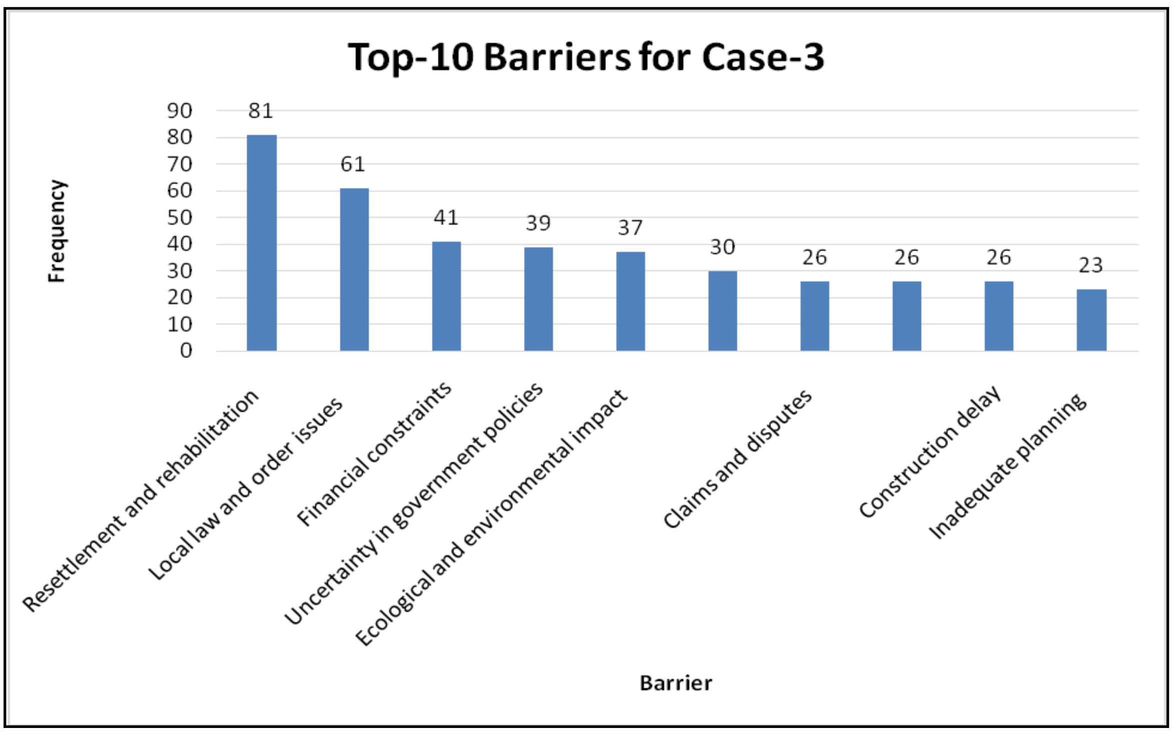
In a response to the same question number 7, Respondent number 5 by way of few appropriate examples exposes the poor project allotment mechanism, incomplete planning and ineffectiveness of the policy implementation. He comments that "*The government should take care of existing projects while allotting new projects. The example of Debal SHP (5MW) on Kaliganga River (a tributary of Pinder River) in Chamoli District of Uttarakhand reflects the effectiveness of the current policies. The powerhouse of Debal SHP is located on the right bank of the River Kaliganga near the confluence with Pinder River. Without any planning and thought, the government allotted Devasari HEP (252MW) on the downstream of the Pinder river. The DAM is proposed to be constructed at about 1.75km downstream of the Debal SHP with a proposed DAM height of 35meters. If completed, this will completely submerge the Debal SHP power house on the upstream of the much bigger Devsari HEP. The very existence of the existing Debal has been left in complete jeopardy. If again the Devasari HEP dam height is readjusted for Debal SHP, the Devasari HEP may not remain feasible at all. Similar case happened with two big projects the THDC and Maneri Bhali –II project of the central and state generators respectively. The impact of big projects on other projects and on SHPs has to be accessed properly before project allotment.*"

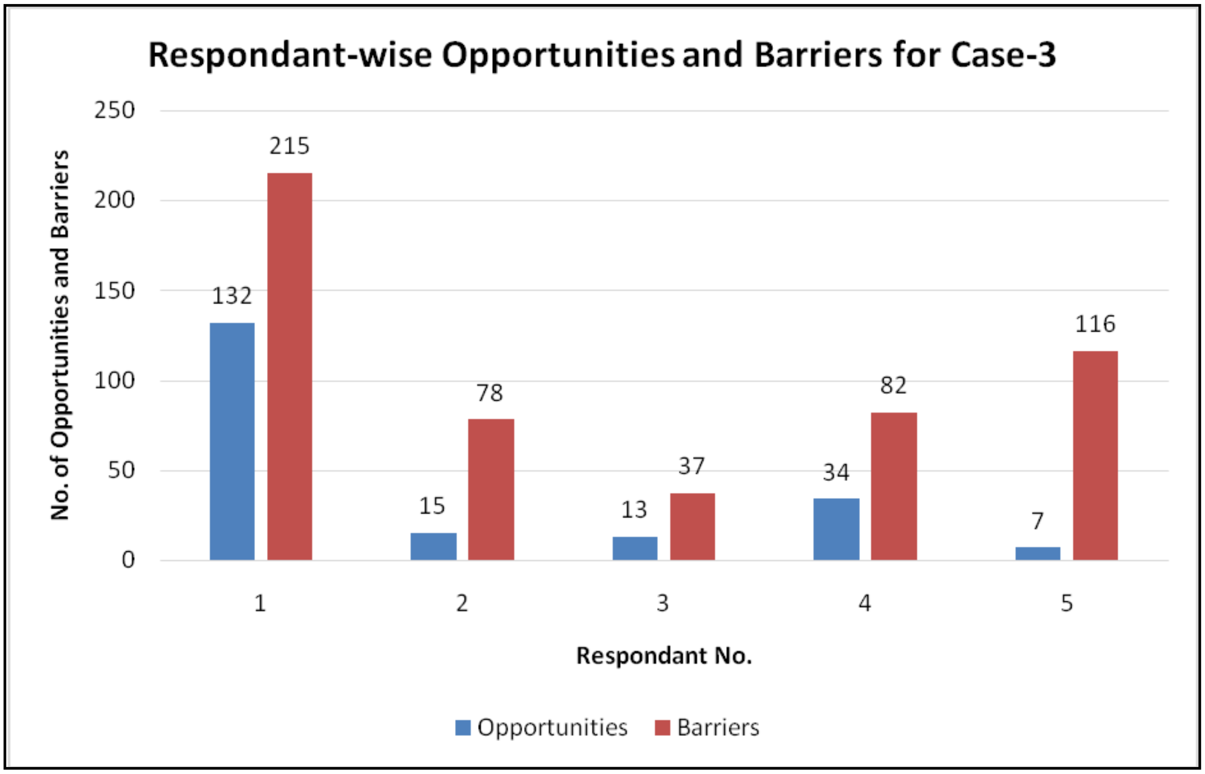
In the literature reviewed the progress of the project was reported as delayed due to delay in signing of the implementation agreement by the state government and prolonged agitation by the local people. However, contrary to this general perception, it is interesting to find that during the interview responses of the stakeholders, the project had experienced few R&R issue. However prolonged agitation by the local people, due to construction of underground tunnels, had delayed the project by about 75 months.

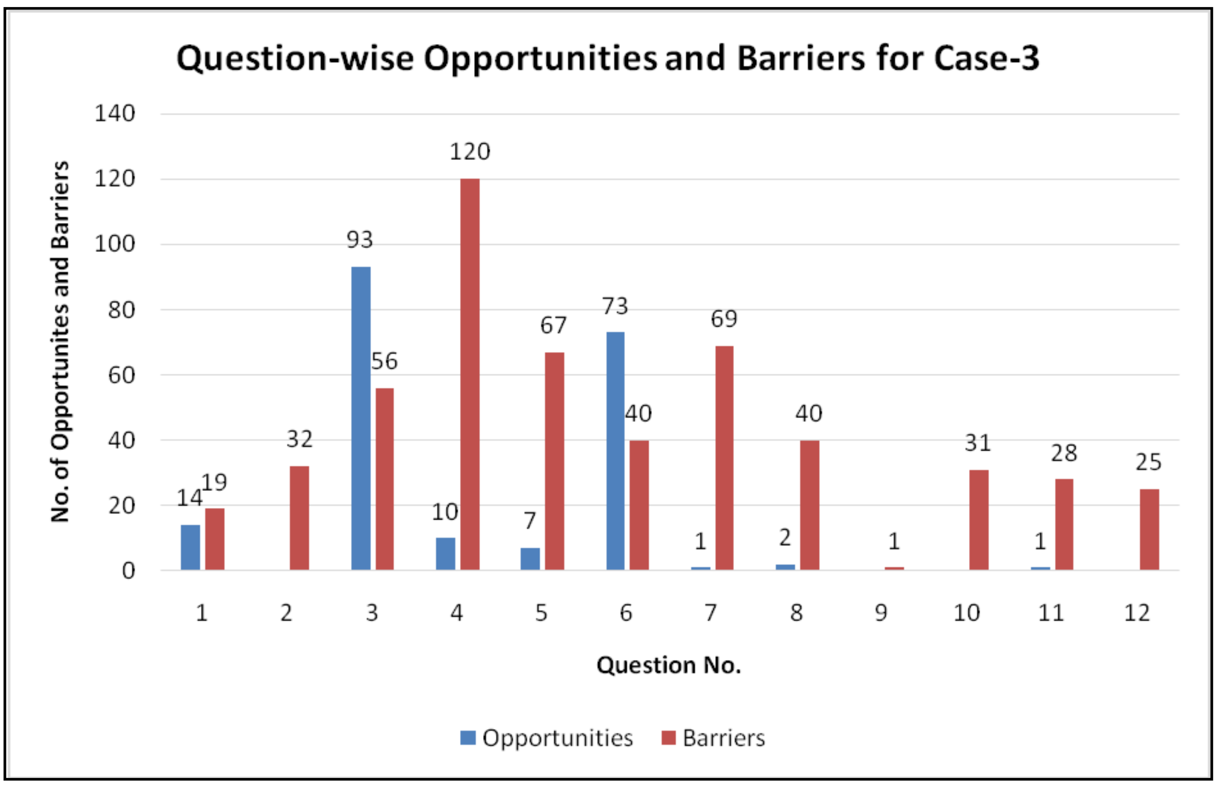
The case also draws attention towards another peculiar aspect of the reverse migration trend in the surrounding villages of the project. In Uttarakhand plenty of “Ghost Villages” exist where people and families have moved out of their native places in search of better options of employment, education, livelihood and medical care. This run of the river type (ROTR) hydropower project is a case that has been instrumental in quantizing the impact of reverse migration trend.

Case -3 Analysis






Respondant-wise Opportunities and Barriers for Case-3
250
200
150
100
50
0
No. of Opportunities and Barriers
132
215
15
78
13
37
34
82
7
116
1
2
3
4
5
Respondant No.
Opportunities
Barriers


Question-wise Opportunities and Barriers for Case-3
140
120
100
80
60
40
20
0
No. of Opportunites and Barriers
14
19
32
93
56
10
120
7
67
73
40
1
69
2
40
1
31
1
28
25
1
2
3
4
5
6
7
8
9
10
11
12
Question No.
Opportunities
Barriers

Suggestive notes on the Case Study

It is understandable that in the research work, during interviews and responses to the questionnaires, the respondents use varied style and choice of words in their responses to describe a certain scenario in their own unique manner. These sentences, keywords may be unique but in several cases indicate to a similar conclusion or inference. In the case study, such codes have been extracted from the responses of the participants. Due to different response style of the respondents, these codes in their responses are segregated into the possible code groups which have been separately identified during this study.

In order to keep the study focused to the topic "Opportunities and barriers in hydropower development in Uttarakhand", such keywords and sentences were selected and clubbed together into a similar group of broad codes to which they should belong.

For example respondent number 1 in reply to question number 9 comments, "***It will be worth mentioning that even after 12 years of deposition of an advance amount for the Construction Power Lines, it could not be completed, which has resulted building up huge claims by working agencies towards non-availability of Construction Power in case of Tapovan Vishnugad and earlier at Loharinag-Pala***". Likewise to question number 10, Respondent number 1 responds, "***Lack of will by the state government even knowing very well that delay of projects will hugely impact state revenue. Andhra Pradesh and Himachal Pradesh could do, why not Uttarakhand. Political will is needed. PTCUL is constructing Power Evacuation System for TVHPP. Most of the issues are within the control of the state government., in spite of that the Power Evacuation System progress is extremely poor, even forest land transfer proposal could not be submitted. TVHPP project will be commissioned but lines availability is doubtful***". Similarly, in response to question number 6, Respondent number 2 comments, "***In particularly TVHPP, transmission line has become critical due to no work started by PTCUL in this particular front***". Thus all the respondents are trying to describe the problems that arise due to the failure of PTCUL to timely construct the power evacuation lines. Though the responses of the respondents are different but the responses are generally trying to describe the barriers due to unavailability of grid lines of the state transmission utility. Hence the responses of both the respondents fall under the "Grid Availability" barrier code group.

Further paraphrasing the responses and grouping them into the pre-identified exhaustive set of code groups helps to keep this study focused, quantized and to develop the responses into a mathematical model. Such approach of code grouping allows us to bring the responses within the framework of this study and stay focused on identifying the opportunities and the risks involved in hydropower development in Uttarakhand.

It is also to be noted that few respondents have repeated their responses several times within the same question. If such repeated responses are considered multiple times, it may result in assigning of inaccurate code weightage and calculation of significance factor of a code group may vary depending on the responding style of the respondent. Hence, such repetitions have been ignored in this study.

Wherever the actual responses of the respondents are incorrect in grammar, spelling or need other definitive corrections, the same has be done in the extracted response text and all the study has been carried on this extracted response text to derive at the most accurate conclusion.

The code groups identified during the literature study, case studies and interviews for this research work have been broadly divided into two main groups, i.e. opportunities and risks groups. The code groups in each of the respective opportunities and risk group are illustrated in table 9A & 9B below.

Barrier Codes Groups (B - Codes)	**Identified Barriers**
B1	Land acquisition
B2	Local law and order issues
B3	Uncertainty in government policies
B4	Resettlement and rehabilitation
B5	Financial constraints
B6	Clearances/permits from relevant organizations
B7	Inadequate political support and political interferences
B8	Dearth of competent contractors and subcontractors
B9	Force majeure (bad weather flood landslide etc)
B10	Geological surprises

Barrier Codes Groups (B - Codes)	Identified Barriers
B11	Claims and disputes
B12	Construction cost escalation
B13	Safety concerns
B14	Construction delay
B15	Ineffective communication with stakeholders
B16	Lack of coordination among stakeholders
B17	Unrealistic estimates while bidding
B18	Ecological and environmental impact
B19	Weak (old and inadequate) transmission network
B20	Delay in tendering process
B21	Shortage of construction labour
B22	Third party delays
B23	Deviations in scope of work
B24	Inappropriate risk allocation
B25	Quality of construction work
B26	Incorrect estimation of quantity of material and equipment requirement and subsequent variations
B27	Inadequate planning
B28	Non-compliance by contractor with contractual provisions
B29	Inadequate availability of skilled personnel
B30	Delay in supply of drawings
B31	Logistics and supply of material and equipment
B32	Inappropriate designs and consequent deviations
B33	Poor accessibility to site
B34	Obsolete construction method and technology
B35	Quality of material and equipment
B36	Currency exchange rate fluctuation and inflation
B37	Reducing River Discharge
B38	Difficult family life of project employees
B39	Long gestation period and payback period

Opportunities Code Group (O - Codes)	Identified Opportunities
O1	Improved socio-economic conditions
O2	Tourism and area development
O3	Employment generation
O4	Revenue generation
O5	Clean power source
O6	Flood control, irrigation, agriculture and drinking water
O7	River water trash removal
O8	Cheap power source
O9	No fuel cost
O10	Less O&M cost
O11	Reliability and Grid Stability
O12	Long lifespan
O13	Requires less land in the hills as compared to the plains.
O14	Food security health

6.3. Findings from Case Studies:

6.3.1: Case: 1 TapovanVishnugad Hydroelectric Project

Article: 1 - CEA, Progress of on-going hydro electric projects, No. 85, 2016

Findings: Bad geology in HRT; rock fall on tunnel boring machine due to bad geology; tough geology posed challenges; geological surprises causing delays; flash floods in 2012; flash floods in 2013 damaging coffer dam; flash floods damages led to delay; flash floods escalated cost; incompetent contractors; dispute due to incompetence of contractors; termination of civil contracts for barrage and HRT; agitation and opposition by local people; local law and order issues;

Codes: Geological surprises; Force majeure such as floods; Incompetent contractors; local law and order issues

O Code	-	Nil
B Code	-	2,8,9,10,29
Total New O Code	-	0
Total New B Code	-	5

Article: 2 - Project Document (November, 2017)

Findings: Geological surprises; rock fall on tunnel boring machine due to bad geology; tough geology posed challenges; geological surprises caused time and cost overruns; flash floods in 2012; flash floods in 2013 damaging coffer dam; flash floods damages led to time and cost overruns; dispute due to incompetence of contractors; termination of civil contracts for barrage and HRT; agitation and opposition by local people; local law and order issues;

Codes: Geological surprises; Force majeure such as floods; Incompetent contractors; local law and order issues

O Code	-	Nil
B Code	-	2,8,9,10,29
Total New O Code	-	0
Total New B Code	-	0

Interview: 1- GM - Project, NTPC

Findings: Geological surprises posed challenges, geological surprises caused damage to equipment, for example rock fall on tunnel boring machine due to bad geology. Bad geology resulted in time and cost overruns but it was easier to manage as NTPC officials have necessary knowledge, skills and experience to address such geological surprises. Engaging national and international agencies to conduct more accurate geological studies could reduce the chances of geological surprises. The project faced flash floods in 2012 and once again flash floods in 2013 damaged the coffer dam. These flash floods eventually caused damages that led to time and cost overruns. However, as flash floods are tough to forecast, not much can be done apart from being more prepared for flash floods. Time and cost overruns in the project were also due to lack of compatibility between the client and contractor, incompetence of contractor, and dispute due to incompetence of contractor. This finally led to the termination of contract due to the incompetence of contractor. Termination of contract and engagement of new contractor took time that added to time and cost overruns.

A mechanism to rate contractors based on their earlier work in hydropower projects and incentivizing highly rated contractors by giving priority to them in big projects of national importance can develop pool of competent contractors and subcontractors. In addition, the project faced and is still facing agitation and opposition from local people due to land acquisition and resettlement and rehabilitation issues.

Political interferences often provoke the project affected people to demand more for land acquisition and resettlement and rehabilitation. NTPC has engaged many locals as transport service operators, vendors and project personnel (semi-skilled and unskilled) by helping facilitating loans and training to them. A well constructed school has also been donated by NTPC to the local community but the school is yet to be used as the relevant Headmaster is unwilling to use the school. Every now and then, local people obstruct work and come up with new demands. The recent one has been of fodder for their cattle.

NTPC, a professional power generation company, can't waste their expertise in arranging fodder for the cattle of project affected people. All this after NTPC has paid the best compensation to the project affected people. Inadequate political support often complicates the situation and creates law and order issues for the project. Uncertainty in government policies has often created problems for hydro projects.

Uncertainty regarding permission to construct hydro projects on rivers of Uttarakhand has been a big issue and often led to delays in getting clearances from relevant organizations. This uncertainty in government policy also creates financial constraints as funding gets struck causing delay in payments to contractors. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process can help reduce conflict with local people. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles due to uncertainty in government policies. A clear and easy to understand R&R policy that is implemented in a transparent and fair process is the need of the hour. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. Ideally, all the project affected people must be resettled and rehabilitated in a similar socio-economic environment.

Mechanism to ensure timely payments along with penalty provisions for delayed payments can address delays due to financial constraints. Mechanism for time-bound, criteria-based, online clearances can reduce delays due to clearances/permits. As state government is a beneficiary of the project, it must share the responsibility for timely completion of the project. The central government can devise mechanisms to incentivize or penalize state governments for their role in completion of hydropower projects in the state.

Codes: Geological surprises; Force majeure such as floods; Incompetent contractors; local law and order issues; Land acquisition; Uncertainty in government policies; R&R; Financial constraint; Clearance/permits from relevant organizations; Inadequate political support and political interferences.

O Code	-	Nil
B Code	-	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 29
Total New O Code	-	0
Total New B Code	-	6

Interview 2 - Project Engineer, NTPC

Findings: Geological surprises posed challenges; geological surprises caused damage to equipment. Bad geology resulted in time and cost overruns. Engaging foreign professionals to conduct more accurate geological studies could reduce the chances of geological surprises. The project faced flash floods in 2012 and once again flash floods in 2013 damaged the cofferdam. These flash floods eventually caused damages that led to time and cost overruns. As flash floods are tough to predict, not much can be done apart from being more prepared for flash floods. Time and cost overruns in the project were also due to lack of coordination between the client and contractor, incompetence of contractor, and dispute due to the incompetence of the contractor which finally led to the termination of contract. Termination of contract and engagement of a new contractor took time that added to time and cost overruns. A mechanism to rate contractors based on their earlier work in hydropower projects and incentivizing highly rated contractors by giving priority to them in big projects of national importance can develop pool of competent contractors and subcontractors. In addition, the project faced and is still facing agitation and opposition from the local people due to land acquisition, resettlement and rehabilitation issues. Political interferences often provoke the project affected people to demand more for land acquisition and resettlement and rehabilitation. Every now and then, local people obstruct work and come up with new demands. Inadequate political support often complicates the situation and creates law and order issues for the project.

Uncertainty in government policies has often created problems for hydroprojects. Ambiguity regarding permission to construct hydroprojects on rivers of Uttarakhand have been a big issue and often led to delays in getting clearances from relevant organizations. The policymaking agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles due to uncertainty in government policies. A clear and easy to understand R&R policy that is implemented in a transparent and fair process is the need of the hour. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The state government is a beneficiary of the project and thus it should share the responsibility for timely completion of the project. The central government can devise mechanisms to incentivize and penalize state governments for their role in completion of hydropower projects in the state.

Codes: Geological surprises; Force majeure such as floods; Incompetent contractors; local law and order issues; Land acquisition; Uncertainty in government policies; R&R; Clearance/permits from relevant organizations ; Inadequate political support and political interferences.

O Code	-	Nil
B Code	-	1, 2, 3, 4, 6, 7, 8, 9, 10, 29
Total New O Code	-	0
Total New B Code	-	0

Interview 3 - Manager - CSR, NTPC

Findings: The project faced flash floods in 2013. These flash floods eventually caused damages that led to time and cost overruns. However, as flash floods are tough to forecast, not much can be done apart from being more prepared.

NTPC has engaged many locals as transport service operators, vendors and project personnel (semi-skilled and unskilled) by helping facilitating loans and training them. A well-constructed school has also been donated by the NTPC to the local community but the school is yet to be used as the relevant Headmaster is unwilling to use the school. Every now and then, the local people obstruct work and come up with new demands; and all this after NTPC has paid the best compensation to the project affected people. Inadequate political support often complicates the situation and creates law and order issues for the project. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process can help reduce conflict with the local people. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. A clear and easy way to understand the R&R policy that is implemented in a transparent and fair process is the need of the hour. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations.

Codes: Force majeure such as floods; local law and order issues; Land acquisition; R&R; Inadequate political support and political interferences.

O Code	-	Nil
B Code	-	1, 2, 4, 7, 9
Total New O Code	-	0
Total New B Code	-	0

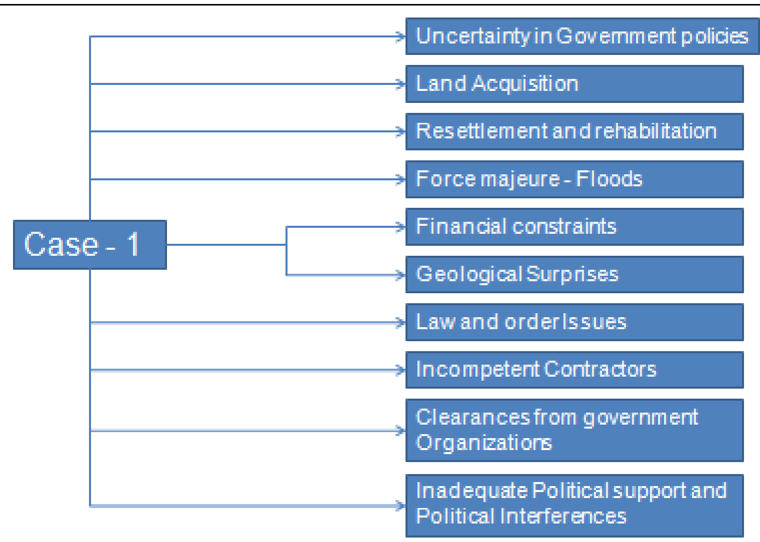


Figure:6 Findings from Case-1 Tapovan Vishugad (Central PSU)

6.3.2 Case 2: Pala Maneri Hydroelectric Project

Article: 1 CEA, Progress of on-going hydro electric projects, No. 85, 2016

Findings: Agitation and opposition by local people, local law and order issues, obstruction of work by the local community and change in the policy environment lead to a ban on projects on the Ganga Basin. As a result, the project was discontinued by the National Ganga River Basin Authority vide notification on 1.11.2010.

Codes: Local law and order issues; Uncertainty in government policies

O Code	-	Nil
B Code	-	2, 3
Total New O Code	-	0
Total New B Code	-	2

Article: 2 Project Documents

Findings: Obstruction of work by the local community and NGOs, local law and order issues and a ban on projects in the Ganga Basin, led to the project being discontinued by the National Ganga River Basin Authority vide notification on 1.11.2010.

Codes: Local law and order issues; Uncertainty in government policies

O Code	-	Nil
B Code	-	2, 3
Total New O Code	-	0
Total New B Code	-	0

Interview: 1 Ex-Project In charge, UJVNL

Findings: Interference in work by local people. Heated exchanges with NGOs and local people. Agitation in front of project office and site by local community. Unfair demands by local people that often resulted in law and order issues. Policies flip flop by the government and its agencies. Uncertainty regarding hydro projects in Uttarakhand. Delay and uncertainty during hearing in Supreme Court. Flip flop policy of state government. Transparent land acquisition policy that is implemented in a fair process. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles.

Codes: Local law and order issues; Uncertainty in government policies

O Code	-	Nil
B Code	-	2, 3
Total New O Code	-	0
Total New B Code	-	0

Interview: 2 Ex-Project Official 1, UJVNL

Findings: Obstruction of work by local people. NGOs and local people provoking labours. Agitation in front of project office and site by local community. Policy flip flop by government and its agencies. Uncertainty regarding hydro projects in Uttarakhand. Uncertain environment created by Supreme Court and Green Tribunals. Flip flop policy of state government. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must get completed.

Codes: Local law and order issues; Uncertainty in government policies

O Code	-	Nil
B Code	-	2, 3
Total New O Code	-	0
Total New B Code	-	0

Interview: 3 Ex-Project Official 2, UJVNL

Findings: Obstruction of work by NGOs and local people. Agitation in front of project office and site by local community. Unfair demands by local people that often resulted in law and order issues. Policy flip flop by government and its agencies. Uncertainty regarding hydro projects in Uttarakhand. Delay and uncertainty during hearing in Supreme Court. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles.

Codes: Local law and order issues; Uncertainty in government policies

O Code	-	Nil
B Code	-	2, 3
Total New O Code	-	0
Total New B Code	-	0

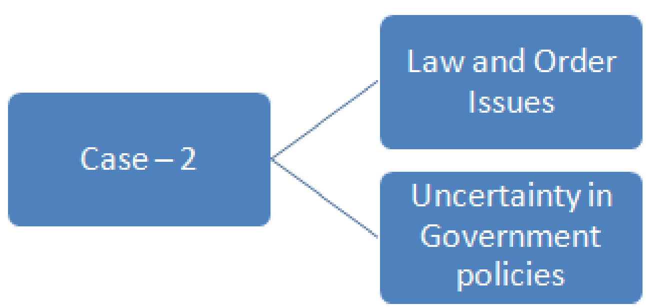


Figure:7 Findings from Case -2 Palamaneri (State PSU)

6.3.3. Case 3: Singoli Bhatwari Hydroelectric Project

Article: 1 CEA, Progress of on-going hydro electric projects, No. 85, 2016

Findings: Poor geology in Head Race Tunnel; Geological surprises causing obstacles in boring of tunnel; Inaccurate geological assessment led to geological surprises; Interference by local causing time and cost overruns; Interference by local people; Obstruction of work by local community; Hurdles created by influential local residents; Flash flood in June 2013; Damage to structure by flash floods; Unexpected flash flood brought boulders that damaged the coffer dam and led to delays.

Codes: Geological surprises; Local law and order issues; Force majeure such as floods

O Code	-	Nil
B Code	-	2, 9, 10
Total New O Code	-	0
Total New B Code	-	2

Article: 2 Project Documents

Findings: Geological surprises caused challenges; Inaccurate geological assessment led to geological surprises; Interference by local people; Obstruction of work by local community; Hurdles created by influential local residents; Flash flood in June 2013; Unexpected flash flood brought boulders that damaged the coffer dam and led to delays.

Codes: Geological surprises; Local law and order issues; Force majeure such as floods

O Code	-	Nil
B Code	-	2, 9, 10
Total New O Code	-	0
Total New B Code	-	0

Interview: 1 GM - Project, L&T

Findings: Geological surprises posed challenges. Bad geology resulted in time and cost overruns. Geological surprises also caused damages to equipment leading to delays. Engaging top-notch national and international agencies to conduct more accurate geological studies could reduce the chances of geological surprises. The project faced flash floods in 2013 that damaged the coffer dam. These flash floods eventually caused damages that led to time and cost overruns. After the devastation by flash floods, reconstruction caused time and cost overruns. However, as flash floods are tough to forecast, not much can be done apart from being more prepared for flash floods. In addition, the project faced agitation and opposition from local people due to land acquisition and resettlement and rehabilitation issues.

Political interferences often provoke the project affected people to demand more for land acquisition and resettlement and rehabilitation. L&T has engaged many locals as transport service operators, vendors and project personnel (semi-skilled and unskilled) by helping them with bank loans and training. Still, every now and then, local people obstruct work and come up with new demands. Inadequate political support often complicates the situation and creates law and order issues for the project.

Uncertainty in government policies has often created approval problems for hydro projects. Uncertainty regarding permission to construct hydro projects on rivers of Uttarakhand has been a big issue and often led to delays in getting clearances from relevant organizations. This uncertainty often creates financial hurdles as funding gets struck causing a delay in payments to contractors. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process can help reduce conflict with local people.

This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy-making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles due to uncertainty in government policies. A clear and easy to understand R&R policy that is implemented in a transparent and fair process is the need of the hour. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. Mechanism for time-bound, criteria-based, online clearances can reduce delays due to clearances/permits. As the state government is a beneficiary of the project, it must share the responsibility for timely completion of the project.

Codes: Geological surprises; Force majeure such as floods; Local law and order issues; Land acquisition; R&R; Inadequate political support and political interference ; Uncertainty in government policy ; Clearance/permits from relevant organisations; Financial constraints ;

O Code	-	Nil
B Code	-	1, 2, 3, 4, 5, 6, 7, 9, 10
Total New O Code	-	0
Total New B Code	-	6

Interview: 2 Manager - CSR, L&T

Findings: The project faced flash floods in 2013 that damaged the coffer dam. After the devastation by flash floods, reconstruction caused time and cost overruns. As flash floods are tough to forecast, not much can be done apart from being more prepared. In addition, the project faced agitation and opposition from the local people due to land acquisition and resettlement and rehabilitation issues. Political interferences encouraged the project affected people to demand more for land acquisition and resettlement and rehabilitation. L&T has engaged many locals as transport service operators, vendors and project personnel (semi-skilled and unskilled) by helping them with bank loans and training. Inadequate political support often complicates the situation and creates law and order issues for the project.

Ambiguity in government policies has often created approval problems for hydro projects in Uttarakhand. Uncertainty regarding permission to construct hydro projects on the rivers of Uttarakhand has been quite an issue and has often led to delays in getting clearances from relevant organizations. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process can help reduce conflict with local people.

This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles due to ambiguities in government policies. An unrestrictive R&R policy that is implemented in a transparent and fair process is the need of the hour.

This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. Mechanisms for time-bound, criteria-based, online clearances can reduce delays due to clearances and permits. As the state government is a beneficiary of the project, it must share the responsibility for timely completion of the project. The central government can devise mechanisms to incentivize/penalize state governments for their role in completion of hydropower projects in the state.

Codes: Force majeure such as floods; Local law and order issues; Land acquisition; R&R; Inadequate political support and political interference; Uncertainty in government policy; Clearance/permits from relevant organisations;

O Code	-	Nil
B Code	-	1, 2, 3, 4, 6, 7, 9
Total New O Code	-	0
Total New B Code	-	0

Interview: 3 Project Engineer, L&T

Findings: Geological surprises posed challenges. Bad geology resulted in time and cost overruns. Geological surprises also caused damages to equipment leading to delays. Need for more accurate geological assessments. The project faced flash floods in 2013 that damaged the coffer dam. These flash floods eventually caused damages that led to time and cost overruns. However, as flash floods are tough to forecast, not much can be done apart from being more prepared for flash floods. In addition, the project faced agitation and opposition from local people due to land acquisition and resettlement and rehabilitation issues.

Uncertainty in government policies has often created approval problems for hydro projects. Uncertainty regarding permission to construct hydro projects on rivers of Uttarakhand has been a big issue and often led to delays in getting clearances from relevant organizations. This uncertainty often creates financial hurdles as funding gets struck causing delay in payments to contractors. A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process can help reduce conflict with local people. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations.

The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any hurdles due to uncertainty in government policies. A clear and easy to understand R&R policy that is implemented in a transparent and fair process is the need of the hour. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. Mechanism for time-bound, criteria-based, online clearances can reduce delays due to clearances/permits.

Codes: Geological surprises; Force majeure such as floods; Local law and order issues; Land acquisition; R&R; Uncertainty in government policy; Clearance/permits from relevant organisations; Financial constraints.

O Code	-	Nil
B Code	-	1, 2, 3, 4, 5, 6, 9, 10
Total New O Code	-	0
Total New B Code	-	0

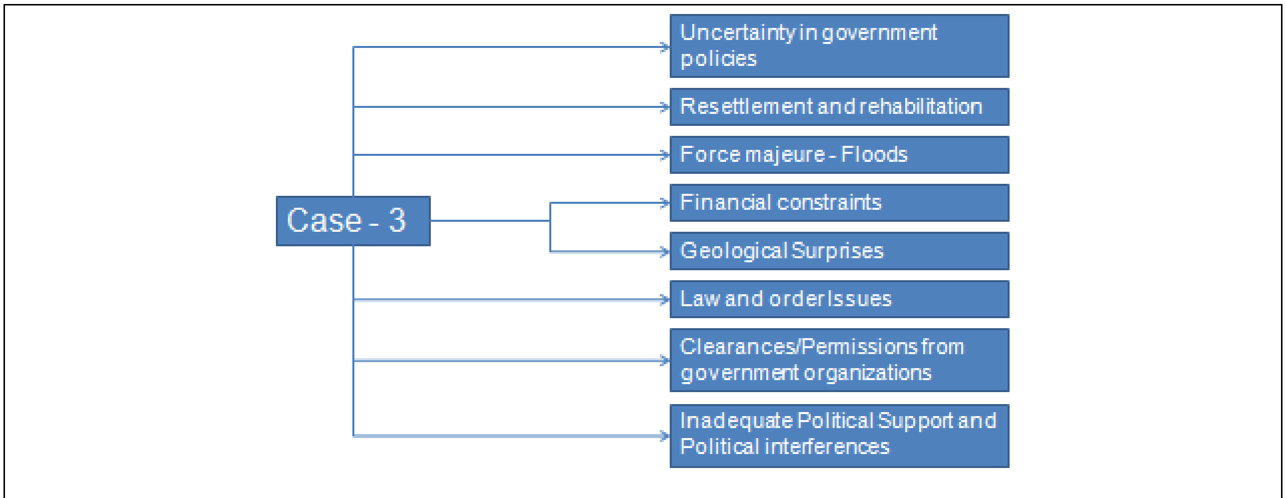


Figure: 8 Findings from Case -3 Singoli Bhatwari (Private)

Table: 10 Frequency of Codes from Articles and Interviews

Barriers	Case: 1 Tapovan Vishnugad					Case: 2 Pala Maneri					Case: 3 Singoli Bhatwari					Frequency
	A1	A2	I1	I2	I3	A1	A2	I1	I2	I3	A1	A2	I1	I2	I3	
Geological Surprises	✓	✓	✓	✓							✓	✓	✓		✓	29
Force majeure such as floods	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓	35
Incompetent contractors	✓	✓	✓	✓												16
local law and order issues	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	42
Land Acquisition			✓	✓	✓								✓	✓	✓	13
Uncertainty in Government policies			✓	✓		✓	✓	✓	✓	✓			✓	✓	✓	25
Resettlement and Rehabilitation			✓	✓	✓								✓	✓	✓	20
Financial Constraints			✓										✓		✓	3
Clearances/Permits from government Organisations			✓	✓									✓	✓	✓	8
Inadequate Political Support and Political Interferences			✓	✓	✓								✓	✓		10

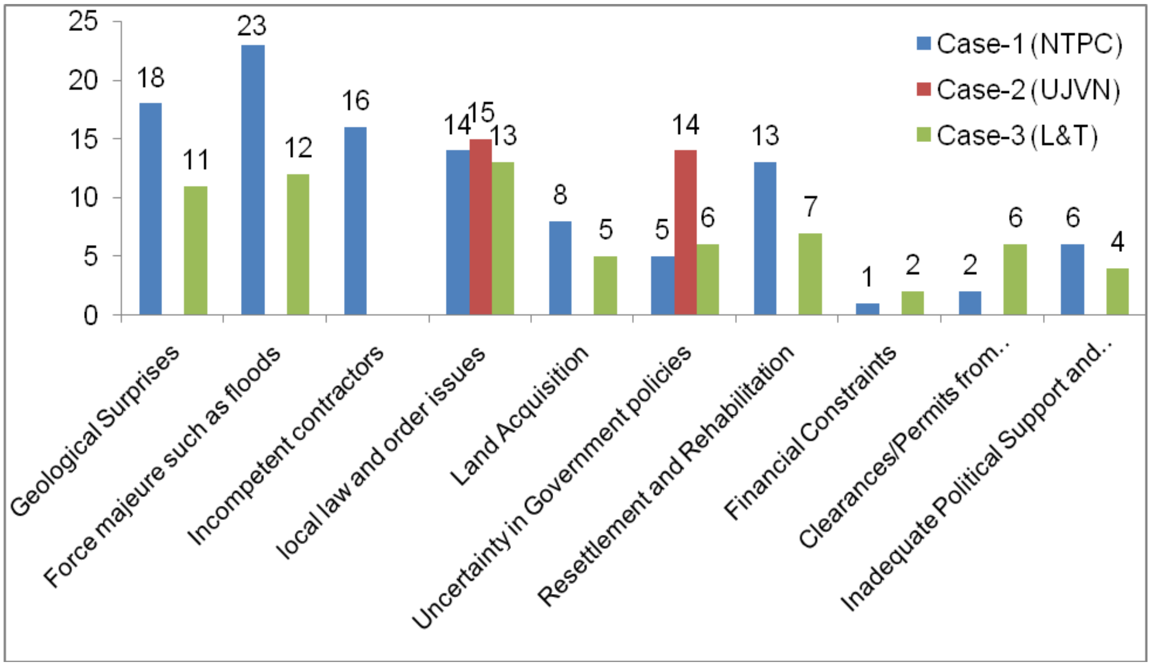


Figure: 9 Frequency of Codes from Articles and Interviews

For the case studies, the information was collected from multiple sources including documents and interviews on the history of the two hydropower projects in Uttarakhand. It also contained their current status reflecting project deadlines, project cost and duration, time and cost overruns, reasons for the overruns, experiences of the stakeholders, their understanding regarding barriers and risks and their suggestions for formulating guidelines which helps in the development of hydropower projects in Uttarakhand.

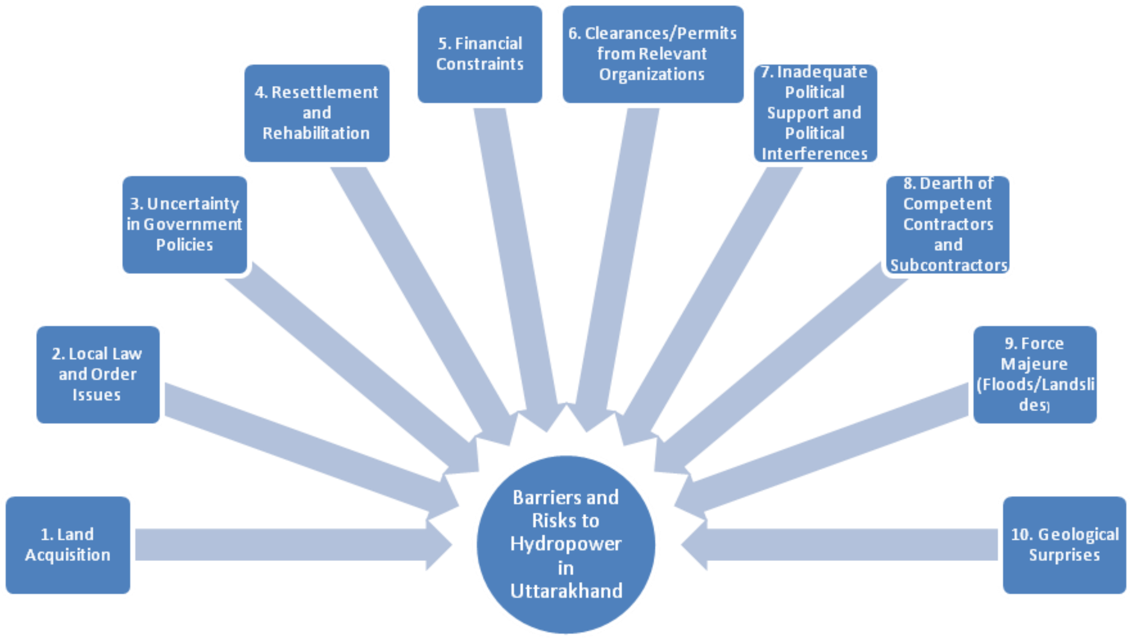


Figure: 10 Holistic Framework

Findings from Case Studies

Parameter	*Case Study 1*	*Case Study 2*	*Case Study 3*
Name of project	TapovanVishnugad Hydroelectric Project	Pala Maneri Hydroelectric Project	SingoliBhatwari Hydroelectric Project
Site address	Joshimath, Uttarakhand	Uttarkashi, Uttarakhand	Rudraprayag, Uttarakhand
Capacity	520 MW	480 MW	99 MW
Project cost (crores)	2978.48		666.47
Type	Run-of-the-river	Run-of-the-river	Run-of-the-river
Client (Developer)	NTPC Ltd. (Central Sector)	UJVNL Ltd. (State Sector)	L&T Ltd. (Private Sector)
Contractors	M/s Rithwik Projects Pvt. Ltd., M/s L&T Ltd. and M/s Alpine Mayreder Bau GmbH, M/s Patel Engg. Pvt. Ltd., M/s BHEL, M/s Om Metal Infra project Ltd.		M/s L&T DPBU, M/s General Mechanical Works Private Limited, M/s Voith Hydro, India
Project dates Date of clearance Date of environmental clearance Date of forest clearance Date of approval	 11.08.2004 08.02.2005 22.04.2006 07.11.2006		 31.05.2006 24.08.2007 16.01.2009 11.07.2008
Project commissioning schedule Original Revised Anticipated	 2012-13 2015-16 2019-20		 2014-15 2012-13 2020-21
Current Status	Project delayed	Project discontinued	Project delayed
Time overrun	84 months	NA	72 months
Cost overrun (crores)	867.82	120Cr. sunken expenditure	533.53
Major reasons for time and cost overruns	• Heavy water ingress due to bad geology in Head Race Tunnel and rock fall on Tunnel Boring Machine • Flash floods in August 2012 and June, 2013damaging coffer dam, • Termination of civil contracts for Barrage and Head Race Tunnel.	• Project discontinued by National Ganga River Basin Authority vide notification on 1.11.2010	• Poor geology in Head Race Tunnel • Agitation by local people • Flash flood in June, 2013.

Barrier/Risk Factor	Explanations based on Case Studies	Remedial measures
Land Acquisition	Land acquisition faces legal and social hurdles due to the following: • Inability of the administrators to convey land acquisition policy in a simple way • Lack of transparency and fairness in the administration of land acquisition • Unclear land titles especially of joint families	A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process
Local Law and Order Issues	Local law and order issues involve protests and strikes (which are sometimes violent) and blocking access to the site that leads to time and cost overruns. These issues are a result of many factors that may involve higher compensation to the project affected people, inclusion of additional households among project affected people, interference by the local politicians and population over petty issues such as demand for sponsorship of local volleyball tournament (Singoli Bhatwari Hydroelectric Project).	A clear and easy to understand land acquisition policy that is implemented in a transparent and fair process. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations
Uncertainty in Government Policies	Frequent changes in policies related to clearance of hydropower projects (Case of cancellation of Pala Maneri project)	The policy making agencies related to hydropower need to ensure that they assess the hydropower projects in a comprehensive way and once a project has been approved, it must not face any

		hurdles
Resettlement and Rehabilitation	Demand for jobs (government or private) to members of the project affected households and access to community services such as schools, hospitals, road, transport, water, electricity and pasture land (case of Chara Patti in Tapovan Vishnugad Hydroelectric Project) leads to time and cost overruns	A clear and easy to understand R&R policy that is implemented in a transparent and fair process. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations. Ideally, all the project affected people must be resettled and rehabilitated in a similar socio-economic environment
Financial Constraints	Delay in the release of funds to contractors, especially when the project gets delayed and contractors claim compensation for loss in profit as their manpower, equipment and fund mobilized for the delayed project becomes a liability to them (Case of Pala Maneri Hydroelectric Project).	Mechanism to ensure timely payments along with penalty provisions for delayed payments
Clearances/permits from relevant organizations	Cumbersome process of getting clearances that often results in delay. Even after getting these clearances, change in government policies can make them null and void (Case of cancellation of Pala Maneri Project and Lohari Nagpala Project)	Mechanism for time-bound, criteria-based, online clearances
Inadequate political support and political interferences	Interference of local politicians in land acquisition and resettlement and rehabilitation making it difficult for the project developers to execute projects in time. Local support of state government administration has also been found to be	As state government is a beneficiary of the project, it must share the responsibility for timely completion of the project. Centre government can devise mechanisms to incentivize/penalize state governments

	inadequate (Case of Tapovan Vishnugad Hydroelectric Project and Singoli Bhatwari Hydroelectric Project)	for their role in completion of hydropower projects in the state
Dearth of competent contractors and subcontractors	Dearth of competent contractors and subcontractors along with lack of skilled manpower affects the project cost and schedule. Cancellation of contracts and re-engagement of new contractors have also lead to delays (Case of termination of contract of M/s SSJV Projects Pvt. Ltd. and M/s ZVS, Russia for Construction of Barrage and De-silting chambers in Tapovan Vishnugad Hydroelectric Project in November 2010 and re-award of the work to M/s Rithwik Projects Pvt. Ltd., Hyderabad in July 2012	A mechanism to rate contractors based on their earlier work in hydropower projects and incentivizing highly rated contractors by giving priority to them in big projects of national importance can develop pool of competent contractors and subcontractors.
Force majeure (bad weather, flood, landslide, etc)	Effect of flash floods in June 2013 on Tapovan Vishnugad hydroelectric Project and Singoli Bhatwari Hydroelectric Project	Apart from being more prepared for floods, landslides, etc., not much can be done.
Geological surprises	Poor geology in Tapovan Vishnugad hydroelectric Project and Singoli Bhatwari Hydroelectric project and rock fall on Tunnel Boring Machine in Tapovan Vishnugad hydroelectric Project	Engaging both national and international agencies to conduct more accurate geological studies.

Chapter 7

7.0 Conclusions and Recommendations

The development of hydropower in Uttarakhand is fraught with risks, as it is abound with opportunities. The overall study done in the form of case study, interviews for projects of state government, central PSU and private sector and literature review with regard to hydropower development in Uttarakhand indicate that the risks outweigh the opportunities. Out of the total identified opportunities and barriers, 77.62% responses point to some kind of risks involved as compared to only 22.38% responses which highlight opportunities in hydropower development in this hilly state. It is evident from the responses summarized in the tables below that there are more responses indicating towards barriers in development of hydropower projects. This may partly be attributed to the 'negative perception' developed due to abundant literature available on barriers to the development of hydropower projects as compared to availability of literature on opportunities due to hydropower development in Uttarakhand. This is also corroborated by the fact that out of a total 39 identified barriers there are 18 barriers that has together been acknowledged in only 4.06% of the responses as being the reason for sluggish growth of the hydropower sector in the state and their impact can be considered insignificant.

The rank of the identified barriers from the most significant to the least significant are as mentioned in the table below:-

S. No.	Identified Barriers	C1	C2	C3	A1	A2	I1	I2	I3	Code Wise Total
1	Resettlement and rehabilitation	68	99	61			2	2	2	**228**
2	Local law and order issues	59	67	37	3	3	3	3	3	**163**
3	Financial constraints	21	46	81			2		1	**148**
4	Uncertainty in government policies	43	41	39	1	1	3	3	2	**123**
5	Ecological and environmental impact	23	37	41						**101**
6	Inadequate political support and political interferences	23	34	30			2	2	1	**87**
7	Claims and disputes	23	38	26						**87**
8	Clearances/permits from relevant organizations	30	26	18			2	2	1	**74**
9	Construction delay	24	14	23						**61**
10	Inadequate planning	6	31	23						**60**

S. No.	Identified Barriers	C1	C2	C3	A1	A2	I1	I2	I3	Code Wise Total
11	Force majeure (bad weather flood landslide etc)	10	13	26	2	2	2	2	2	**49**
12	Land acquisition	9	26	11			2	2	2	**46**
13	Poor accessibility to site	15	19	12						**46**
14	Construction cost escalation	5	13	26						**44**
15	Safety concerns	6	12	12						**30**
16	Weak (old and inadequate) transmission network	9	10	6						**25**
17	Logistics and supply of material and equipment	3	8	11						**22**
18	Geological surprises	5	10	5	2	2	2	1	1	**20**
19	Ineffective communication with stakeholders	6	2	10						**18**
20	Third party delays	5	12	1						**18**
21	Lack of coordination among stakeholders	5	2	7						**14**
22	Long Gestation Period & Payback Period		4	4						**8**
23	Inadequate availability of skilled personnel		4	3	1	1	1	1		**7**
24	Inappropriate risk allocation		3	3						**6**
25	Unrealistic estimates while bidding	2	1	2						**5**
26	Non-compliance by contractor with contractual provisions	1		3						**4**
27	Dearth of competent contractors and subcontractors		2	1	1	1	1	1		**3**
28	Delay in tendering process	2	1							**3**
29	Shortage of construction labour		3							**3**
30	Quality of construction work	2		1						**3**
31	Delay in supply of drawings	2	1							**3**
32	Inappropriate designs and consequent deviations		3							**3**
33	Obsolete construction method and technology		3							**3**
34	Incorrect estimation of quantity of material and equipment Requirement and subsequent variations			2						**2**
35	Quality of material and equipment		1	1						**2**
36	Currency exchange rate fluctuation and inflation		2							**2**
37	Reducing River Discharge			2						**2**
38	Difficult Family Life for Project Employees	2								**2**
39	Deviations in scope of work		1							**1**

The hydropower project throughout its life faces floods, landslides and earthquakes that frequently damage some of the component of the project and at times lead to damage to all the major components of the project. This is especially true for the Himalayan region which has significant hydropower potential. As has been noticed during last decade, the climate change has led to change in rainfall pattern whereby extreme weather events have increased in frequency as well as ferocity. In the recent past the hydropower projects operating or being developed in Uttarakhand have also faced back to back flash floods in 2012 and then a major flood disaster in 2013. This aberration may have caused a "Most Recent First" syndrome; and hence "*Rehabilitation and Resettlement*", "*Ecological and Environmental Impact*" figures amongst the top five barriers in hydropower development sector in Uttarakhand.

Rehabilitation and Resettlement has 14.94% significance from amongst the identified list of barrier for hydropower development in Uttarakhand. These issues are site specific and considering that people residing in the remote area of Uttarakhand with their limited resources find it an easy option to get maximum gains in the course of resettlement and rehabilitation. The landowners are often instigated and misguided by some of the stakeholders who oppose development of hydropower. Their demands keep on increasing and changing which has a cascading effect on the other population of the area. The law and order issues often crop up due to resettlement disputes and inadequate compensations.

Rehabilitation & Resettlement, Law & Order, Financial Constraints, uncertainty in policies, Ecological and Environmental Impact, are the top five barriers and 50% of the times they are considered to be reasons that limit the growth of hydropower in Uttarakhand. These individually identified risks though appear to be isolated but instead they are closely knit together with each of the factors either being a result of the other or impacting the other. It was also noted that responses which addressed the *Rehabilitation & Resettlement* or the *Ecological and Environmental Impact* issues did also include the *Law & Order* issues. Similarly this study indicates that *Financial Constraints* and *Uncertainty in Policies*, leads to problems in disbursal of compensations and this in turn has an impact on both *Law & Order* and *Rehabilitation & Resettlement* related to the project. This suggests that there is a strong correlation between the identified top five barriers for hydropower development in Uttarakhand and hence they cannot be looked as individually isolated factors.

Financial constraint which has 9.7% significance amongst the identified barriers, is a major bottleneck. Most of the lending agencies are reluctant to finance hydropower projects. With increasing environmental concerns, global warming, frequent cloud bursts and flash floods incidents, the Financial Institutions (FIs) treat it as a high risk investment with long term commitments and uncertainties in development and operations of the hydropower plants. Further, already volatile and evolving energy market with a stable share coming from thermal energy and focus of the government on alternate renewable energy sources, has also fuelled the fear of the investors and kept the FI investment in hydropower at bay. In case when a hydro project is declared NPA, the FIs find it difficult to recover their cost. There is always an uncertainty between projected generation and actual generation, with actual generation generally being less than the projected, making the returns on investment uncertain. To cover these risks most of the banks insist on short maturities of loan and ask for high interest rates making projects unviable for the IPPs to avail the loan at these conditions. Each of the barrier leads to delay in project execution which in turn results in increase in project cost. The FIs are required to make provisions for this cost escalation which further lead to increased risks exposure.

Interestingly, *land acquisition* issue has drawn only 3.01% importance and is ranked as the 12th most significant barrier, which is at par with the issue of *"poor site accessibility"*. Land acquisition has been a tricky issue that leads to delay in project construction. This could be because this barrier is generally encountered during initial phase of a green field hydropower project development. The private sector projects can acquire land at market rates and exercise certain liberties during compensation process, whereas this is not the case with the state/PSU led projects where compensation process has to be followed.

With a total forest cover area of about 65% and situated in a high risk seismic zone, Uttarakhand is situated in an ecologically fragile terrain. Thus obtaining environmental clearances is ranked as the 8th most significant constraint and is one of the major cause that leads to delay in project completion.

3.01% of the responses on barriers also indicate that the sites for hydro power projects are normally located in the remote areas which lack approach roads and other communication facilities. In hilly areas the quality of bridges and culverts is suspect thereby severely hampering the movement of raw material and equipment. The cost of construction of the communication system of roads and telephone etc is to be borne by the project which have substantial impact on the financial viability and at times lead to delay in construction of the projects. 1.64% responses indicate that *power evacuation and grid stability* as one of the barriers in hydropower development in Uttarakhand.

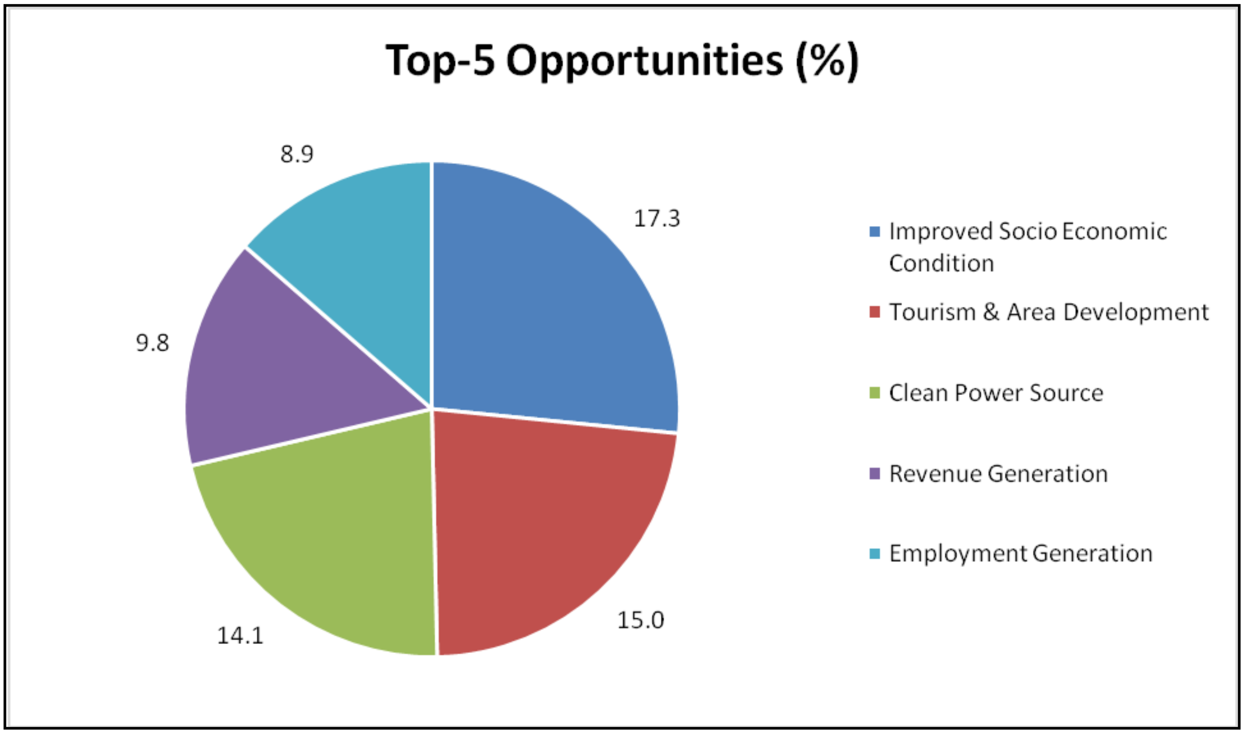
The rank of the identified opportunities from the most significant to the least significant are as mentioned in the table below :

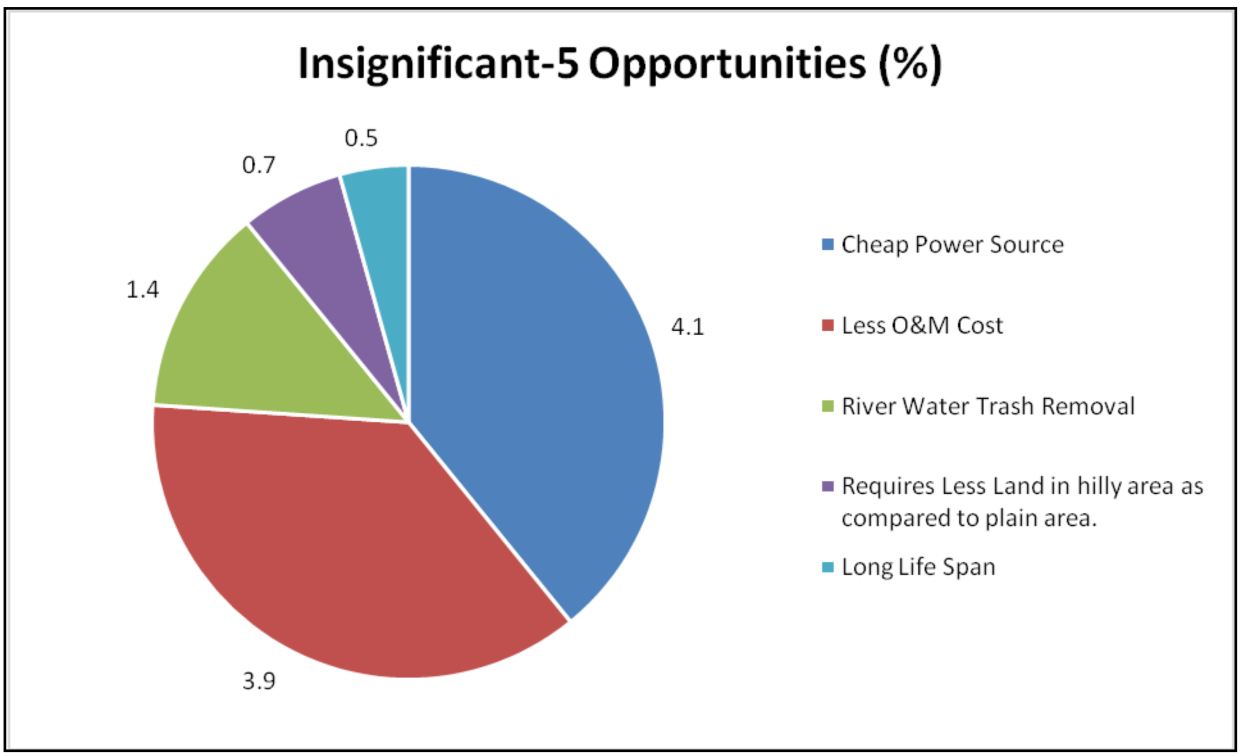
S. No.	**Identified Opportunities**	**C1**	**C2**	**C3**	**A1**	**A2**	**I1**	**I2**	**I3**	**Code Wise Total**
1	Improved Socio Economic Condition	17	22	37						**76**
2	Tourism & Area Development	15	24	27						**66**
3	Clean Power Source	8	24	30						**62**
4	Revenue Generation	12	12	19						**43**
5	Employment Generation	9	14	16						**39**
6	Flood Control & Irrigation & Agriculture & Drinking Water	5	14	14						**33**
7	Reliability & Grid Stability	4	16	11						**31**
8	Food Security & Health	1	7	15						**23**
9	No Fuel Cost	3	7	11						**21**
10	Cheap Power Source	5	4	9						**18**
11	Less O&M Cost	4	4	9						**17**
12	River Water Trash Removal	4	1	1						**6**
13	Requires Less Land in hilly area as compared to plain area.		1	2						**3**
14	Long Life Span		2							**2**

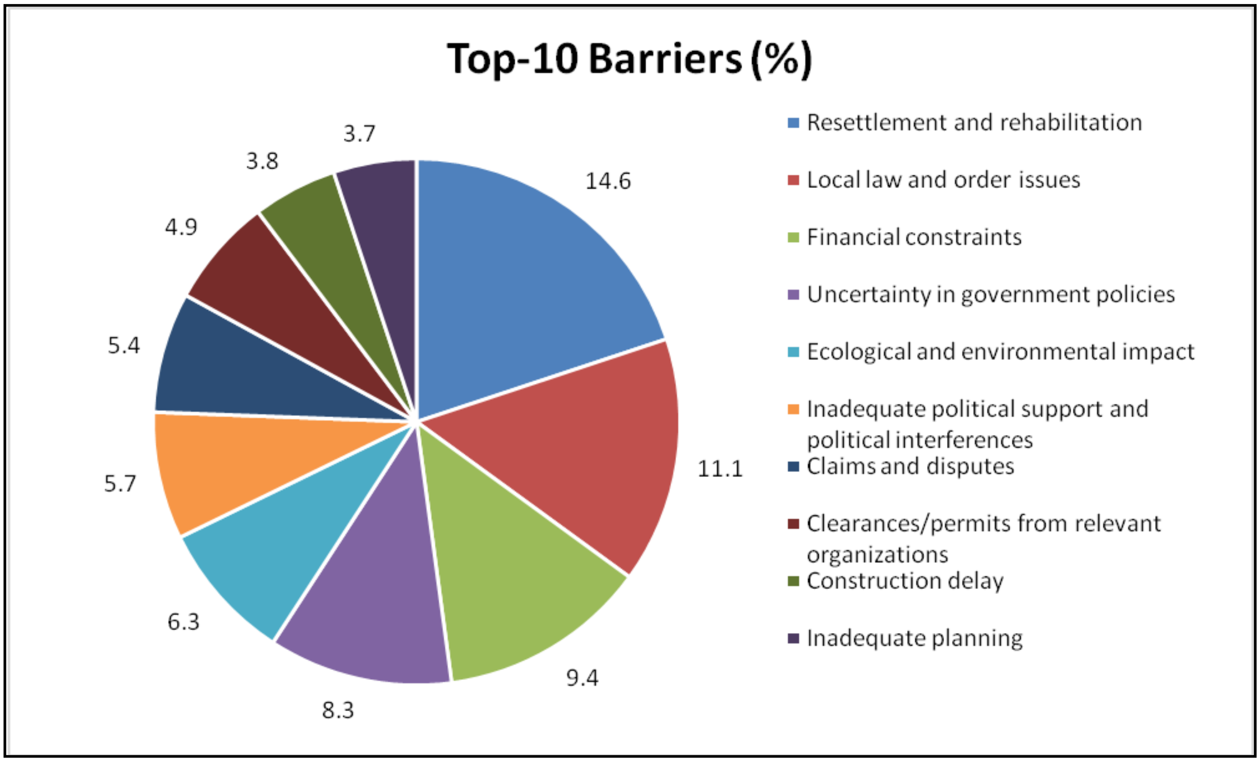
The major opportunities identified for hydropower development in Uttarakhand are *improved socio-economic condition, tourism & area development, clean source of energy, revenue generation and employment generation.* These opportunities individually account for 17.27%, 15.00%, 14.09%, 9.77%, 8.86% respectively of the total significance from among the opportunities identified. Majority of the respondents believed that *improved socio-economic condition* is one of the major opportunities for development of hydropower in Uttarakhand. Interestingly, the opportunities of *River Water Trash Removal*, *Long Life Span* and *Less Land requirement in hilly area as compared to that in plain area in case of hydropower projects* has been identified as having an importance of 2.50% among the identified opportunities; together making them the 3 least significant opportunities from amongst the total 14 identified opportunities.

This study indicates the weights of various risk factors and opportunities that the investors should take into account while making decisions on investment in hydropower development in Uttarakhand. This significance ranking of opportunities and risk factors provide the investors a holistic overview to invest judiciously in hydropower development in Uttarakhand. Also the authorities interested in development of hydropower in the state should take note of the barriers and take action to find ways and remedial measures to mitigate them so as to exploit the existing hydropower potential for the benefit of the state.

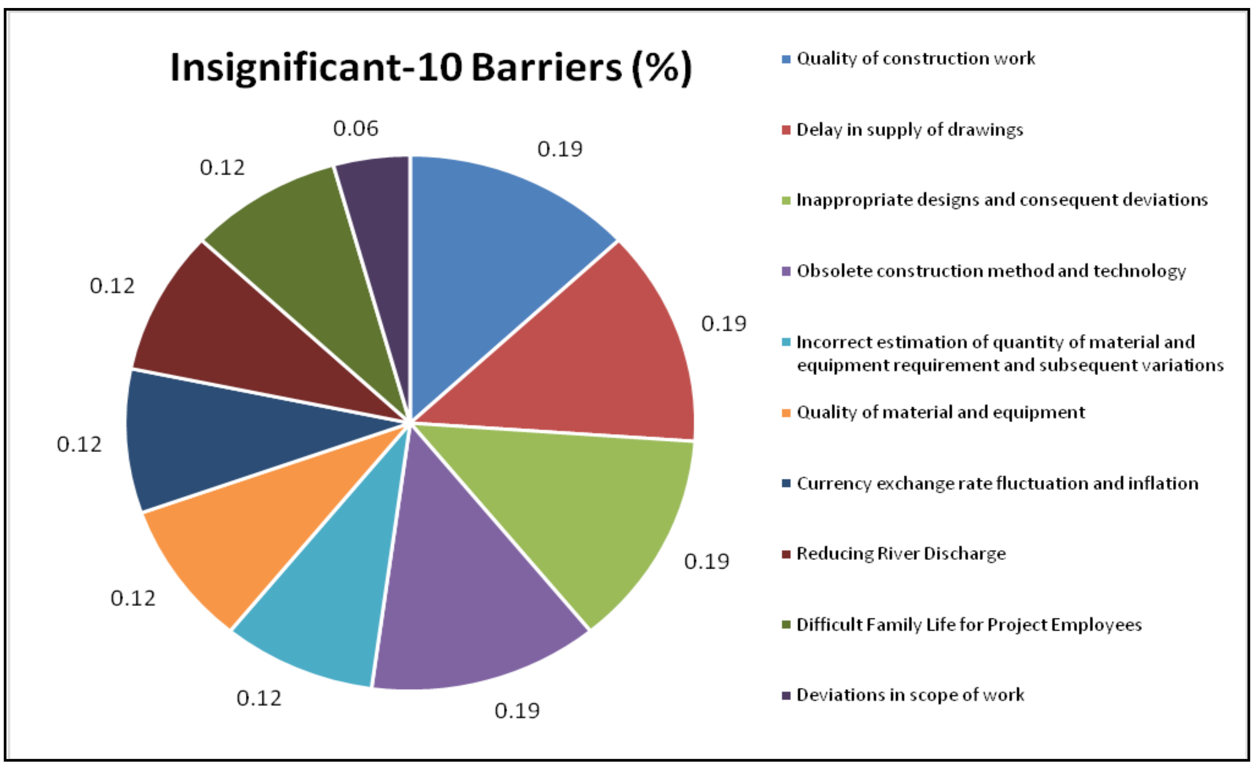
Significant Opportunities and Risks Identified in the Study



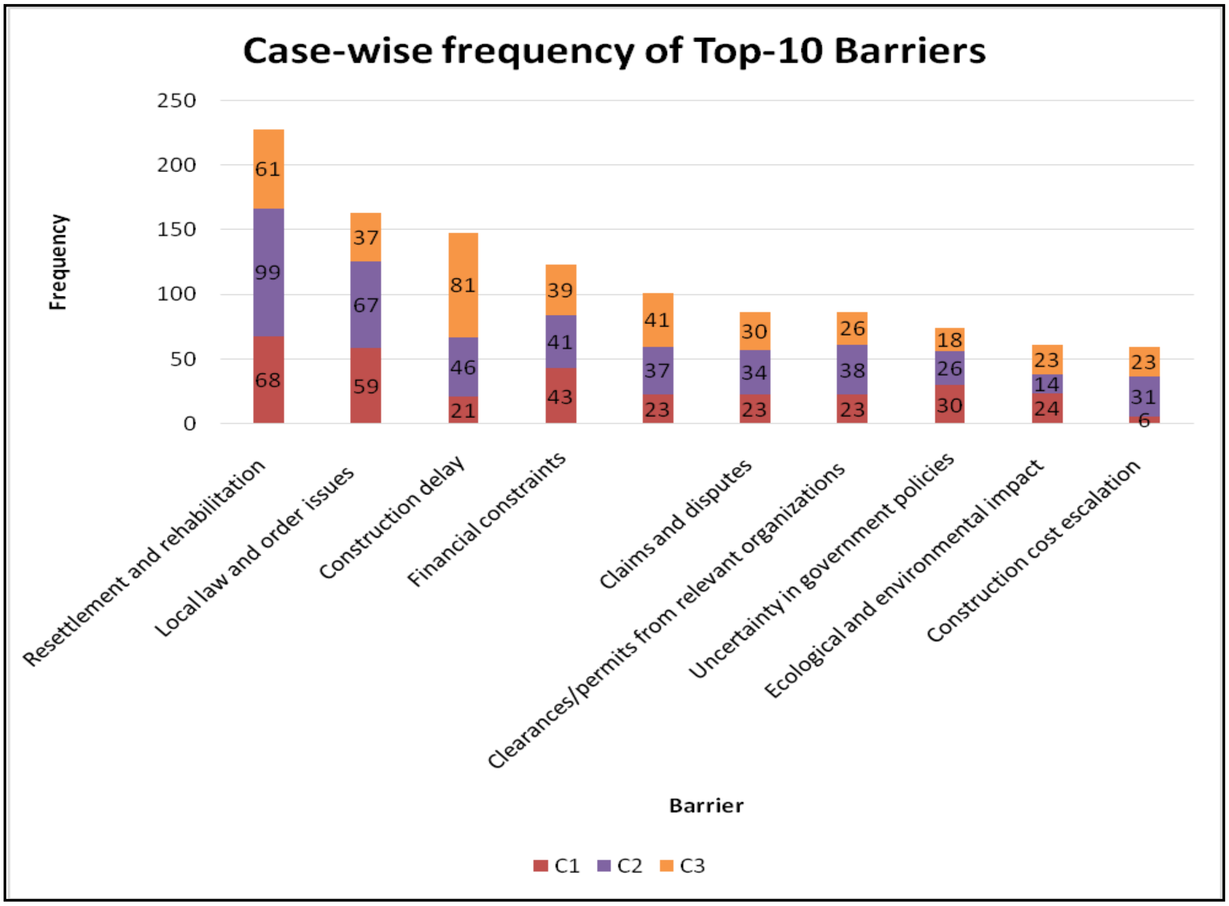


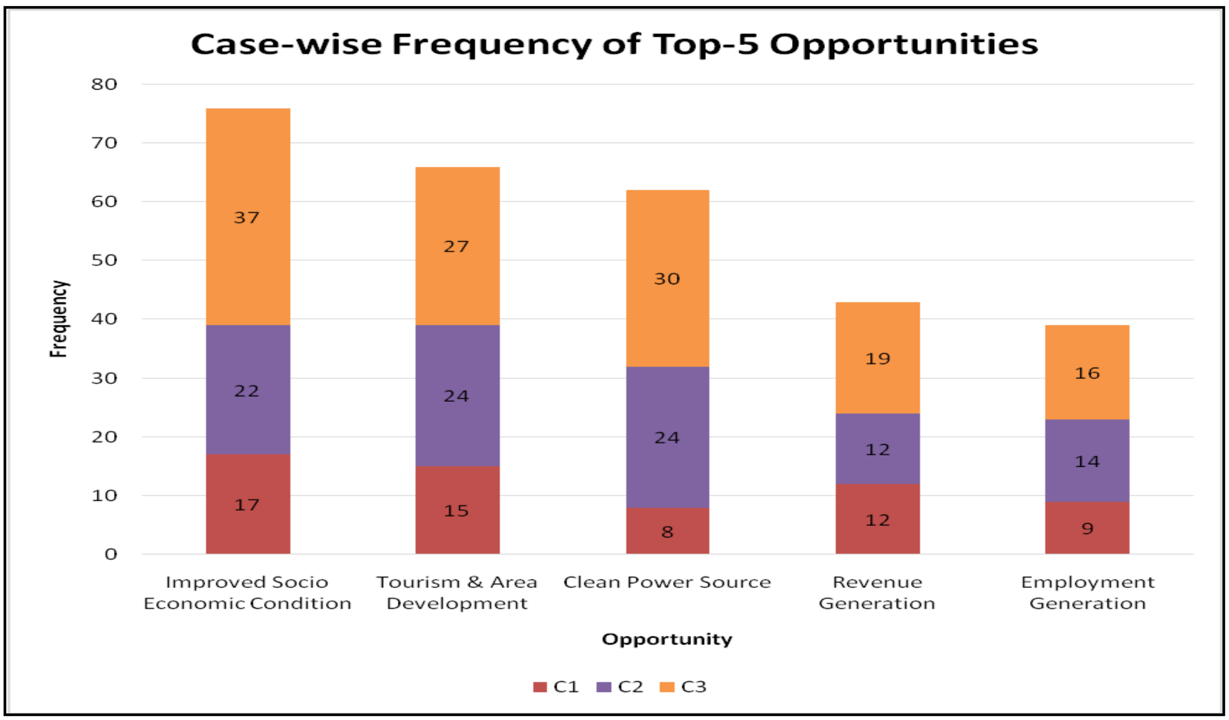


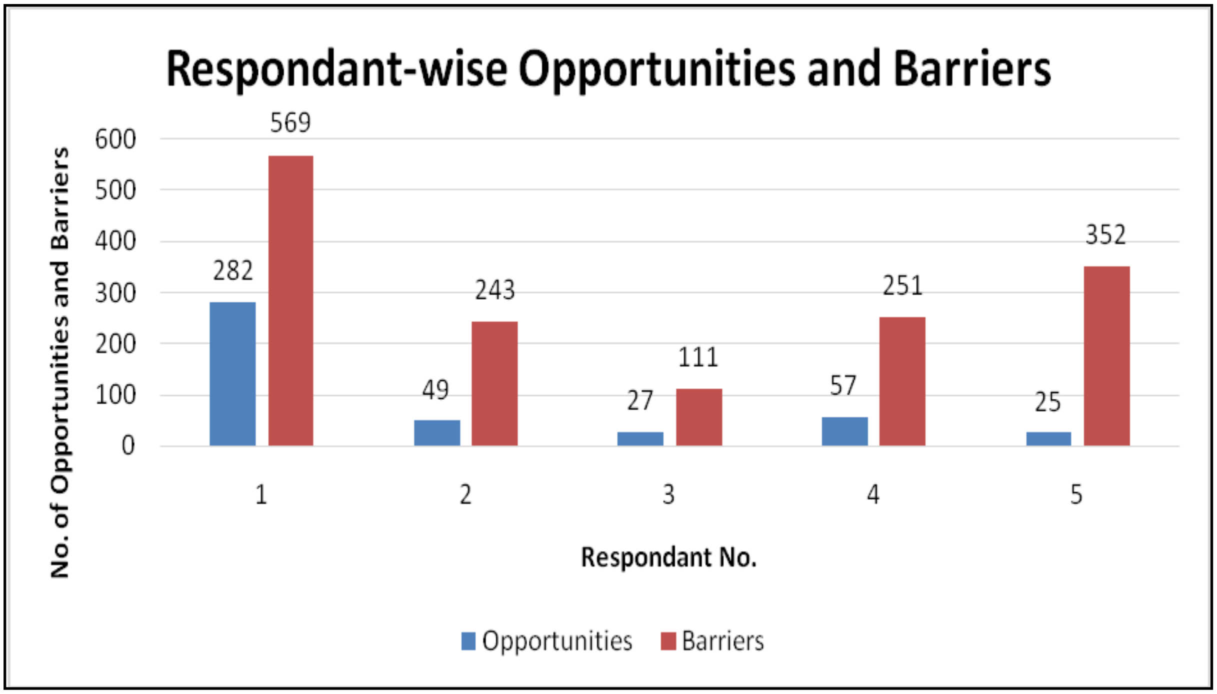
Top-10 Barriers (%)
Resettlement and rehabilitation
Local law and order issues
Financial constraints
Uncertainty in government policies
Ecological and environmental impact
Inadequate political support and political interferences
Claims and disputes
Clearances/permits from relevant organizations
Construction delay
Inadequate planning
14.6
11.1
9.4
8.3
6.3
5.7
5.4
4.9
3.8
3.7



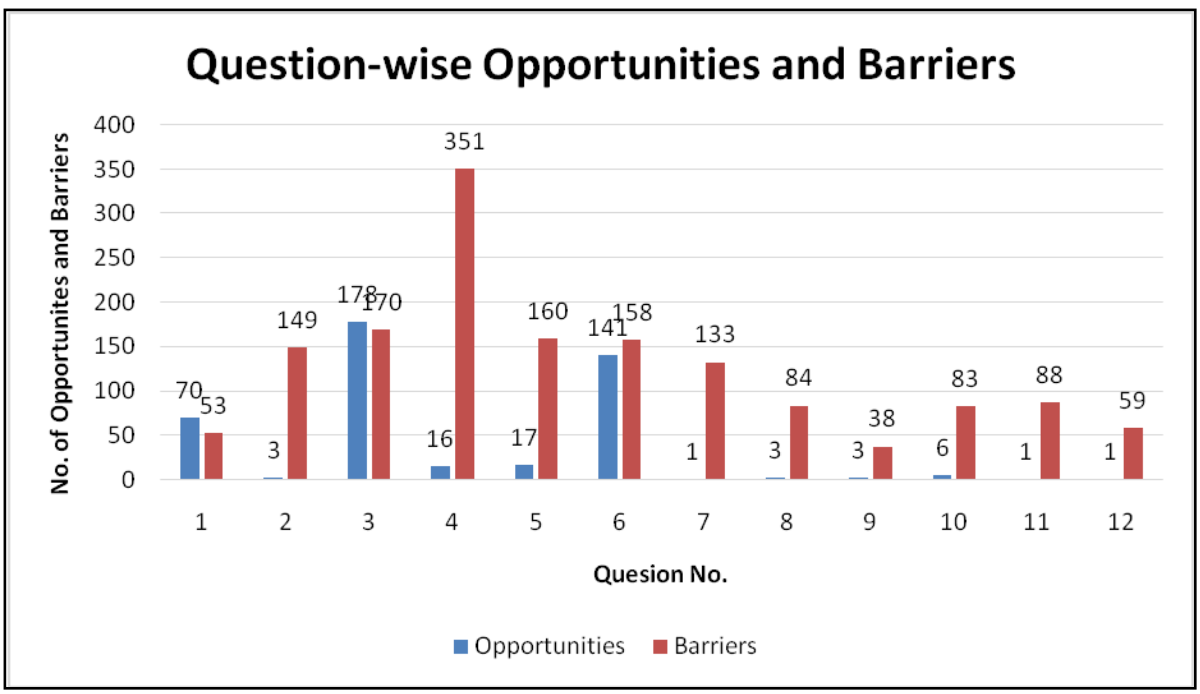
Insignificant-10 Barriers (%)
Quality of construction work
Delay in supply of drawings
Inappropriate designs and consequent deviations
Obsolete construction method and technology
Incorrect estimation of quantity of material and equipment requirement and subsequent variations
Quality of material and equipment
Currency exchange rate fluctuation and inflation
Reducing River Discharge
Difficult Family Life for Project Employees
Deviations in scope of work
0.19
0.19
0.19
0.19
0.12
0.12
0.12
0.12
0.12
0.06


Case-wise frequency of Top-10 Barriers
Frequency
250
200
150
100
50
0
61
99
68
37
67
59
81
46
21
39
41
43
41
37
23
30
34
23
26
38
23
18
26
30
23
14
24
23
31
6
Resettlement and rehabilitation
Local law and order issues
Construction delay
Financial constraints
Claims and disputes
Clearances/permits from relevant organizations
Uncertainty in government policies
Ecological and environmental impact
Construction cost escalation
Barrier
C1
C2
C3

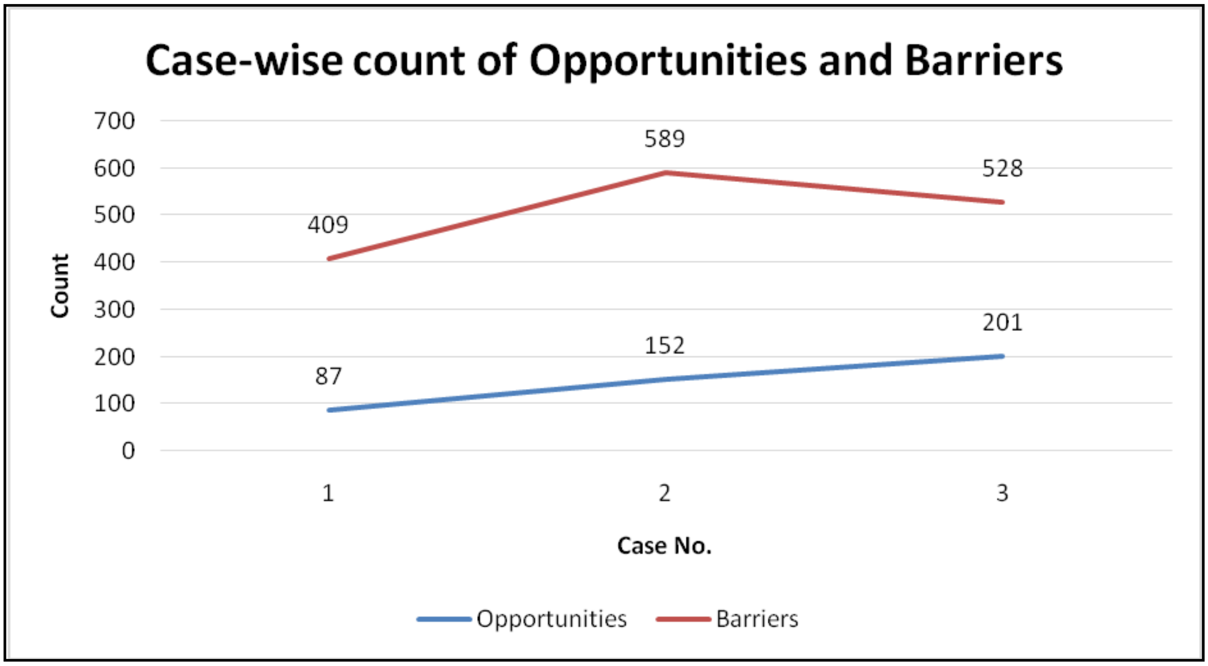

Case-wise Frequency of Top-5 Opportunities
Frequency
80
70
60
50
40
30
20
10
0
37
22
17
27
24
15
30
24
8
19
12
12
16
14
9
Improved Socio Economic Condition
Tourism & Area Development
Clean Power Source
Revenue Generation
Employment Generation
Opportunity
C1
C2
C3



Respondant-wise Opportunities and Barriers
No. of Opportunities and Barriers
600
500
400
300
200
100
0
569
282
243
49
111
27
251
57
352
25
1
2
3
4
5
Respondant No.
Opportunities
Barriers



Question-wise Opportunities and Barriers
No. of Opportunites and Barriers
400
350
300
250
200
150
100
50
0
70
53
3
149
178
170
16
351
17
160
141
158
1
133
3
84
3
38
6
83
1
88
1
59
1
2
3
4
5
6
7
8
9
10
11
12
Quesion No.
Opportunities
Barriers


Case-wise count of Opportunities and Barriers
700
600
500
400
300
200
100
0
Count
409
589
528
87
152
201
1
2
3
Case No.
Opportunities
Barriers

Recommendations

The Government of India has assigned priority to hydropower and on 7th March, 2019, the Union Cabinet has approved measures to promote hydropower power sector. Under the new Cabinet decision, large hydropower projects are also to be declared as renewable energy source unlike the earlier practice of categorizing only hydropower projects of less than 25MW as renewable energy. Further, hydropower purchase obligation (HPO) has been made as a separate entity within the non-solar renewable purchase obligation. Provisions for budgetary support for funding flood moderation component, and enabling infrastructure component (roads & bridges) and tariff rationalization has also been considered under the new measures. The above measures will promote development of hydropower in Uttarakhand.

Uttarakhand has large untapped hydropower potential that is yet to be harnessed due to barriers and risks associated with them. *Resettlement and rehabilitation, Local law and order issues, Financial constraints, Uncertainty in government policies, Ecological and environmental impact, Inadequate political support and political interferences, Claims and disputes, Clearances/permits from relevant organizations, Construction delay, Inadequate planning* are the top 10 barriers and risks hindering the development of hydropower in Uttarakhand. As a result of these risks, projects often get delayed leading to time and cost overruns. This delay can at times make the project economically unviable and force it to be discontinued after large sunken expenditure. To address these barriers and risks, it is necessary to develop a conducive framework for the development of hydropower projects in Uttarakhand. The framework needs to have the following features to promote the development of hydropower projects in Uttarakhand:

1. A clear and easy to understand resettlement and rehabilitation policy that is implemented in a transparent and fair manner. This policy must not have any scope for modification as that opens up the gate for bargaining, protests and litigations.

2. Hydropower projects need to be assessed in a comprehensive way and once a project has been approved, it must not face any hurdles.

3. Mechanism to ensure timely payments along with penalty provisions for delayed payments.
4. Mechanism for time-bound, criteria-based, online environment and forest clearances.
5. A mechanism by the central government to incentivize and penalize authorities for their role in completion of hydropower projects in the state.
6. A mechanism to rate contractors based on their earlier work in hydropower projects and incentivizing highly rated contractors by giving priority to them in big projects of national importance, can develop pool of competent contractors and sub-contractors.
7. A mechanism to engage both national and international agencies to conduct more accurate geological studies.

7.1 Limitations

- ✓ This research is only for the State of Uttarakhand.
- ✓ Only for Run-of-the River, Large Hydro power Projects with/without pondage.
- ✓ Small, Mini and Micro hydropower projects have not been considered.
- ✓ Impact of flood like 2013, is beyond scope of Research.

7.2 Further Scope of Study

- ✓ This Research can be done for the States of Arunachal Pradesh and Sikkim which has huge potential. This can also be done for Neighbouring countries such as Nepal and Bhutan.
- ✓ The correlation of the individually identified risks and opportunities, and the interrelation between the identified factors is one area of research that can be explored.
- ✓ This study also can be taken for Small, Mini and Micro hydropower projects across India.
- ✓ RMU (Renovation, Modernization and Up gradation) projects can also be taken up for further study.
- ✓ Policy framework to address all the individual and important Barriers and Risks to the development of hydropower for various hydro rich States.

Chapter-8

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Abbreviations	
ABT	Availability Based Tariff
AFC	Annual Fixed Charges
AMC	Annual Maintenance Cost
ARR	Annual Revenue Requirement
BG	Bank Guarantee
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CMNAP	Common Minimum National Action Programme
CoD	Date of Commercial Operation
CTU	Central Transmission Utility
DPR	Detailed Project Report
DSM	Deviation Settlement Mechanism
DSM	Demand Side Management
EA	Electricity Act, 2003
FAQ	Frequently Asked Questions
FY	Financial Year
GIS	Geographical Information System
GoI	Government of India
GoU	Government of Uttarakhand
GoUk	Government of Uttarakhand
HP	Himachal Pradesh
HPDF	Hydro Power Development Fund
HPO	Hydropower Purchase Obligation
IEGC	Indian Electricity Grid Code
kWh	(kilowatt hour)
LC	Letter of Credit
MNRE	Ministry of New & Renewable Energy
MoP	Ministry of Power
MU	Million Units
MW	Mega Watt
NGO	Non-Government Organization
NHPC	National Hydroelectric Power Corporation Ltd
NTPC	National Thermal Power Corporation Limited
O&M	Operation & Maintenance
PAF	Plant Availability Factor
PFC	Power Finance Corporation Limited
PGCIL	Power Grid Corporation of India
PLF	Plant Load Factor
PLR	Prime Lending Rate
PPA	Power Purchase Agreement

Abbreviations	
PTC	Power Trading Corporation
PTCUL	Power Transmission Corporation of Uttarakhand Limited
R&M	Repair & Maintenance
R&R	Rehabilitation and Resettlements
RDBMS	Relational Database Management System
RE	Renewable Energy
RLA	Residual Life Assessment
RLDC	Regional Load Dispatch Center
RMU	Renovation
ROE	Return on Equity
SEB	State Electricity Board
SERC	State Electricity Regulatory Commission
SLDC	State Load Dispatch Center
STU	State Transmission Utility
SQL	Structured Query Language
RMF	Renovation & Modernization Fund
T&D	Transmission & Distribution
TEC	Techno Economic Clearance
UERC	Uttaranchal Electricity Regulatory Commission
UJVNL	Uttaranchal Jal Vidyut Nigam Ltd
UPCL	Uttaranchal Power Corporation Limited