Risk Identification & Taxonomy in Small Hydro Power Projects of Uttarakhnad

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In this paper risks have been identified in small hydro power (SHP) projects using global literature review, it was noticed that there are around 37 risk variables are associated with SHP projects across the world. However, in case of Uttarakhand SHP projects all these risk variables are not applicable as was observed with the expert opinion of uttarakhand SHP projects investors, officials with average experience of 15-18 years in the form of semi structured interview. A total of 32 risk variables were found to be significant for Uttarakhand which further classified into operational & Construction stage small hydro power projects.

Keywords: Risk Identification; Risk Taxonomy; Small hydro power projects; Investment Decision

1. Introduction

With the fast growing economy and population, there has been a huge increase in energy demand in India. India ranks sixth in the world in total energy consumption. The rapid increase in use of energy has created a problem by defining a significant gap between energy production and consumption. Global declining of non-renewable energy brings future uncertainty in the energy supply to meet with an increase energy demand in India. To combat with future uncertainty in energy India has to meet with increased production of energy. However, given the raise of sustainable development concerns, there is the need to think about alternative sources of energy production, with a particular emphasis on renewable energy sources (RES) as India has a large amount of, supply of renewable energy resources.

1.1 Indian Small Hydro Power Sector

In five year plan the hydroelectricity is always considered to be prime motive of government to generate power from it, as in 10th five year plan government has targeted to harness 36000 MW, which will grow till 150000 Mw by the end of 14th five year plan around 2026-27(fig 1.1)

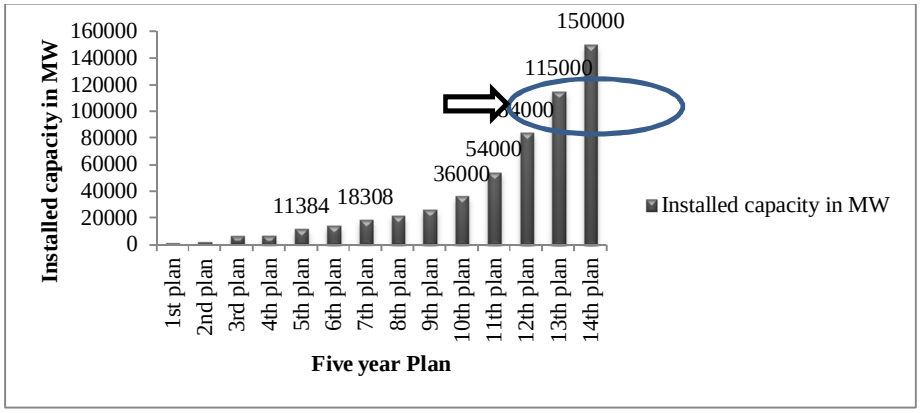

Figure 1.1 Hydroelectric Power Status with Five Year Plans

In order to provide focused attention to small size projects, the subject of small hydro was brought under the purview of renewable energy. Small hydro power sector in Indian context is defined as that hydro power project whose installation capacity is less than 25 MW. MNES is encouraging development of small hydro projects in the State sector as well as through private sector participation in various States.

1.2 Small Hydro Power Sector Uttarakhand

Uttaranchal Jal Vidyut Nigam Limited (UJVNL) was incorporated as a Company by the Government of Uttaranchal on 14th February 2001, under the Companies Act 1956. UJVNL manages hydropower generation at existing power stations,

organizes development and promotion of new hydropower projects with the purpose of harnessing already identified and yet to be identified hydro power resources of the State of Uttaranchal. Uttaranchal is currently a net importer of electric power, but generates a seasonal surplus and plans to become a net exporter of power by 2015 by expanding its hydropower and high voltage transmission capacity. Total capacity expansion of 10,000 megawatts (MW) is planned through 2018. Currently 14 projects totaling 5,525 MW are under construction and expected to be commissioned by 2015. An additional 4,791 MW are under development, with expected commissioning dates after 2015, and another 9,090 MW are planned. Fig. 1.2 shows the projected annual and cumulative capacity additions from 2005 through 2018.

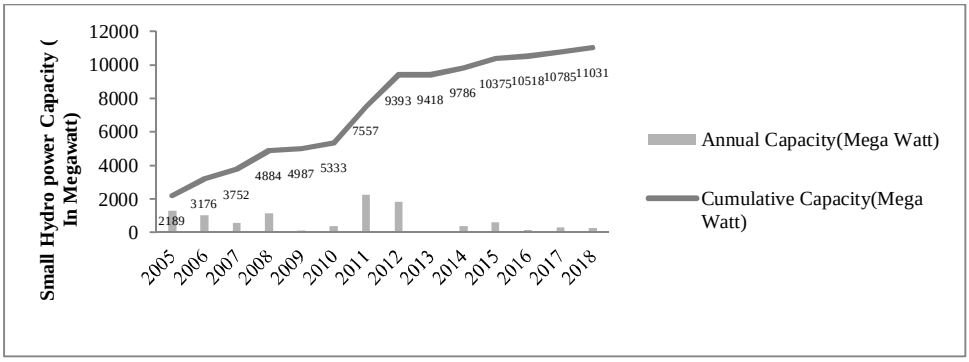

Figure 1.2 *Planned Hydro Power Capacity Addition Till 2018*

2. Investment Issues in Power Sector

The most serious issue facing hydro power sector is the fact that, despite the high power shortage that has continued over the past several years, there has been little progress in developing new power projects to meet power demand. Behind this is a negative spiral rooted in uttarakhand price regulation policy that keeps electricity prices. (Tohoku Electric Power Co., Inc., March (2010)

In particular, with regard to small-medium sized hydropower projects, many domestic private companies (particularly small and medium companies) from other industries flocked to the power sector in an investment boom in the midst of soaring economic growth, but with little know-how and experience in developing as well as unrealistic funding plans, in many cases construction had to be halted due to shortages of funds and the partially constructed waterway abandoned. Over the past 10 years of our consultation activities in Vietnam encountered numerous abandoned projects, but in fact of these there are many projects that could be restarted if the necessary technological support and funding could be provided. (Tohoku Electric Power Co., Inc., March (2010)

vann et al. (2013) infers that investment in hydro power remain limited in part of because of federal and nonfederal financial constraint, uncertainty in electricity generation, policy deregulations and price fluctuation. (Popovski, Gnjezda, Niederbacher, Naunov, & Milutinovic, 2000) concludes Considerable investment is needed to harness the potential of renewable energy and more efficiency energy use to reduce carbon emissions and provide energy essential for economic growth more investment required for economic growth. (Pejovic, Karney, Zhang, & Kumar, 2007b); (Kumar,R., 2006) mentioned investment in hydro power in Nepal is considered as best source for the development of women and children as well as societal development but major issue that faced my Nepal hydro power department is the policy deregulations. (Lundmark & Pettersson, 2007a) mention technical issues of modeling via proving that there is roughly a ten percent chance that the investment occurs in either t+5, t+10 and t+15, respectively in hydro power sector of Norway. (Ghosh & Kaur, 2002) highlights the two major challenges for hydro power investment as uncertainty and irreversibility he mentioned clearly that risk and uncertainty not highlighted in the modeling. (Zhang et al., 2010a) emphasis that a better investment model is always useful for investors as clarity about the risk and uncertainties mentioned. (Shahi, 2006) lukewarm response for investments in Indian power sector in last ten years has been the less reliability on hydro power DPR's, Environmental aspect, rehabilitation and resettlement issues, Dam security, construction time and creditworthiness of the sector. (Zhang et al., 2010b) Major challenges with this approach are input uncertainty and risk assessment. (Han, Kwak, & Yoo, 2008a) highlights on the infrastructure projects in electrical power industries have two important characteristics: one is taking much time and the other need of a big amount of capital. Therefore, a long time is needed for taking results from capital for performing any activity which needs large Investments. For this reason, it has a high risk for the investor. (Yang, 2007a) said that risks and uncertainties often compel investment in flexible power production technologies with short periods of ROI, brief construction times and the capacity to switch between fuels. (Filippini & Luchsinger, 2002) investments in the power sector in a regulated market and conclude that the possibilities to invest is better when electricity price is regulated, at least for projects requiring large capital investments per unit of output. The main problem for raising money for projects in the, small hydro power market is lack of investor confidence (Wiemann, 2011a).

Major Investment Issues in Power Sector

- Cost variation occurs due to negligence of risk

- Better investment model give clarity to investors
- Reliability of detailed project report needs to be enhanced
- Create competitive environment for private investors
- Policy deregulations
- Risk ignorance
- DPRs need to enhanced
- Financing problem to investors

To sum-up all the above mentioned investment issues the conclusion drives to identify the various risks for the investors who have interest in investing but still they have lack of confidence of generating better profit to overcome this problem this research will help investors to invest in SHP's with more clarity and with less fear.

3. Risk Identification in Small Hydro Power Projects

Knight, (1921) describes risks as a situation where probabilities cannot be objectively assigned and where all future contingencies may not be known. ; Luce and Raffia (1957) explained risk is uncertainty that occurs in future which needs to be coped so as to evade variation of penalties ranging from negative wonders to enduring loss. In this research risks have been identified using global literature review based on small hydro power projects. Based on literature studies it was noticed that there are around 37 risk variables are associated with small hydropower projects across the world. Those risk variables are enumerated below.

- Delay from suppliers(Wiemann, 2011)
- Approvals (Mittal, 2004)
- Fund Blockage (Wiemann, 2011)
- Clearances ((Berchmans, 2013a)
- Relocation (Kucukali,S, 2011)
- Noise pollution (Wiemann, 2011)
- Water quality (Wiemann, 2011)
- Employment (Pharlia, 2007)
- Flora & fauna (Wiemann, 2011)
- Financing Resources (Kucukali,S. 2011)
- Interest rate (Ghosh & Kaur, 2011)
- Tax rate (Ghosh & Kaur, 2011)
- Inflation (Wiemann, 2011)
- Climate (Wiemann, 2011c)
- River flow (Noor-E-Alam & Doucette, 2010b)
- Soil erosion (Kucukali,S. 2011)
- Precipitation (Noor-E-Alam & Doucette, 2010b)
- Construction schedule (Wiemann, 2011)
- Construction Budget (Tuna, 2013)
- Machinery (Fleten et al., 2010)
- Regulatory (Kucukali,S. 2011)
- Breakdown technical (Wiemann, 2011)
- Public private partnership (Jayant Sathaye (USA), Oswaldo Lucon (Brazil), 2012a)
- Tourist attraction (Kucukali,S, 2011)
- Clearances (Kucukali & Report, 2011a)
- Capital cost (S. M. H. Hosseini, Forouzbakhsh, & Rahimpoor, 2005b)
- Generation (Kucukali,S, 2011)
- Evaluation technique (Shang & Hossen, 2013b)
- Terrorism (Kucukali,S, 2011)
- Breakdown technical
- Operation & Maintenance (Pasha & Nasab, 2012)
- Electricity price (Kucukali & Report, 2011a)

However, in case of Uttarakhand small hydro power project all these risk variables are not applicable as was observed with the expert and officials of uttarakhand Small hydro power projects and investors, with average experience of 15-18 years in the form of semi structured interview. A total of 32 risk variables were found to be significant in Uttarakhand small hydro power projects such as generation, modeling techniques, terrorism, breakdown technical, operation & maintenance, electricity price, capital cost, clearances, machinery, tourist attraction, water quality, regulatory, interest rate, inflation, tax rate, employment, noise, precipitation, soil erosion, river flow, construction time, construction schedule, delay from suppliers, relocation, fund blockage, approvals, public.

3.1 Identification of Risks for SHP's of Uttarakhand

All the risk variables which are applicable for uttarakhand small hydro power projects which come after semi structured interview with officials are categorized further. There are many different risks existing which should be subdivided into tangible (quantitative) and intangible (qualitative) features. Typical tangible features are costs and benefits because they can be expressed in monetary terms. Intangible features cannot be readily valued in money, for example socio-economic and environmental risks (Goldsmith, 1993). Fig. 3.1 shows the classification of small hydro power risks in Uttarakhand and it is important to mention that this is a selection – and not a complete list – of possible risks facing a low head, small hydropower project. The importance and emphasis of every kind of risk depends on the target group, the technology, the potential site and the stage for an implementation of a hydropower plant. The following scenario describes some risks in different stages of a hydropower project.

The risk in small hydro power projects of Uttarakhand are classified few major categories and then further subdivided in various risk factors. The major classes of risk are as follows:

- **Technical Risk:** as mentioned in chapter 2 the various risk classes has come out from literature review in compilation the technological risk in SHP of Uttarakhand includes mainly segregated as operation & Maintenance, machinery and Breakdown which further moved in tributary as delay from suppliers. ; ; .
- **Construction Risk:** construction is major area in small hydro power sector as dam construction is huge capital investment project which includes construction schedule and construction budget risk.
- **Financial Risk:** Financial risk is interim risk which plays major role in small hydro power project. The financial risk diversified into financial resources, tax rate and inflation risk. Financing resources again divide into fund blockage and interest rate risk. Though foreign investment in small hydro power project is less in Uttarakhand so exchange rate risk is not play major role in this area.;; .
- **Legal Risk:** Legal or regulatory have vital importance in SHP of Uttarakhand which is divided into clearances and regulatory. There are various clearances that hydro power project investor has to take into consideration as MOEF, gram panchayat, high court stay, NGO's i.e. the regulatory further subdivided into Public private partnership and norms and rule & regulation changes that affects the investor benefit altogether; ; .
- **Business risk**: This is the risk that issuers of an investment may run into financial difficulties and not be able to live up to market expectations. The classification in this area into electricity price, generation and modeling techniques; .
- **Environmental Risk:** Environmental risk is also considered as huge project of power if it creates environmental problems as removal of forests so clearance is necessary. The Environmental risk further classified as climate and forest. Which is further associated with river flow, precipitation and flora & Fauna
- **Socio Economic Risk:** Socio-economic is one of the important areas moving around Hydro power projects. The further sub classification is segregated as local community and safety. These are further moves to another stage considering noise, employment, tourist places, rehabilitation, and water quality and soil erosion; .

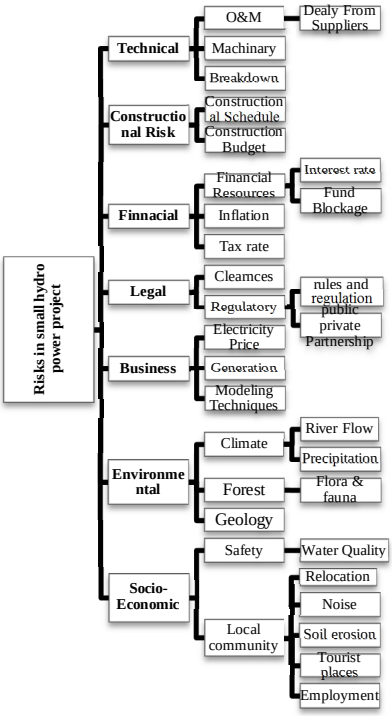

Figure 3.1 Small Hydro Power Sector of Uttarakhand Risks Classification

4. Risk Classification Based on Life Cycle of Small Hydro Power Project

Risk classification is another pertinent task as per this research, study area is decided only operational & construction stage small hydro power project. The classification of risks has been done based on responses of experts. The questionnaire was floated risk identification and classification. Based on the questionnaire responses taken from experts of small hydro power projects of Uttarakhand the risk variables has been classified into operational & construction stages. 25 & 23 risk variables has been categorized in Construction and operational stages mentioned in fig 4.1.

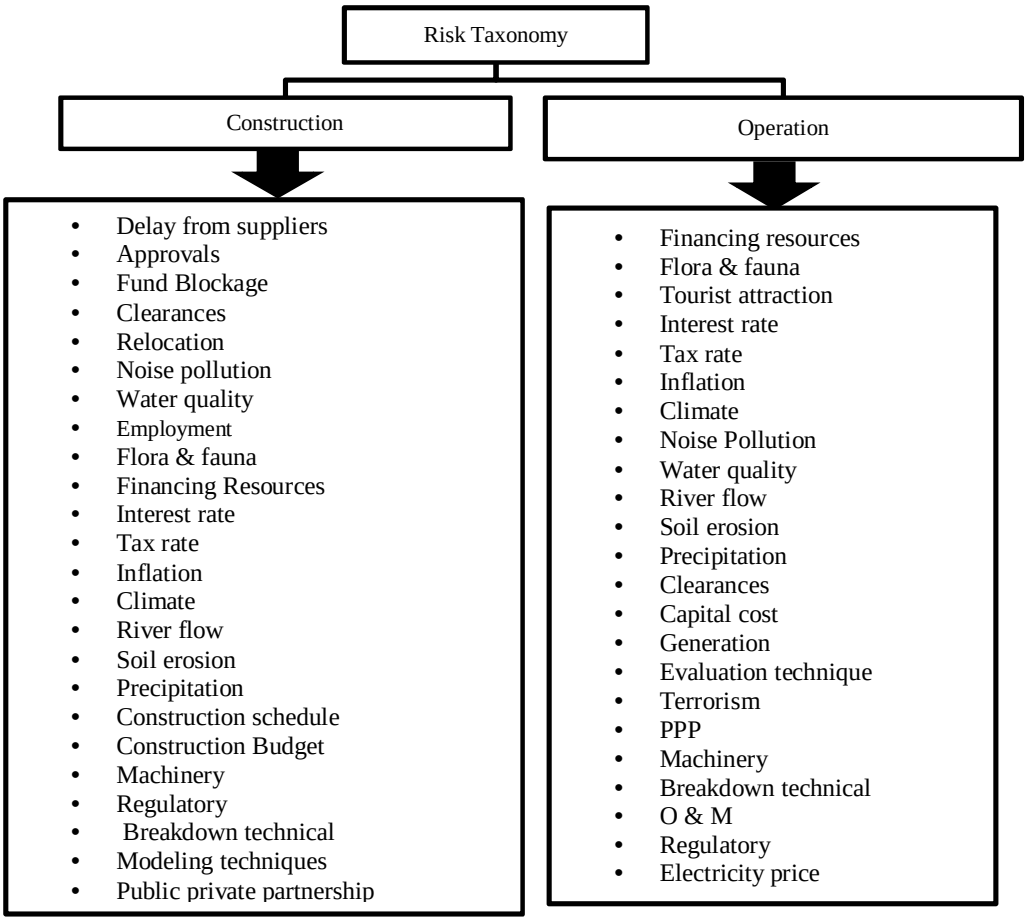

Figure 4.1 Risk Taxonomy in Construction & Operation Stage

4.1 Validation of Risk Identification

Validation of risk identified based on semi structured interview is performed using Z score formula mentioned in equation 4.1.

$$z_{score} = \frac{p - P}{\sqrt{\frac{pq}{N}}} \text{ - - - - - - - - - - } (4.1)$$

Where p-possibility of getting result (32);
q- Possibility of not getting result (0.8);
P- Respondents responded/total sample (0.2);
N- Sample Size (40) (Hofstede, G.; 2008)
Using $\mathbf{Z_{score}}$ the acceptance & rejection criterion is validated lies in the range between +3 to -3, the risk variables are validated and z core of all risk variables are mentioned in table 1.

Table 4.1 Z score values of Risk Variables

Risk Variable	Z score	Accept/Reject	Risk Variable	Z score	Accept/Reject
River Flow	1.98	Accept	Exchange rate	-10.28	Reject
soil erosion	2.37	Accept	Delay of supplies of technology, buildings and/or raw material	3.16	Accept
precipitation	1.19	Accept	Approval by authorities	2.77	Accept
construction time	2.37	Accept	Financial resources	3.16	Accept
Competency	-12.25	Reject	clearance	2.77	Accept
Budget Construction	3.16	Accept	Relocation	3.16	Accept
Cost Overrun	-7.51	Reject	Human factor	-12.65	Reject
machinery	2.77	Accept	local Community	1.19	Accept
breakdown	-2.37	Accept	Relocation cost	-9.49	Reject
Preventive maintenance	-12.65	Reject	Employment	1.58	Accept
Regulatory	3.16	Accept	Tourist Places	1.19	Accept
clearances	3.16	Accept	dam site	-10.67	Reject
Electricity Price	1.19	Accept	Tourist Revenue	0.40	Accept
System procedures	-8.30	Reject	flora and fauna	1.19	Accept
Competitors	-12.65	Reject	Financing	2.37	Accept
evaluation techniques	2.37	Accept	Interest rate	0.00	Accept
Financial Resources	3.16	Accept	tax rate	1.19	Accept
generation	1.98	Accept	inflation rate	1.58	Accept
Public private partnership	2.77	Accept	Climate	-0.40	Accept
terrorism	0.00	Accept	Noise pollution	0.79	Accept
Communication	-11.46	Reject	drinking water quality	0.40	Accept
Fund Blockage	0.79	Accept			

The risk variables which come out from study has been validated using Z_{score} values which lie between -3 to +3 values and the result is validated using table 1.

5. Conclusion

This paper identifies and classifies investment related risk in small hydro power sector through literature and finally validates it using discussion with experts. The main challenges facing the sector in the 21st century were identified and the effects of these changes on the Uttarakhand small hydro power sector were examined. This highlighted the growing complexity of the business environment of those investors associated with small hydro power projects that has prompted increasing interest in risk assessment for decision analysis in the sector. The chapter showed how there has been limitations in the recent studies into current practice in risk identification in small hydro power projects and henceforth understand the need for a study to investigate investment decision in the small hydro power projects.

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