UNDERSTANDING THE GOVERNANCE OF MICRO AND MINI HYDRO PROJECTS IN UTTARAKHAND

Major Project Thesis

Submitted by

NITISH KANETKAR

For the partial fulfilment of the

Degree of Master of Technology in
RENEWABLE ENERGY ENGINEERING & MANAGEMENT

Submitted to
Department of Energy and Environment
TERI University

June 2017

ABSTRACT

The aim of the study is to understand the governance of micro and mini hydro project operations in Uttarakhand. The total potential of SHP in India stands at 19749MW and out of which only 3803MW has been exploited. India has pledged to achieve 175GW of renewable energy capacity by 2022. Out of this, it is targeted to reach 5GW of renewable energy through Small Hydro Projects (SHPs). The SHP potential of Uttarakhand amounts to 9% of the countries potential. Exploiting the Uttarakhand's potential can significantly contribute to the national target. In the 12th plan, the government had proposed SHP development at a rate of 250MW/year. Some analysts also estimate that even with capacity addition rate of 600MW/year the government will not be able to exploit the full potential. All these figures and targets are excellent but, the commissioned projects must be sustainable, and they must continuously contribute to the society. Along with technology, even deliberations must happen on the topics like administrative aspects, the effect on local livelihood and users' ability to use power; thus enriching the governance of the sector.

Presently Uttarakhand has 101 SHPs and out of which 78 are Micro and Mini hydro projects. In these 78 projects, 77 are owned by government agencies, and a majority of them operate in the decentralised mode. Presently there are three administrative models. To understand the governance of MHPs different models of project administration were studied by visiting the sites and by conducting semi-structured interviews with stakeholders. The reviewed projects were assessed using SWOT analysis.

Keywords: SHP, MHP, VEC, livelihood, administration, benefit-sharing

DECLARATION

This is to certify that the work embodied in this report "UNDERSTANDING THE GOVERNANCE OF MICRO AND MINI HYDRO PROJECTS IN UTTARAKHAND" is an original work carried out by me and has not been submitted anywhere else for the award of any degree.

I certify that all sources of information and data are fully acknowledged in the project thesis.

NITISH KANETKAR

Date:21.06.2017

CERTIFICATE

This is to certify that NITISH KANETKAR has carried out his major project in partial fulfilment of the requirement for the degree of Master of Technology in Renewable energy engineering and management on the topic "UNDERSTANDING THE GOVERNANCE OF MICRO AND MINI HYDRO PROJECTS IN UTTARAKHAND" during January 2017 to June 2017. The project was carried out at TERI University.

The thesis embodies the original work of the candidate to the best of our knowledge

Date: 21.06.2017

Kamna Sachdeva.

Dr Kamna Sachdeva
(External Supervisor)
Assistant Professor
&
HI-AWARE Project Coordinator
Department of Energy
and Environment
TERI University, New Delhi

Mr Sapan Thapar
(Internal Supervisor)
Fellow

Department of Energy
and Environment

TERI University, New Delhi

Dr Suresh Jain
Professor & Head
Department of Energy and Environment
TERI University
New Delhi

ACKNOWLEDGEMENT

First and foremost, I am extremely grateful for the invaluable guidance and inputs provided by Mr Sapan Thapar and Dr Kamna Sachdeva. Through their exemplary dedication to work and knowledge, they have always been a source of inspiration. I would also like to express my gratitude to Dr Som Mondal for his continued guidance and inputs throughout the project duration.

I would like to thank Dr P C Maithani for his constructive criticism in the initial stages of my work and also directing me to meet UREDA officials. Thanks to Mr L D Sharma, Mr S S Rawat and Mr Vinod Kumar for their valuable input and time. I would also like to express my heartfelt gratitude to Dr Basudev Prasad for his unreserved support and sharing the contact of his friend and his former colleague Mr Devaki Nandan Purohit. Special thanks to Mr Devaki Nandan Purohit and his daughter Prerna Purohit for directing me to Mr Sameer Gupta.

I wish to extend my gratitude to the faculty at the Department of Energy and Environment, TERI University, especially to Dr Priyanka Kaushal and Dr Naqui Anwer for their guidance and support. I would also like to thank Dr Gopal Sarangi for his inputs.

Thanks to Anand Kumar and Sudeshna Maya Sen for their help in the project.I would also like to acknowledge the financial support provided by the HI-AWARE (Himalayan Adaptation Water and Resilience) team at TERI and TERI University. I am extremely grateful to Mr Sameer Gupta, Mr Mohan Singh Rawat and Mr Yogeshwar Kumar for their time and valuable inputs during my field visit in different case sites of Uttarakhand. I am also indebted to Mr Ashwini Sharma, Mr Jayendra Singh Rawat, Mr Mahendra Singh, Mr Uday Singh Mehta, Mr Uttam Singh Kurunga, Mr Raghubir Singh Rawat, Mr Nagendra Singh Rawat, Mr Madhavendra Rawat, Mrs Basanti Negi, Mr Deenanath Nautiyal, Mr Nathi Singh Negi, Mr Mukesh Panwar, Mr Durgesh Singh, Mr Satish Semwal, Mr Mahendra Singh Negi, Mr Kishan Singh Negi, Mr Prakash Nautiyal, Capt. Siddharth (Indian Army), Mr Dayal Singh Rawat, Mr Prakash Singh Rawat, Mr Virendra Singh Rawat, Narendra Singh Rawat, Ranjeet Singh Negi and Mr Mangal Singh Gujwan for helping me in conducting my field investigations

Finally, this project would not have succeeded without the constant support and motivation of my family. I would like to thank my friends Ashutosh Negi, Sachin Payyanad, Suchitra Subramaniyan, Noor Fatima Zaidi, Jnanabhaskar Rao, Kamna Waghray Mahendra, and Kala Sunil Bada. Last but not the least, heartfelt gratitude to my beloved friend Aditya Kumar Singh for keeping me motivated through his constant encouragement and unflagging faith in my work.

Table of Contents

LIST OF ABBREVIATIONS

BOOT	Build-Operate- Own-Transfer
BOT	Build-Operate -Transfer
CBO	Community-Based Organisation
DISCOM	Distribution Company
GoI	Government of India
HPP	Hydro Power Project
IHR	Indian Himalayan Region
MHP	Mini or Micro Hydro Project
MNRE	Ministry of New and Renewable Energy
NGO	Non-Governmental Organisation
PRI	Panchayat Raj Institution
RES	Renewable Energy Sources
SHP	Small Hydro Project
SNA	State Nodal Agency
UERC	Uttarakhand Electricity Regulatory Commission
UJVNL	Uttarakhand Jal Vidyut Nigam Limited
UPCL	Uttarakhand Power Corporation Limited
UREDA	Uttarakhand Renewable Energy Development Agency
VEC	Village Electricity Committee

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

It is evident from IPCC report(IPCC 2014) that climate change is affecting human life on the earth from all the fronts; energy(especially hydro energy), resources (forests and rivers) and livelihood are getting affected. Indian Himalayan Region spread across 12 states (ENVIS Center on Himalayan Ecology GBPIHED n.d.) is also susceptible to climate change. In these Himalayan states, more than 65% of the area is under forest cover, and it acts as a primary source of income, livelihood for millions of locals and people staying downstream (INCAA 2010); but, this study will only focus on Uttarakhand. Uttarakhand being a Himalayan state is rich in natural resources and dependence on natural resources is significant for livelihoods(Government of Uttarakhand 2014). Climate change impact is pronounced in India, and 12% of the country is flood prone, and in this 12%, Uttarakhand is also one (Government of Uttarakhand 2014). More than three-fourth of the population in the state depends on agriculture for livelihood (Mittal et al. 2008). Owing to geographical and environmental constraints subsistence-based agriculture is practised (Mittal et al. 2008) in the state.

In the face of all these environmental and climate-related uncertainties, energy interventions through hydropower projects shall be considered successful if they bring in positive changes to the livelihood options. It is the responsibility of the government and other stakeholders to ensure the reliability of power projects so that more benefits can be reaped in the process of supporting the livelihood options.

Moreover, there has not been comprehensive study carried out to ascertain the adverse effect on Uttarakhand's energy sector due to climate change and same has been mentioned in UAPCC (Government of Uttarakhand 2014). However, International Energy Agency in its report (IEA 2015) has pitched for developing climate-resilient energy systems. Resilient energy systems are essential for meeting the ever increasing energy demand and economic operations of the power plants(IEA 2015). Besides, it is crucial to frame and follow the best possible administrative models to make power projects a success. Moreover, we believe that these resilient power plants may pave new avenues for livelihood and same will be assessed in the study.

BACKGROUND AND RATIONALE

Total installed power capacity in Uttarakhand is 3719.67MW, and out of which 2451.39MW is from large HPPs (CEA 2017a), which accounts for ~66% of the total installed capacity[1] (see Table 1). In November-2016 the state had 0.6% power supply deficit, and peak power deficit stood at 3.7% (CEA 2016). The state has 3756.4MW of hydroelectric (large hydro >25MW station capacity) capacity under operation (CEA 2017b; CEA 2017c). The difference of ~1305MW in the share of hydropower in installed capacity and operational capacity is an obvious issue of benefit sharing. Surveys conducted at affected villages in Uttarakhand have proven that urban localities are the primary beneficiaries of large HPPs (Buechler et al. 2016). Apart from losing the benefits from the projects, livelihood options (fishery, subsistence agriculture and fodder for livestock) of the local population (project affected families) severely gets impaired (Buechler et al. 2016).

Table 1 Installed capacity of power utilities in Uttarakhand as on 31.01.2017

Ownership / Sector	Thermal (MW)				Nuclear (MW)	Hydro (MW)	RES (MW)	Grand Total (MW)
	Coal	Gas	Diesel	Total				
State	0.00	0.00	0.00	0.00	0.00	1252.15	62.87	1315.02
Private	99.00	450.00	0.00	549.00	0.00	730.00	264.28	1543.28
Central	300.50	69.35	0.00	369.85	22.28	469.24	0.00	861.37
Total	399.50	519.35	0.00	918.85	22.28	2451.39	327.15	3719.67

Source: CEA (CEA 2017a)

At present Uttarakhand has 17998 MW of identified large hydro capacity across 84 sites, and out of which the only 3756.4MW is operational and 2435MW is under construction(CEA 2017b). Uttarakhand stands second in hydroelectric power potential in the whole of India(CEA 2017c). In Uttarakhand when both large and small hydro put together, the total potential will be ~20000MW.

Small hydropower potential

India has an ambitious target of setting up 175GW of renewable energy by 2022. Out of 175GW, it is aimed to achieve 5GW through SHPs(MNRE 2017a). India has a total of 19749.44MW of SHP potential spread across twenty-nine states(MNRE 2016a). Out of the total capacity, the agencies concerned (both

[1] Installed capacity includes allocated shares in joint & central sector utilities

government and private) have been able to harness only 3803.68MW (MNRE 2016a). Also, Uttarakhand stands third (see Figure 1) at the national level with a capacity of 1707.87MW, out of which the only 174.82MW has been harnessed(MNRE 2016a); which gives a tremendous opportunity for developing the untapped potential. The SHP potential of Uttarakhand amounts to 9% of India's SHP potential (see Figure 2), which is a sizeable share when we look at the national target.

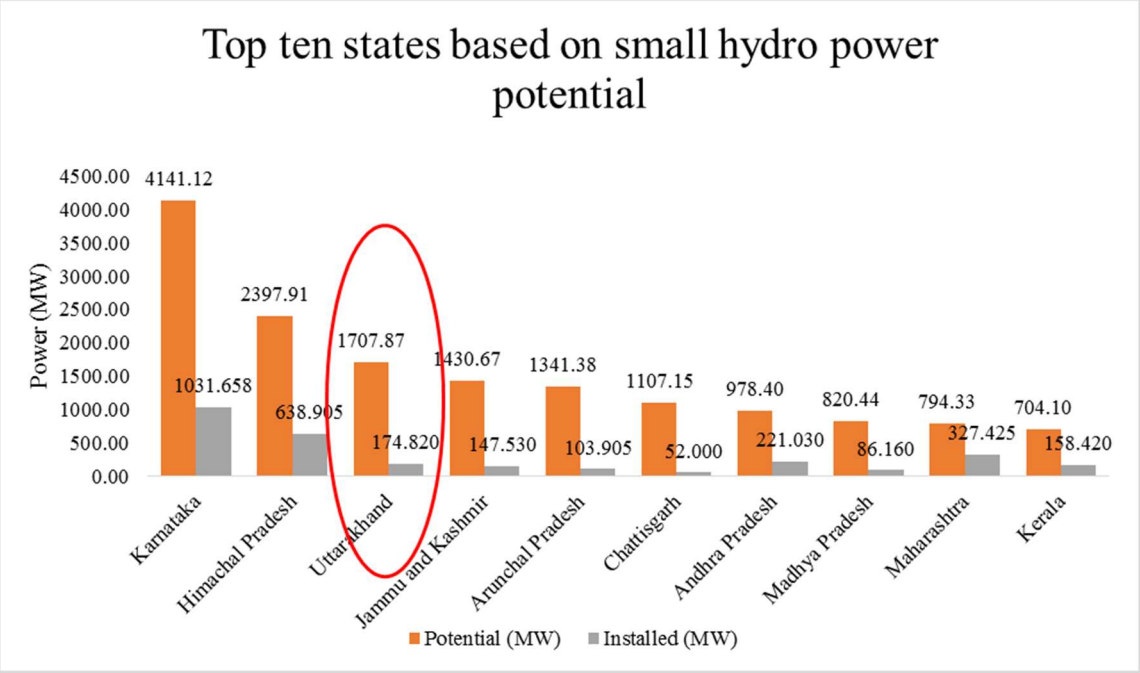

Figure 1 SHP status in top ten states of India

As per the MNRE, small hydropower projects are subdivided into three categories namely, mini, micro and small hydro (See Table 2) power based on the installed station capacity (MNRE 2016b). In Uttarakhand, the state's nodal agency for renewable energy development UREDA has installed mini and micro hydropower projects as a measure for electrifying villages and hamlets. As per the report by UREDA, forty-four MHPs amounting to 4.29MW (UREDA 2016; UREDA 2014) are owned by them. This decentralised generation has helped in electrifying more than 300 villages.

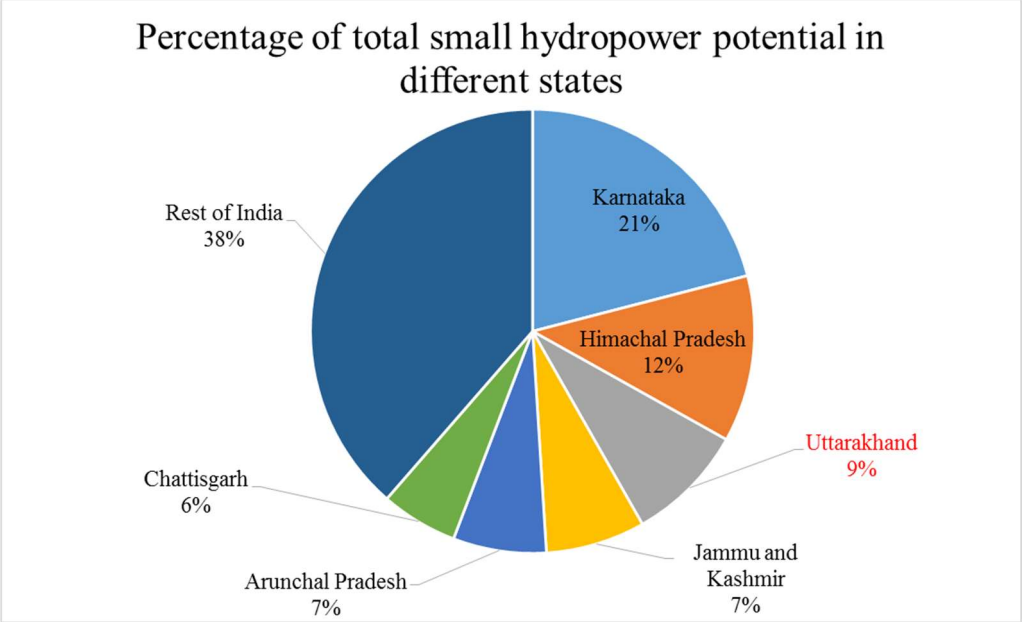

Figure 2 Share of SHP potential

Table 2 Categories in SHP

Class	**Generating capacity in kW**
Micro hydro	<100
Mini hydro	101 to 2000
Small hydro	2001 to 25000

Renewable Energy in Uttarakhand

Uttarakhand has a total of ~327MW of installed renewable energy out of which ~209MW of power is from SHPs. This contribution shows the dominance of small hydro potential in Uttarakhand (see Table 3).

Table 3 Installed renewable energy capacity in Uttarakhand

Resource	**Installed Capacity (MW)**
Solar	45.10[2]
Wind	0[3]
Small Hydro (<25MW)	209.32[4]
Bio-power	72.72[5]

Source: Reply to RTI query and MNRE Annual Report 2016-2017

[2] As on 28.02.2017; Source: Information got through Right To Information Act 2005
[3] As on 20.02.2017; Source: Information got through Right To Information Act 2005
[4] As on 31.01.2017; Source: Information got through Right To Information Act 2005
[5] Date up to 31.12.2016; Source: MNRE annual report 2016-2017 (MNRE 2017b)

Impetus and assistance from central government

As already mentioned out of 20000MW total SHP potential only 3803MW has been realised, and MNRE had the aim of achieving 7000MW by the end of the twelfth five-year plan, i.e., by March 2017. However, as per the annual report of MNRE, only 4334MW was established as on 31st Dec. 2016(MNRE 2017b). The MNRE is aiming to realise at least 50% of the potential in next ten years (MNRE 2016b). MNRE is promoting MHPs by providing financial assistance in every stage of the project (MNRE 2016a; MNRE 2014) (see Table 4). However, the MNRE directs MHP developers to bear a minimum of 10% of the project cost on their own. For developing MHPs, SNA will receive 1% of the total subsidy or a minimum of ₹25,000/- as service charges if the SNA is not the owner of the project (MNRE 2014). If an NGO is installing the project, then the service charges have to be shared between the NGO and UREDA in 50:50 ratio.

The central financial assistance is available for only those MHPs which are being developed by

- State government department
- SNA
- local bodies
- Co-operatives
- NGOs
- Tea garden and
- Individual entrepreneurs

Table 4 Central financial assistance available for MHP

Sl. No.	Stages of the MHP	Central Financial Assistance
1	Identification of new sites, preparation of plan and DPR[6]	₹6,00,000/-
2	Setting up of MHP[7]	₹1,25,000/- per kW
3	For renovation and modernisation of existing MHP[8]	₹10,000/- per kW

[6] Applicable to government departments & agencies of central/state/union territories or local bodies in state or union territories(MNRE 2014). This financial assistance is the maximum amount that can be availed for the preparation of DSI and DPR for projects up to 1MW capacity.

[7] Applicable to state government departments/SNAs/local bodies/co-operatives/NGOs/tea garden and individual entrepreneurs

Inaccessibility of the project location increases the project cost. Some power projects are located in such a remote places which are as far as ~12km from motorable roads. Delivering heavy equipment like transformers to such remote locations by foot makes the project dearer. For example, 250kVA transformer weighs up to 400kg. In Uttarakhand, it costs up to INR70000/- per kW. The cost of the project varies from the site to site, and it depends on load to be carried and the distance to be traversed by foot.

Technical aspects of micro and mini hydro projects

Table 5 mention the key elements of an MHP and their functions. Figure 3 shows the pictorial representation of a typical MHP.

Table 5 Key elements of MHP and their functions

Elements	**Function**
i. Intake or diversion	To divert water into the channel
ii. Desilting tank	To settle silt and other trash from diverted water
iii. Power Channel	To carry water to forebay tank and make the flow laminar
iv. Forebay tank	To act as a short term storage and absorb flow variations during load variation
v. Penstock and	To facilitate flow of water from forebay to turbine and to withstand high-pressure variation
vi. Turbine & Generator	Turbine acts as the prime mover, and the generator converts mechanical energy into electrical energy.

Irrespective of the size of the project the elements mentioned above are must for operating a hydropower project. The expression P=ηρQgh can give the power output of the generator. Where ‘P' is the power output from the generator in watt (W), ‘η' is overall efficiency of turbine and generator, ‘Q' is flow rate of water through turbine in m^3/S, ‘g’ is acceleration due to gravity in m/S^2 and ‘h’ is the net head on turbine. Head is nothing but the vertical distance between intake and turbine.

[8]The project must be commissioned for a minimum of seven years before submitting the proposal to the ministry (MNRE 2016a; MNRE 2014).

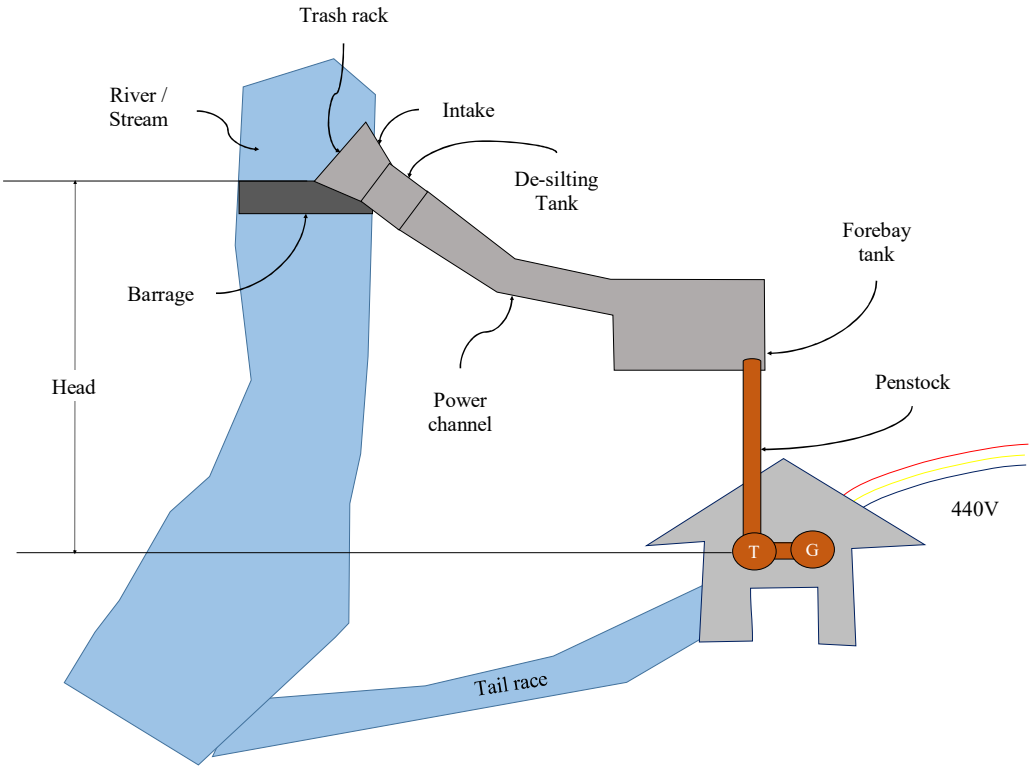

Figure 3 Pictorial representation of an MHP

Depending on the head available at the site, a suitable turbine is selected. If the head is very high Pelton wheel is used, Francis turbine is used for medium heads and Kaplan for low head projects.

State agencies in Uttarakhand for development of MHPs

Uttarakhand state was formed on 9th November 2000 (UREDA 2017b). UJVNL came into existence on 12th February 2001 (UJVNL 2017), and since its inception, all hydropower projects in the state were under its purview. Even though UREDA was established in the same year i.e. in July 2001, it was at the state government's discretion to allot new SHPs either to UREDA or UJVNL. At present, when it comes to developing or felicitating an MHP, undoubtedly UREDA is the nodal agency, and it is evident from the following mentioned reasons.

- UREDA being the state nodal agency of MNRE, it is vested with the responsibility of deploying renewable energy projects in the state(UREDA 2017a). Hence MHPs do come under its purview, and

- The government of Uttarakhand's policy on developing mini and micro hydro projects up to 2MW-2015 indicates UREDA as the nodal agency for MHPs development (Government of Uttarakhand 2015).

After the implementation of new policy in the year 2015, it has become clearer that UREDA will be responsible for developing hydro projects up to 2MW capacity. However, the role of UJVNL cannot be neglected, and it remains as a primary nodal agency for hydropower development in the state, and it is currently operating projects varying from 200kW to 376MW(UJVNL 2017). However, on the orders of Uttarakhand government UJVNL has transferred many projects with station capacity lesser than 3MW to UREDA. The following mentioned order is one among those orders.

- The government of Uttarakhand's order no. 1311/I/2012-03/17/2012 dated 07.11.2012 to transfer 32 SHPs up to 3MW capacity from UJVNL to UREDA(UERC 2016a)

Presently in Uttarakhand new MHPs can be installed under 'Policy for the development of micro & mini hydropower projects up to 2 MW-2015[9]'. Before the formulation of this policy MHPs were installed under,

i. Uttarakhand Policy on hydropower development by the private sector (up to 25MW).
ii. Uttarakhand policy for renewable energy sources with the private sector and community participation-2008.

Most of the MHPs in the northern districts of Uttarakhand are developed keeping in mind the social welfare of the communities, and the government does not focus on the economic benefits from those projects. It is the responsibility of the government to fulfil the basic need of the society and check the emigration from remote rural locations to urban setup. Presently DISCOMs of the state have managed to reach the far remote places; hence the communities are preferring grid power over decentralised MHPs. This expansion of grid network in the state

[9] Salient features of the policy are listed in Table 9 in ANNEXURE

has also led the development of more and more grid feed MHPs rather than a decentralised one[10].

Different models of MHP administration

MHPs in Uttarakhand operate under four different administration models (See Figure 4). In Uttarakhand presently there are 101 SHPs, out of which 78 are MHPs (AHEC 2016). Among those 78 projects 77 are owned by state government agencies (see Figure 5). Because of this reason, this project will focus on model II and III. Currently due to extensive privatisation model IV has become obsolete. Case studies of II and III models each are discussed in the RESULTS AND DISCUSSION section of the report.

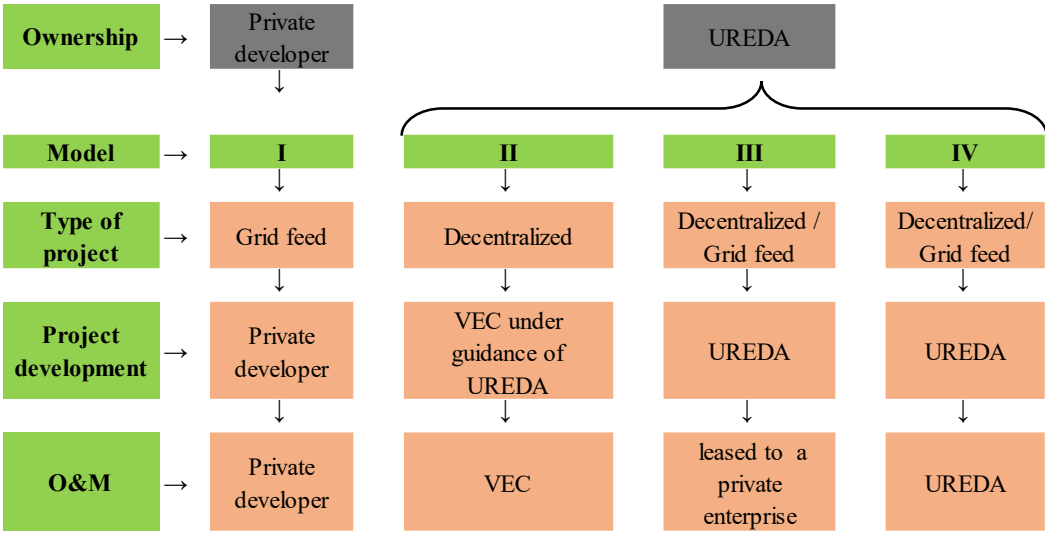

Figure 4 Different models of MHP administration

When we look at projects under private ownership (see *Figure 5*), it can be easily observed that private players are more interested in SHPs(>2MW). As already mentioned, Majority MHPs operate in decentralised mode and provide electricity to remote locations where loads are considerably less. Contrary to these MHPs, SHPs can fetch more benefits to the owner, and they are installed in grid feed mode. Capacity utilisation is maximised in grid-feed projects when compared to decentralised projects.

[10] The information mentioned in the paragraph was collected through semi-structured interview of official at UREDA, Dehradun on 02.03.2017

Capacity → / Owner ↓	Micro hydro projects (<100kW)	Mini hydro projects (100kW to 2MW)	Small hydro Projects (2MW to 25MW)	Total
UREDA or UJVNL	44	33	9	86
Private	0	1	14	15
Total	44	34	23	**101**

Figure 5 SHPs of Uttarakhand across different categories and ownership

Significance of BOT and BOOT models

Be it be any power projects they are established either in BOT model or BOOT model. The government agencies own more than ninety percent of the projects. Initially, the SNA submits PFR to the MNRE, if the MNRE accepts the proposal they will give go ahead for the DPR. Usually decentralised projects which are operated by VEC are developed on BOT basis. Whereas the projects which are solely developed by UREDA at locations where there is an availability of grid but, the government wants to develop the project for the sake of utilising the resource (river or stream) are developed in BOOT model. Also, the projects which are solely developed by private developers are established in BOOT model. VECs lose their existence once the grid reaches the village. Also, VECs are not formed to operate and maintain the projects where there is already grid has reached.

There are two modes of project operation, one is the decentralised mode, and another is grid connected mode. In the case of decentralised mode, the government decides to provide the electricity supply to a village or hamlet using local resources and hands on the project to VEC.

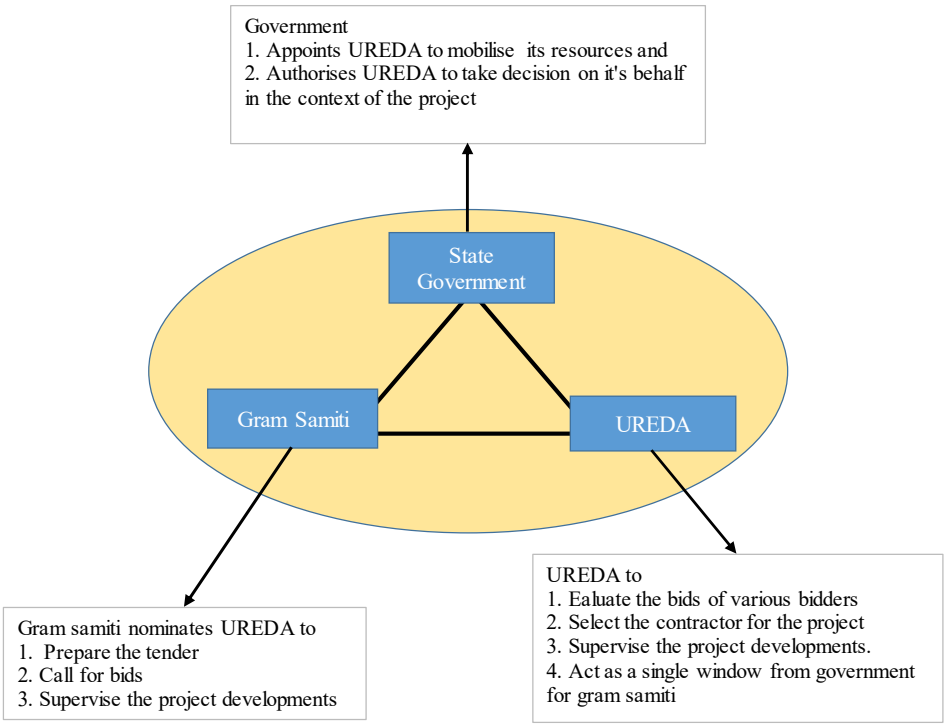

Figure 6 Tripartite agreement before the development of decentralised projects for VECs

VEC consists of local elected members, appointees of Gram Pradhan and Kshetra Pradhan and operator of the project. In these decentralised projects, the government helps VEC to arrange for funds and helps the village to get the electricity supply.

The government, UREDA and the VEC enter into a tripartite agreement (see figure 6) where UREDA does the job of preparing tenders and receiving bids on behalf of the VEC. UREDA acts as a consultant to VEC and as a watchdog for project developments. AHEC being the working agency of the government prepares the DPR for government's MHP's and SHP's. Contractors involved in establishing the projects are supposed to get all the machinery/equipment approved from AHEC.

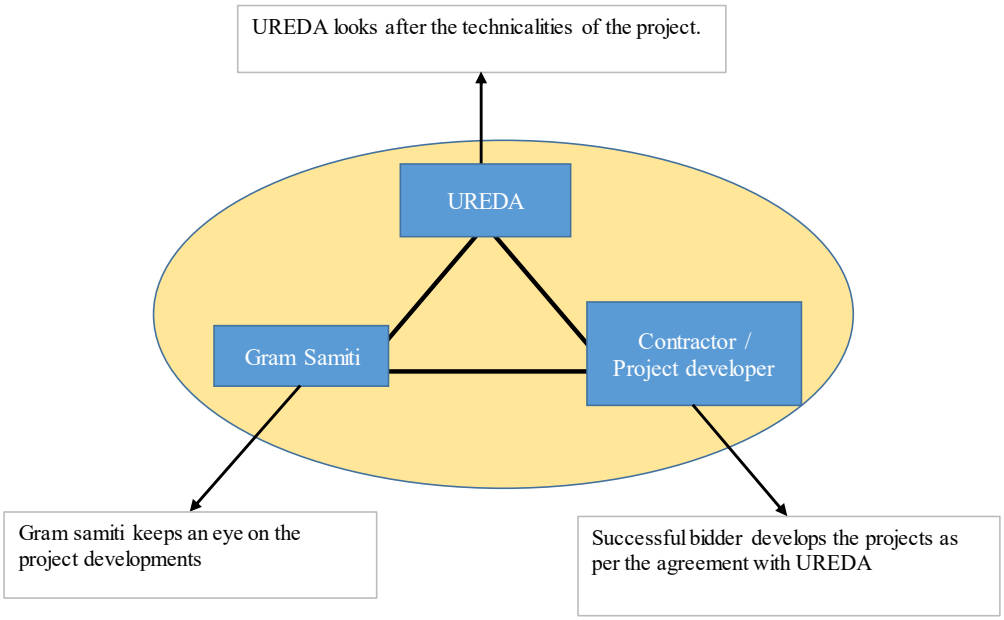

Figure 7 Tripartite agreement during project development of decentralised projects for VECs

Operation and maintenance of the MHP can be looked after by any one among the following three, UREDA or Lessee or VEC. In VEC maintained projects, UREDA does the job of supervision. Officials of UREDA notify the VEC if there are any problems. In VEC operated projects VEC has to arrange the funds for maintenance. VEC is empowered to collect usage charges from beneficiaries. This collected money is utilised to pay the salaries of operators and to pay for regular wear and tear. If there is any major failure, then VEC approaches UREDA for financial help, at this situation UREDA supports VEC by acting as a single window to get the funds from various sources available. UREDA is entitled to listen to the grievances of the VEC. It is even recommended for VECs to have engineers in their team but, it proves to be expensive for VEC to pay them, so they are not appointed. The VEC itself regulates the tariff of VEC operated projects.

Renovation and modernisation projects

At present, there are many renovation and modernisation projects which are offered to a lessee in two schemes. In first scheme the lessee is offered the project in ‘as is where is' condition. For example, even if the power channel of the project is damaged, it will be handed over in the same condition. The lessee

has to arrange the funds for repair and maintenance. As the lessee has spent the money on repairing the project, the lessee will be offered the higher rate for initial three years so that the lessee gets back his investment as soon as possible.

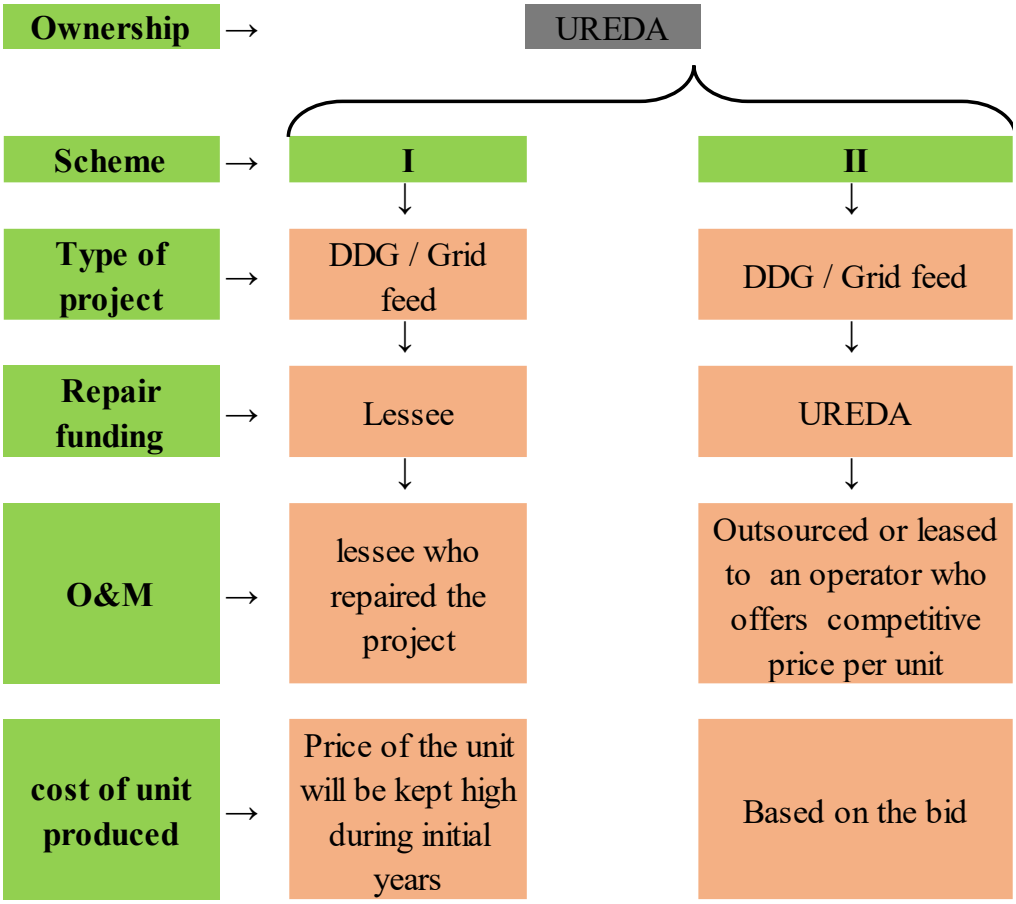

Figure 8 Schemes for renovation and modernisation of projects

Also, the project will be leased for longer periods like 20 or 30 years. In the second scheme, UREDA arranges the fund for repair and maintenance and releases the tender for the repair work. Once the plant is repaired a separate tender will be released for operations of the project. The first scheme was not successful as the contractors who are involved in MHP business are not that financially stable where they can bear the enormous investment in crores.

Dynamics of governance and its relevance

Governance of natural resources can be understood as representing the mechanisms through which decisions are made on allocation and management of resources. It reflects the processes of the community, state and market - the role of different organisations and institutions in governing these resources. When we read good governance, we majorly sub-vocalize – "Accountability",

"Transparency", "Effectiveness", "Efficiency", and "Participation". For instance, if one were to examine small hydro resource exploitation in China, according to conventional indicators (e.g. capacity utilisation) they would appear equal to or better than those of India. If we take transparency as a concern, however, then India would be better off as the governance processes are not inclusive of stakeholders in China. The study concludes that MHP's governance is not directly linked to outcomes. Further, definitions of governance may be subjective corresponding to the objectives of the concerned actor.

This report focuses on local institutions - the norms, practices and codes of conduct that shape people's relationship with and access to resources, and situate this analysis within the larger discourses on and understandings energy governance.

Governance is usually rationalised as a duty or a role of the top level actors in national and international institutions. On the other hand, we fail to understand how governance erupts from the ground. The ground realities serve as the core in understanding the dynamics of resource governance

Aim and objectives

The aim of the project is to assess the MHPs on administrative fronts. As already mentioned, the majority of the small hydro projects in Uttrakhand are MHPs. More than 99% of MHPs are operated and maintained by either VEC or government agencies (UREDA & UJVNL). Government agencies either operate and maintain on their own or lease it to a private operator.

The project will focus on following mentioned objectives.

i. Reviewing the current state of administrative mechanism and functioning of three different projects.
ii. Assessing projects against strengths, weaknesses, opportunities and threats
iii. Assessing the benefit sharing of the projects.

METHODOLOGY AND RESOURCES

At present for the development of SHPs technology is not a deterrent as it is a century old technology in India. In 1897 the first hydro project was established

in India. This project was in hills of Darjeeling, and it was of 130kW capacity (Kesharwani 2006; Mishra et al. 2015). Whereas Qualitative aspects like policies, business models and instruments for financial assistance are to be subjected to more deliberation. For making decisions on energy systems for an isolated or rural community, details from all fronts say, social, financial and technology are crucial. The dearth of credible information on financial and technical aspects in rural locations has resulted in a failure of energy installations (Henao et al. 2012). Moreover, merely the financial and technological perspectives are not enough for developing a sustainable energy system (Henao et al. 2012).

There have been many analysis and ambitious targets on capacity addition front. However, this endeavour of capacity addition has to be complemented with strong policy and administrative framework As per an analysis even with the capacity addition of 600MW/year, India will not be able to tap the full small hydro potential of 20000MW(Mishra et al. 2015).

Stakeholder interviews and visits to projects (MHP) are done to collect the realistic data about the changes brought in after the establishment of the project, to make the study complete and holistic.

The purpose of the field visit.

As per AHEC's report, there are 101 commissioned SHPs in Uttarakhand out of which more than 20 projects are not in working condition (AHEC 2016). Reasons behind this failure can be many, and there is no mention of it- climate change related disasters are also the reason behind it. Even after the strong policy impetus in the country and state, it is difficult to see what impediments stalled these projects. For successful operation of the project, there has to support from all the stakeholders, and it must be a performing well from all the fronts say, technical, institutional, ecological and most importantly financial. Based on the policy and literature review it appears that the existing rules and regulations are very supportive. The current policies are drafted by keeping in mind the easing of the participation of private developers, PRIs, and CBOs.

The field visit is done to verify the policy impetus by meeting different stakeholders and conducting semi-structured interviews. MHPs are operated

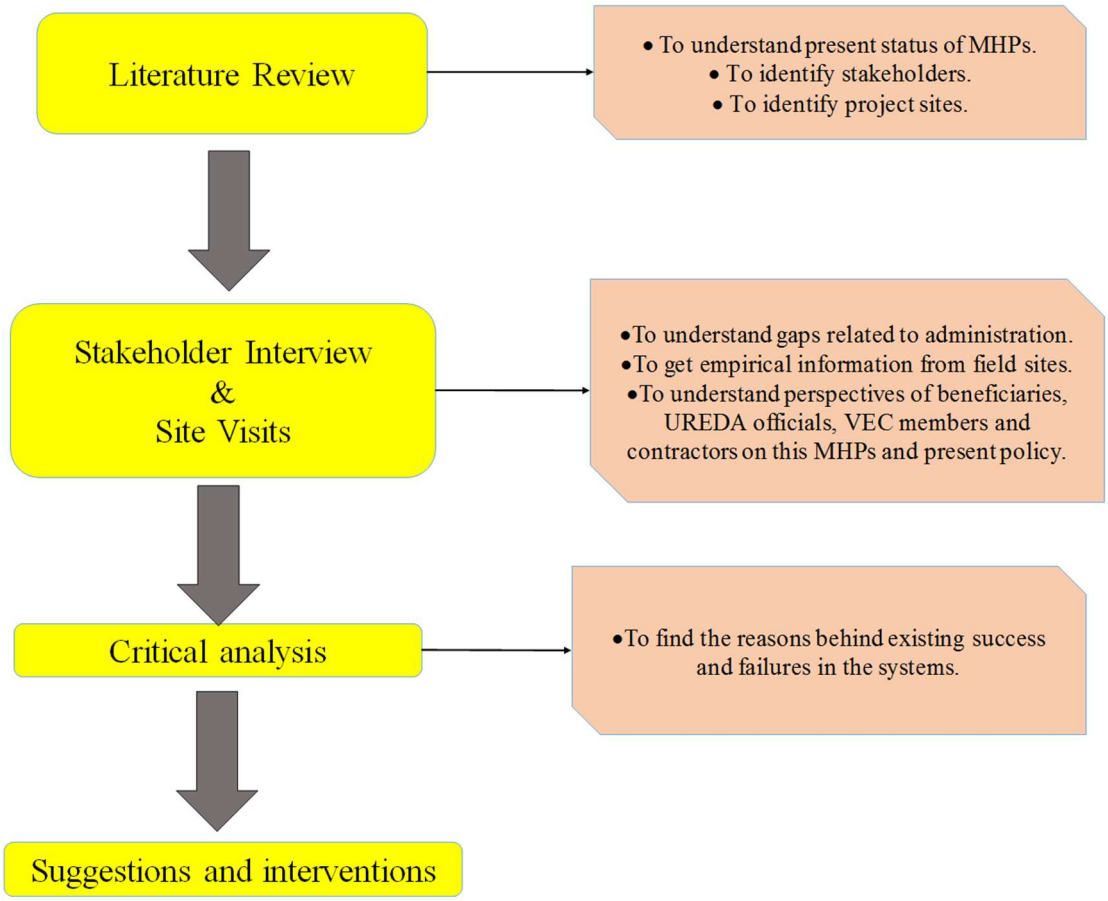

Figure 9 Methodology followed in the project

under different administrative models as mentioned in the previous sections. One case from each administrative model (except privately managed model), i.e., two projects, are studied to understand the governance of UREDA owned MHPs. Besides these two projects, one multipurpose micro hydro project is studied to understand benefit sharing of the hydro resource among the locals. Finally, a comparison will be made among all studied projects to find out which model performed better and why.

RESULTS AND DISCUSSION

This section consists of the practical information collected from field visits and qualitative data gathered from stakeholder interviews. As already mentioned in the methodology, perspectives of different stakeholders on 'Policy for the development of micro & mini hydropower projects up to 2 MW-2015' has been

presented in this section. In the field visit, three project sites were visited (See Table 6).

Table 6 Specifications of projects visited

Project	**Harsil**	**Gulari**	**Rampur**
Capacity	2 X 100kW	2 X 100kW	6.5kW
Established in	1965	2000	2014
River/stream	Kakora gaadh	Nandakini	Kaladhungi
River to which the stream joins	Bhagirathi	Alaknanda	Mandakini
Owned by	UREDA	UREDA	Five-member group
Operated by	Sam Enterprise	VEC	Five-member group
Mode of operation	Decentralised	Grid feed	Decentralised/Captive use
Turbine	Pelton wheel	Francis	Crossflow
Head	110m	44m	5m
Flow	0.26 m^3/S	0.891 m^3/S	0.06 m^3/S
Generation Voltage	440 V	440 V	230V
Threshold generation	5,09,000 kWh	Not applicable	Not applicable
Transmission voltage	11kV	11kV	230V
Metering	Net metering	Net metering	NA
Consumer	Three villages (Harsil, Mukhava & Dharali)	Gulari, Ala, Bura, Baduk, Jokhna, Sitel, Ghuni[11]	One dhaba
Make of turbine and generator	Jyoti Limited	Jyoti Limited	Custom designed turbine and Kirloskar generator

[11] Loads of these were the villages were met when the project was operating decentralised mode from the yeara 2000 till 2013

Harsil 2x100kW Mini Hydro Project

Harsil is a village in Uttarkashi district of Uttarakhand (see Figure 10) on the way to Gangotri (Gangotri is one among the famous pilgrimage sites of Hindus). Harsil MHP was established in the year 1965 by then Irrigation Department of Uttara Pradesh. The project was set up to support tourism, pilgrimage (at Gangotri) and to meet the demands of the locals, as extending the grid supply to the location was a big challenge. During the initial days, the project was supplying power to nearby eight villages. As this area is bordering China, in 1966 Indian army battalion was stationed there. Even army's power demand was met with this project. At present, the project is owned by UREDA, and it has been leased out to a private operator (Sam Enterprises) for operations and maintenance. The MHP at Harsil has two machines of 100kW each. The project caters to nearby three villages namely Harsil, Mukhava and Dharali. Among two machines one is dedicated to Harsil and the second machine caters power to Dharali and Mukhava. Comparatively, load at Harsil is more as it houses the Indian army battalion. Load of Harsil crosses the rated capacity of 100kW in the peak season.

Grid reached Harsil in the 1980s, but till date, the project has not been synchronised with the grid. Harsil uses the project as a backup. If grid power gets interrupted, Harsil is powered by the MHP. The project has been kept operational because of the other two villages, Mukhava and Dharali solely depend on it. Residents of Mukhava and Dharali consider this project as a reliable option when compared to grid power. As per the information provided the residents, the grid is unreliable as the substation is 75km away and transmission line passes through difficult terrains and dense forest. Especially during winters snow fall worsens the grid supply condition. Fixing faults and reinstating power supply takes time in days and sometimes in weeks. When the grid supply is interrupted the Harsil MHP feeds the nearby villages in decentralised model

Sale of power and stakeholders involved

Distribution of power in these villages is looked after by UPCL, and it is empowered to collect charges from the users. The contractor who operates the project is paid by UREDA on per unit basis and UPCL purchases power from

UREDA. The contractor is mandated to produce certain units of energy in a year, and it is based on the average of units generated in past years.

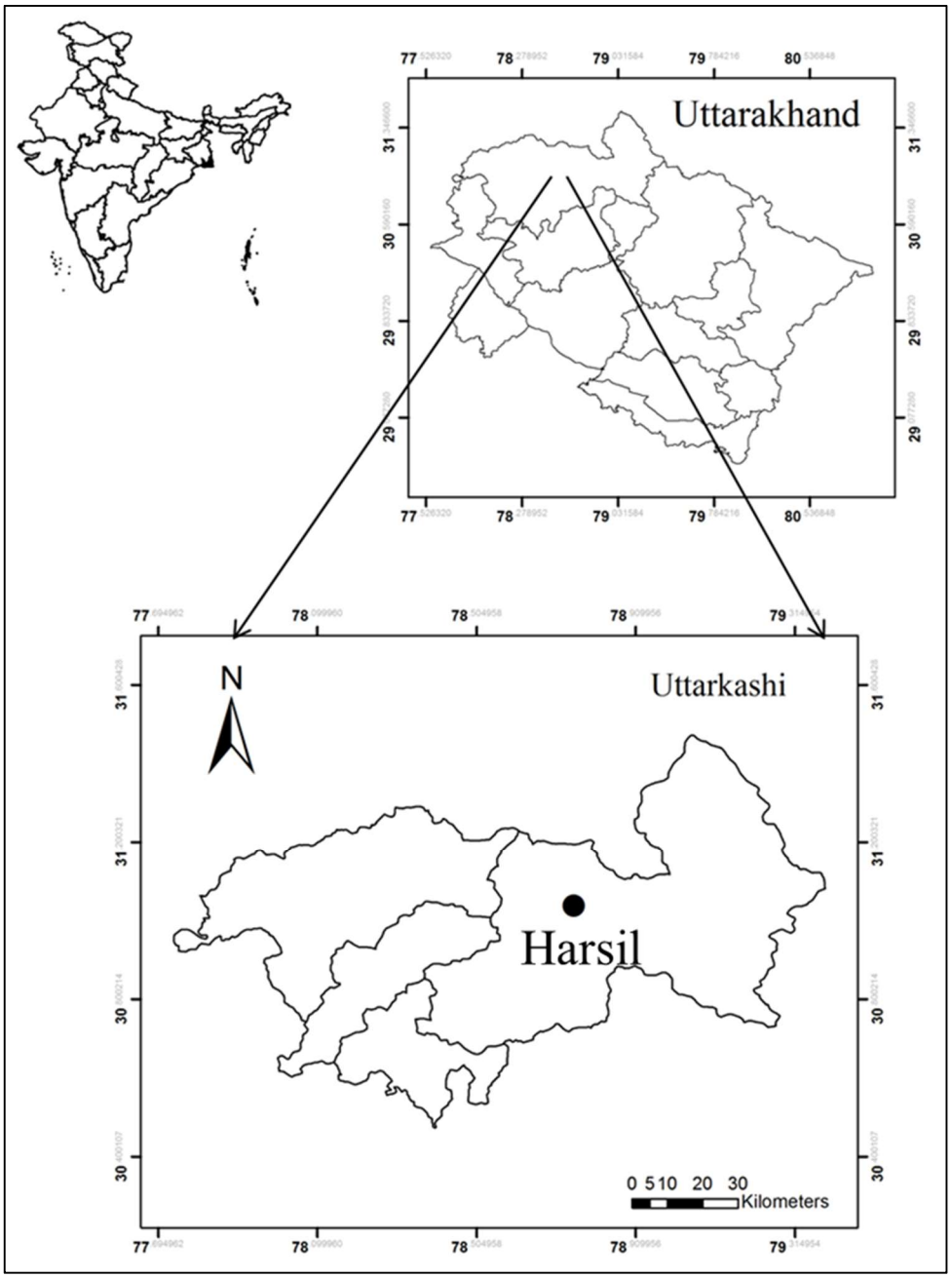

Figure 10 Location of Harsil

Projects which are leased out to a private lessee/contractor PPA is signed between UREDA and UPCL, and UERC regulates it. There will be two agreements, one between UREDA and the lessee and second one between UPCL and UREDA (see Figure 11 Stakeholders and agreements in projects maintained by private operator Figure 11). In leased projects, only the caution money of the contractor is at stake, which the lessee will get back once the agreement terminates.

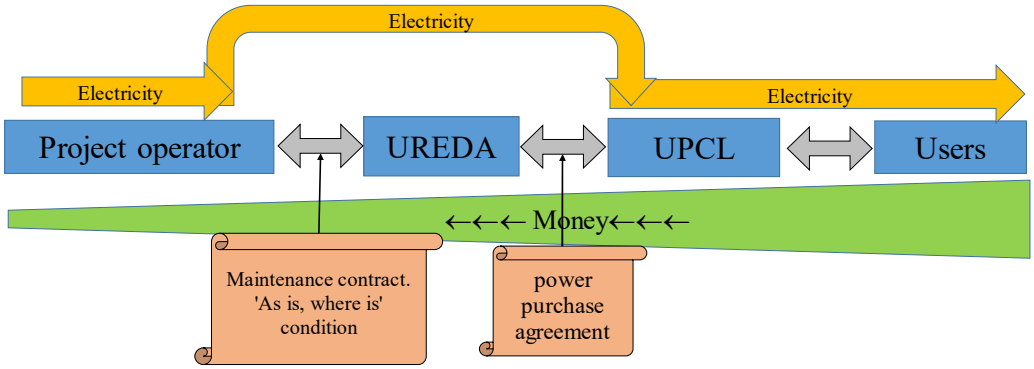

Figure 11 Stakeholders and agreements in projects maintained by private operator

Presently in Uttarakhand, the average cost per unit in domestic sector is ₹3.56/- (UERC 2016b). In the Harsil project, the lessee gets ₹0.90/- per unit of electricity fed into the UPCL distribution network. The remaining amount, i.e., ₹2.66/- is shared among UREDA and UPCL as per the power purchase agreement.

Challenges in the project

Currently, it is planned to synchronise the project to the grid and once it is done the project can utilise the capacity to its maximum. At present even machine to machine synchronisation is not done the project. The project has two generators, and both have separate circuits; one machine supplies to Mukhava and Dharali whereas another machine is dedicated to Harsil. The powerhouse has bi-directional meters (trivector meters) and project exports electricity to the transmission line at 11kV.

In the present year i.e. in 2017, the sale of electricity came down as grid supply was reliable. This reduction proves that the capacity remained underutilised and the operator incurred losses. This business model at Harsil is a challenge where grid supply and decentralised operation of the plant are independent of each other. Income of the operator increases when the grid fails and even the theft from distribution lines increases contractor's income. Hence running the project in a decentralised mode where grid supply is already available is not a good business model as it is not a win-win situation. As the machines are not synchronised with each other load distribution has become a challenge. One machine remains underutilised, and other machine gets overloaded.

Picture 1 Inside the powerhouse Harsil MHP

Picture 2 Growth of plants and grass on forebay tank of Harsil MHP

Overloading of generator results in lower voltage and thus deteriorating the service quality. Adding to the problems are the faulty controls panels at the power house which show erroneous values.

Issues with water flow

Contrary to apprehension even in winters water does not freeze because it is flowing water. Channel blockages are caused because of snowfall, harsh winds and falling of trees in the intake structure. During summers and rainy season silting will be an issue. As the power channel is open, it is prone to accumulation of dry leaves and other plant matter which will clog the trash rack near the forebay.

Picture 3 Tailrace of Harsil MHP joining Bhagirathi river

Effect on livelihood

Presently three people are employed in the project. This MHP provides only the service (electricity) and indirectly supports livelihood (hotels and restaurants). The majority of the residents depend on apple farms, potato and rajma cultivation and tourism for their livelihood. All these aforementioned livelihood options are active only during summer and rainy season, i.e. from April to September. Tourism business remains active from May until September because

pilgrims head for pilgrimage at Gangotri. Hotels in these villages are maintained by locals. In the context of earning, tourism business remains lucrative, and it is dependent on electricity. All the needs, comforts and luxuries like lighting, television, water heating and phone charging can be provided only when there is a reliable power supply. Ensuring the reliable power supply from the MHP improves the service quality of tourism business thereby improving the livelihood dependence on it. Mini hydro project in Harsil has supported the hotel business to grow. Some do mention that local economy is money order economy. At least one person from all households has shifted to out in search of employment.

Apple farms, potato and rajma cultivation are not dependent on electricity. Availability of electricity has no direct impact on farming. However the social status of the farmers might have improved but, the power supply has not affected the local agriculture directly. Nevertheless, the intake channel of the powerhouse has helped some farmers to irrigate their apple farms in in Kachora area. Otherwise, these farms would not have been developed, states a local farmer.

Reliability of power supply

The MHP at Harsil was established in 1965, the residents of village those who are in their 30s and 40s say that they never faced any power severe outages. From the day of its establishment, the machines in the plant have not been changed, as stated by the majority of interviewees. When compared to grid power residents feel that the power from Harsil MHP is more advantageous as it is near to users and easily accessible. The street bureaucracy of the MHP (local powerhouse) is much approachable when compared with grid power.

Plant utilisation and load

Load on the plant goes up to a maximum of ~30% to 50% during the day time, and plant remains underutilised. Only in the evening, the load on the plant increases up to 80% to 90% of the capacity. The project is utilised to its maximum only in summers because of the tourism business. However, during winters (after October) migration of the residents reduces the load on the MHP (see Figure 12). Last year i.e. in 2015 UPCL changed distribution cables from bare to insulated type which resulted in checking power theft thus reducing the overloading of one machine (dedicated to Harsil); which improved the voltage

condition. As mentioned earlier, in 1980 Harsil got connected to the national grid and because of this utilisation of powerhouse further reduced. The MHP acts as a backup for Harsil.

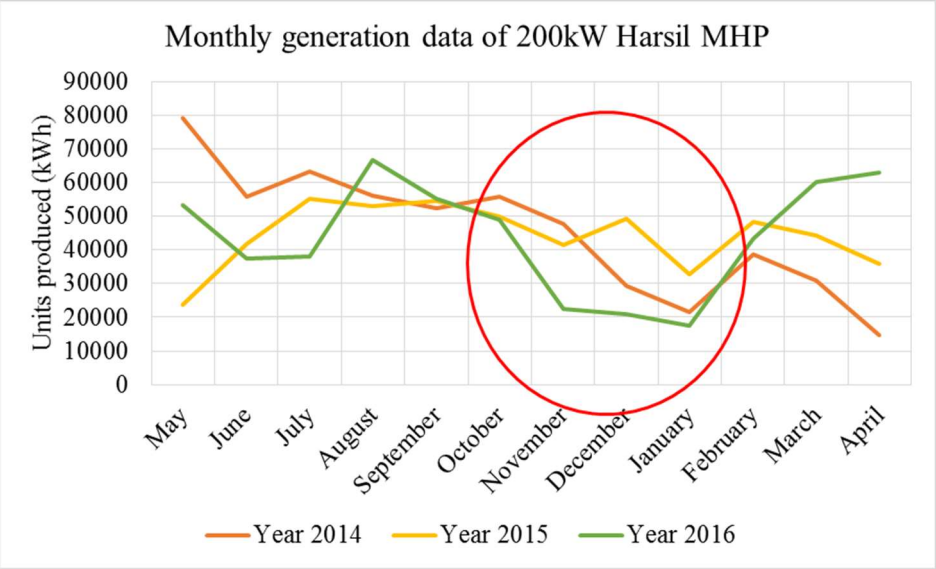

Figure 12 Seasonal variation of load in Harsil MHP

As mentioned in Table 6 the lessee is mandated to sell 5,09,000 units but, to achieve this, there must be an appropriate amount of load. As the project is not synchronised with the grid, powering Harsil with grid supply reduces the revenue to MHP (see Figure 13). in the recent years as the grid is getting stabilised the power sales are reducing from MHP, which is a setback for the lessee.

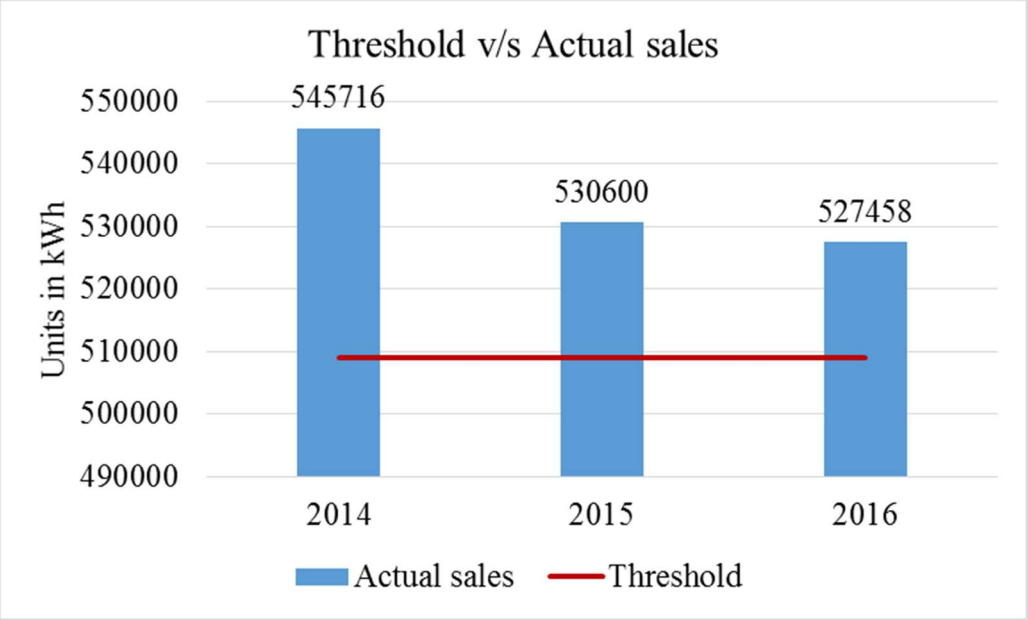

Figure 13 Threshold sales versus actual sales of Harsil MHP

The stream (Kakora Nala) on which the project is built is capable of delivering more power but, upgrading the project is a big task which calls for a huge investment. All the civil structures (diversion, power channel, forebay tank) accessories (penstock, valves, generator, turbine, and transformer) and electromechanical equipment are to be upgraded.

Maturity of technology

Turbines and generators manufactured by Jyoti Limited are considered to be among the best machines ever. As of now the firm is not manufacturing turbines for smaller capacities i.e. <1MW capacity. Identifying reliable turbine manufacturers for MHPs has become a great challenge. If we consider the case of the 'Jyoti' turbines at Harsil, they are the best in class. These machines are operating from 1965; it is more than 50 years. In earlier days there was no competition and Jyoti was only the option, whereas now the competition has increased and because of competitive rates substandard turbines are in the market. Also, turbines' life depends on the quality of water. Cleaner the water better the life of the turbine. In those projects where silt is high turbines life reduces drastically

Community participation

Villagers are very much involved in maintaining distribution lines, especially during winters. In the events like fixing a pole or cable or conducting minor repair works on the channel, villagers get involved. Moreover, Harsil Battalion (Indian Army) also gets involved in major maintenance work as their camp is dependent on the powerhouse.

Presently, the villagers were actively involved in maintaining the distribution line, and they are of the view that communities must help maintain it as they are benefitted from it in their livelihood.

Three years before a local contractor operated the project and he wants that project to be transferred to Gram Panchayat so that the locals get a feel of ownership and it will act a source of income for Gram Panchayat.

Alternative energy options

Apart from grid electricity and electricity from MHP, Harsil village is powered by solar street lights. Residents do feel that this dusk to dawn solar street lights

as a boon because they work irrespective of the grid or MHP's condition. Some residents are also considering of installing grid-connected solar power plants on rooftops. They feel that installing and operating the solar photovoltaic has fewer hassles and also it earns income too. For protecting apple orchards from vermin animals, some villagers want to go for solar energy based electric fencing.

The majority of residents feel that firewood cannot be replaced by any other energy source when it comes to heating the living spaces in the winter season. It is because firewood is available free of cost and electrical room heater add to the financial burden of a household.

Forest officials forbid the villages from collecting firewood, but there is no other feasible option. When it comes to cooking induction stove seems to a clean option, and many restaurants in the villages are using it.

Benefit-sharing

Always decentralised projects are the best solution in the context of benefit-sharing; because decentralised projects benefit local population by utilising locally available resources. Water from hill streams meets drinking water facility in these villages. Contrary to plane regions these villages do not require any water pump for meeting drinking water needs. Water from hill stream is diverted filtered and stored in a tank from which water is distributed to households through the network of pipelines, and Uttarakhand Jal Sansthan maintains it. Similarly, for apple cultivation water from hill streams is utilised. Whereas in Harsil in an apple orchard near the power project water is tapped from power channel. Even though it is illegal has been in place from long, and it is in the process of getting regularised.

For benefit sharing the project has to contribute towards those aspects which aimed at solving the existing problems of the locals. Migration remains a bigger problem here, and just electricity cannot address this issue. Even though the powerhouse shares the benefits, the beneficiaries must also be empowered to utilise that benefits. Unavailability of all-weather roads, good education, and medical facilities forces the habitants to shift to lower altitudes where all these can be accessed very easily.

Migration can be reduced if locals are provided with yearlong employment opportunities in the locality. Because, farming, restaurant and lodges will last only for six months (April to May). Residents do feel that food processing industries like fruit (apple) jam, juice manufacturing and wine brewing industries can be set up to fill this gap. Besides food processing, also match stick production unit can be established owing to the availability of plenty wood.

During 2013's disaster in Uttarakhand the project in Harsil was supplying power to nearby all the eight villages. However, the voltage was very low due to overloading, but the user was able to charge their mobile phone which was a basic necessity at that moment.

Gulari 2x100kW Mini Hydro Project

Gualri is a small village in Chamoli district of Uttarakhand (see Figure 14). Construction of the project at Gulari was started in 1996 by UPNEDA, and it was commissioned in the year 2000. This project was powering nearby nine villages. This project has been operated and maintained by VEC since it is commissioning. In 2013 grid reached the locality, after that, transmission and distribution has been taken care by UPCL. In 2013 the project was synchronised with the grid. Presently the project is stalled completely due to multiple causes like the failure of power channel and turbine failure.

Sale of power and stakeholders involved

Gulari MHP was established with a sole motive of electrifying nearby nine villages and improve the life condition of the locals. As a majority of residents of these villages belong to economically weaker section usage charges were fixed based on the number of bulbs in a household. In this project, VEC was dependent on two sources of funds, fees paid by users and funds from URED (see Figure 15). Unlike Harsil MHP here in Gualri UREDA does not earn any income from the project. Instead, UREDA supports VEC by providing funds.

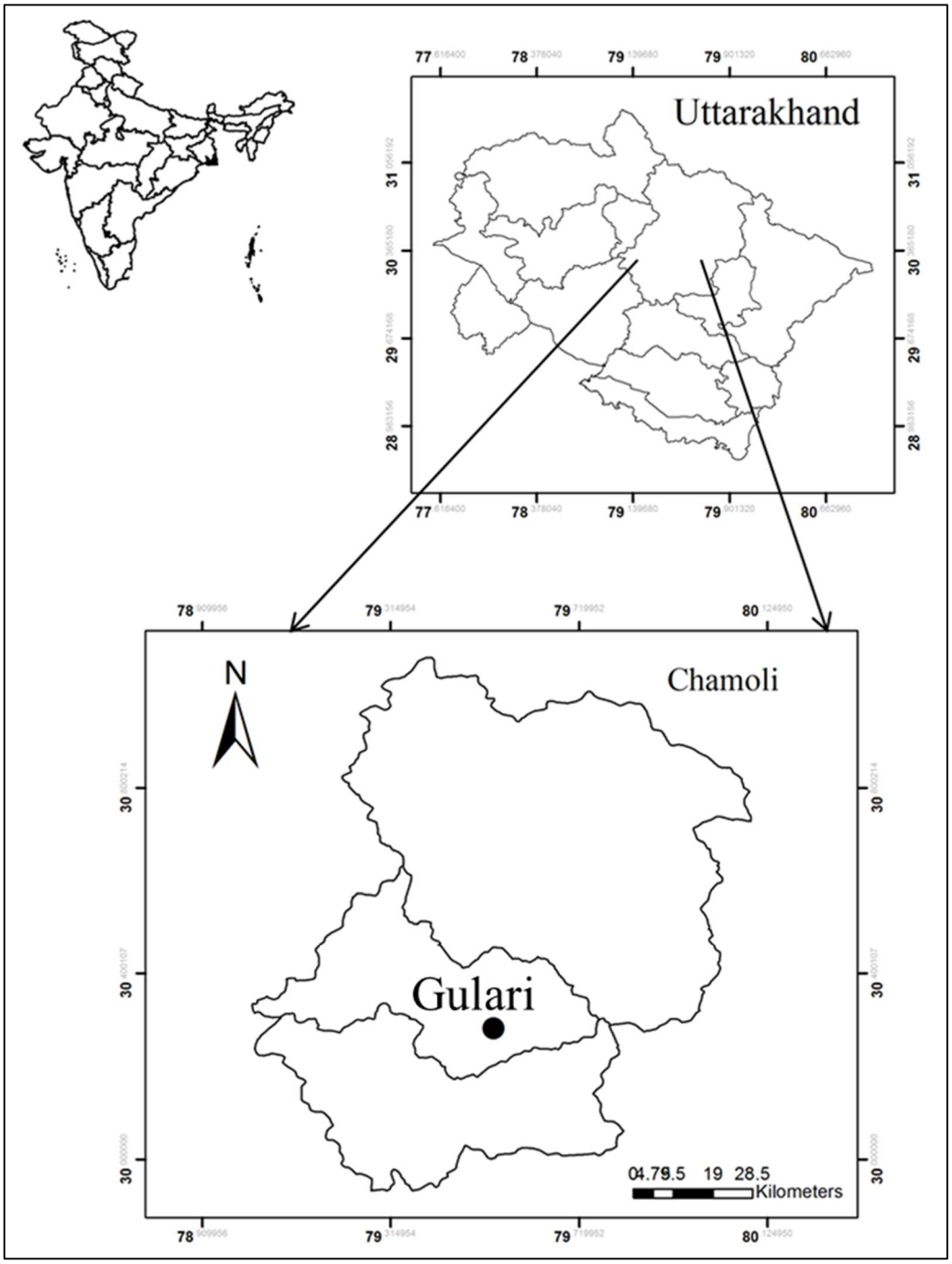

Figure 14 Location Gulari

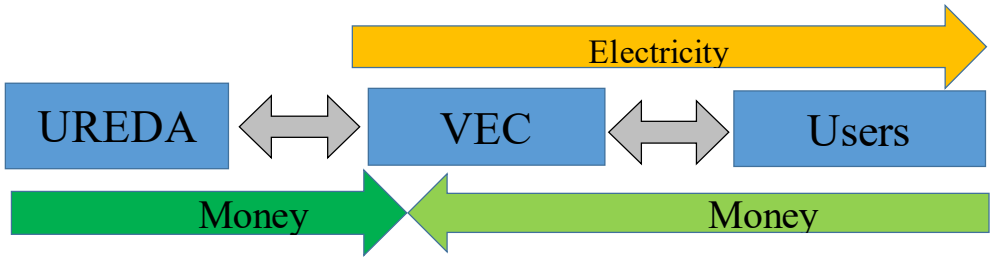

Figure 15 Sale of power and stakeholders involved in VEC operated decentralised projects

Functions of VEC its transition

When the project was operating in decentralised mode, the VEC was entitled to following tasks,

- Generation of power
- Operation and maintenance of the project
- Transmission and distribution of power
- Collection of fees from users and
- Service obligation to provide power to users.

After the once the grid had reached the locality, responsibilities of the VEC were reduced to

- Generation of power
- Operation and maintenance of the project

In VEC the members do not depend on income generated from it. Only the operations and maintenance cost is paid through the generated income. It is the responsibility of the government to invest in these projects for major overhauling. Without the government's investment, it is not possible to successfully run the project.

Challenges in the project

In 2013 disaster, the project was severely affected. Some portion of the power channel was completely washed out. All the civil structures are filled with silt. D-tank, power channel and forebay tank are filled with silt. The condition is so worse that even the silt and wood pieces have infiltrated the penstock. Governor, which is the critical equipment for operating the machine are in dilapidated condition. The belt connecting the turbine shaft and governor shaft were missing.

Without good functional governor, it is not possible to operate the machine in a narrow range of frequency. Even the log books were not maintained properly. Tracing previous log books was tough.

As informed by the operator the condition was such that, if there is some maintenance work to be done in a certain village, then tariff was collected from that locality on the same day so that daily wages of the workers can be paid. If power was not supplied in the evening owning some fault, then villagers used to come to the powerhouse for thrashing the operator.

Picture 4 Inside the powerhouse of Gualri MHP

Technological maturity and skilled human resources

It is the AHEC's job to train the local operator. These trained operators are not obligated to serve the local project for a longer period. Those who gain substantial experience in project operations leave the project owning to underpayment. These experienced operators join some private power projects where they fetch higher salary when compared to VEC managed project. This attrition creates a vacuum for qualified human resources at these VEC operated projects. The president of the VEC also feels that this attrition is a boon as new guys can be hired at lesser salaries. He feels that maintaining the project is not a

challenge but, unavailability of the funds and rigid bureaucracy proves to be a challenge.

Picture 5 Powerhouse of Gulari MHP

Effect on Livelihood

Agriculture is the livelihood option on which majority of the population depends. However, the project did not bring any change in livelihood option. Agriculture is dependent on rain and some mountain streams. First of all the people are not wealthy enough to buy water pumps. The wealthiest farmer owns land as large as one hectare. If the landholding is significant, then it is very scattered. Even after the availability of power, there is no change in the irrigation system. Residents grow wheat, and it depends on the moisture available in the land. Hence, better the snow fall better the wheat yield. People feel that the government has to invest in irrigation too in the similar way it invested in infrastructure projects. Just providing electricity will not bring change in agricultural practices.

Effect on the living status of the residents.

The living condition of people has improved, they have become more aware of cleanliness. As earlier there was no light, people never used to bother about keeping the house clean. Use of kerosene lamp has badly affected the house due

to smoke. A ropeway was installed, and many flour mills were installed. This ropeway helped the resident of some villages in logistics.

Alternative energy option

Rooftop solar PV power plants are considered to be a good alternative as they require less human intervention and no moving parts. Residents feel that government must invest in these rather than on hydropower projects. Presently these grid connected solar power projects will also contribute towards livelihood.

Picture 6 Reconstructed power channel of Gualri MHP

Resistance to privatisation of the project

For these many years, VEC of Gulari did not earn any profits as the project was operating in decentralised mode and users defaulted bills. Now, the project is grid synchronised, and more profits can be reaped but, UREDA thinks of giving it to a private developer for operation and maintenance. For UREDA it becomes easier to command if the project operated by a private player as the private player will be concerned only about his earnings. VEC is not in terms with UREDA when it comes to privatisation, and there is a reason behind it. During the establishment of the project, it was the panchayat and residents who supported it and gave land for its construction. Handing over the project to a

private developer at this juncture of profit earning is a questionable move. UREDA wants private developers to invest in stalled projects as they reduce the financial burden on government. It is government's obligation to provide electricity to the residents. In decentralised projects, VECs did half the job of government, i.e., operation and maintenance of project to electrify the nearby villages. Moreover, VEC acted like a shield to the government by facing the wrath of the user during crisis situations. Hence, VEC feels that it is the responsibility of the government to fund in case of crisis.

As the income from this decentralised powerhouse was very less, the VEC has to depend on government for funds if there is a major maintenance. All maintenance work is carried out on credit basis. Once the work is completed, it will be verified by the government and funds are released. However, getting the work done on credit calls for faith in working team on VEC.

Administrative improvements required in VEC operated projects

Rather than VEC, local panchayats are to be empowered to collect the tariff. Presently the Gram Pradhans are so complacent that they allow electricity theft because they have to maintain a good relationship with their village's residents. If the duty of tariff collection is handed over to the panchayat, then the theft of power and default cases can be reduced. VEC or Gram Pradhan does not have any powers which will assist in the collection of the tariff.

Transition from decentralised to grid-connected project

Presently the function of powerhouse has changed, it has become a commercial powerhouse. Now nobody can question us about the electricity. Earlier it was a burden on VEC to provide electricity to the user without fail and no benefits. It was established to develop the backwards area by providing electricity at cheaper rates. Personally, the president of the VEC feels happy because he is relieved of his unpaid duties. Members of VEC are volunteers, and they are not paid. If they were paid for discharging their duties, then they would have remained motivated to maintain the powerhouse. As there is no income, the interest recedes.

Benefit-sharing

In the Himalayan state like Uttarakhand, the major resources are water, forest and agriculture and same applies to nearby villages of Gulari. It shall be a good

option to tap those resources for providing local solutions and avoid problems like migration. Availability of electricity has helped set up electromechanical flour mills which have reduced the burden on villagers of taking wheat to hydro-mechanical flour mills (Gharats). If we talk of benefit sharing, it should be local to the local solution. resource.

Community managed multipurpose micro hydro project at Rampur

Rampur is small village in Rudraprayag district of Uttarakhand (see Figure 16 Location of Rampur. It is on the way to Kedarnath (one among the famous pilgrimage sites of Hindus). This multipurpose project at Rampur was set up by HelpAge India, an NGO in the aftermath of 2013 flash flood disasters as a rehabilitation measure. This project is the revival of existing water mill. The motives behind reviving and upgrading the project are,

i. Providing yearlong employment opportunity
ii. Making the best use of local resource
iii. Sharing the benefits among locals and
iv. As a source of income for a local self-help group(SHG)

In this project it has been tried to reap the maximum possible profits from the resource by establishing multiple machines for various utilities (see Table 7).

Table 7 Machines of Rampur multipurpose project

Serial no.	Machine	Rating
1.	Generator	7.5kVA
2.	Oil expeller	100kg of mustard seeds/day
3.	Flour mill	200kg of wheat/day
4.	Water pump	2 HP @ 540rpm
5.	Air compressor	2 HP

The total investment in Rampur multipurpose project was around 1 million INR. This enormous investment has to be substantiated by decent returns. In this project fulfilling the motives is considered to be the best return generated. Besides fulfilling the motives, this project is financially stable.

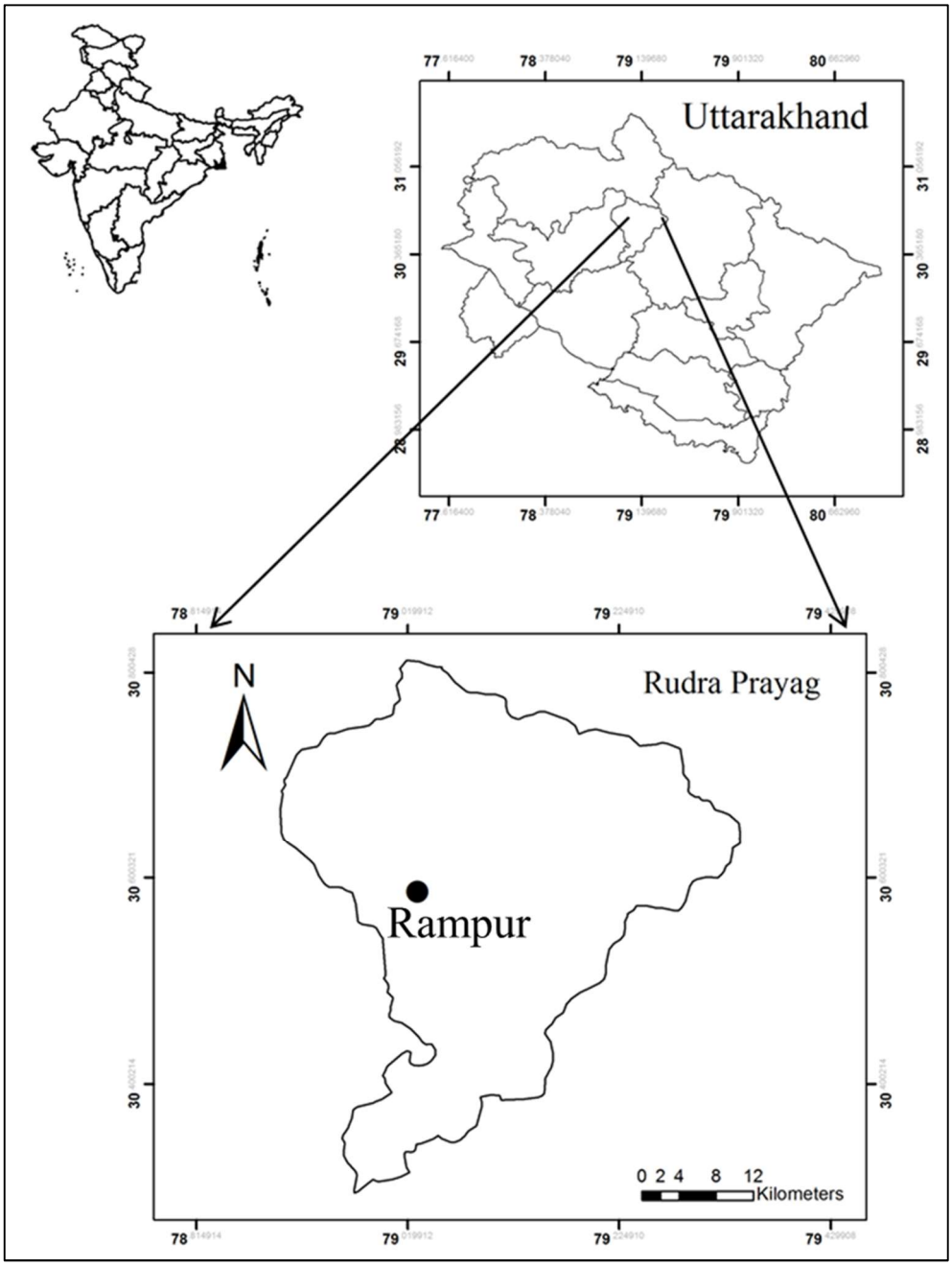

Figure 16 Location of Rampur

Local Economy

As the village on the way to Kedarnath, tourism (hospitality) is the lucrative business option. However, the tourism lasts only for five to six months out of which only the initial two months it will at its peak. Even the three out of five members of the project committee remain busy in tourism business for initial two months. However, these members will return to the multipurpose project once the tourist inrush recedes. Primarily locals depend on agriculture for livelihood; wheat and mustard are the major crops grown here.

Picture 7 Rampur powerhouse and its forebay tank

Administration

The ownership of the project completely remains with the five-member group, but ‘HelpAge India' has all the powers to retake it if the members are found misusing it. Moreover, there should not be the question of misusing it as the members were trained before handing over the project to them. Each machine (see Table 7) in the project have separate owners (virtual ownership) but, the project is collectively operated and maintained by this five member community. As informed by Dayal Singh Rawat (68), the flour mill (Gharat) is there on the site from more than hundred years, presently he is the owner of that flour mill. The oil expeller is owned by Dayal Singh's nephew, Prakash Rawat (38). Apart from owning the oil expeller he also owns a lodging business in Rampur. Presently the power from the generator is not metered but, it is supplied on barter basis to a nearby Dhaba (see Picture 11). The owner of the restaurant provides food to project operators in return of electricity. Presently, among all the machines only flour mill, oil expeller and generator are generating revenue, rest machines remain idle.

Benefit Sharing of multipurpose project

This project has affected the residents of nearby villages in a positive way. Now there is no need to go to Phata (a nearby village Rampur) for oil expeller. The flour mill is preferred by locals as it offers a discount. In the market, electromechanical flour mills charge ₹3/- per kg whereas this hydro-mechanical one charges ₹2/- per kg. Besides this, the lower prices at both flour mill and oil mill are attracting more customers. As there was no investment from the community in setting the project 'HelpAge India' asked the operators to offer the discount on services.

Picture 8 Flour mill at Rampur multipurpose MHP

The services from the project are offered at a discount to the locals. If we think of financial stability, then this benefit shared among locals in the form of the subsidy must also be accounted. This discount offered is a hidden benefit which an outsider will not realise.

This business model shows how the benefit is shared among locals. Employment is a privilege for the members, whereas discounts and availability of necessary

service (flour mill and oil mill) is a privilege to residents. This project is the successful demonstration of utilising the local resources in a viable way.

Picture 9 Oil expeller in Rampur multipurpose MHP

Plans and opportunities

In future, the committee is planning to construct a garage and a restaurant. The restaurant will act as a load for the generator, and as it will remain independent of grid power, it can attract more travellers and tourist. In the garage, they will able to fix punctures of vehicle tyres by utilising the air compressor of the project and wash the tourist vehicles using the water pump.

Picture 10 Air compressor and water pump in Rampur multipurpose MHP

Picture 11 Dhaba powered by Rampur multipurpose project

Experts perspective on community managed micro hydro projects

MHP's ownership must be restricted to a smaller group of people, and the project must be so designed that all the members of the group must directly depend on it for their livelihood (flour mill, oil mill, and restaurant/dhaba). This kind of small projects ranging from 10 to 15kW involving few members will result in the long-running model. In the 1970s there were no policies, especially for governing MHPs. Crowdfunding and funding from beneficiaries of the project were the only sources. Even without the government support, these projects sustained for a long time, and it is because of direct dependents and employing the resource in the financially stable model[12].

[12] This information is based on the interview with Mr Yogeshwar Kumar at IIT Delhi on 15.03.2017. Yogeshwar Kumar is an IIT-Delhi alumnus from 1974 batch, and he is involved in developing micro hydro projects in different Himalayan states from past three decades. Currently, he works as a consultant for IUCN.

SWOT analysis of the projects

As mentioned in the objectives to assess the projects I adopted SWOT tool for comparing the visited projects (see Table 8). This analysis helps to evaluate the projects across four fronts. Based on which we can determine which model is

Table 8 SWOT analysis of the projects

	Harsil project	**Gulari project**	**Rampur multipurpose project**
Operated by	Private operator	VEC	Group of Five members
Capacity	200kW	200kW	6kW
Strength	• Qualified & competent operators • Dependence of tourism on the project • High capacity utilisation during summers. • Bank, ATM, telecom towers and an army battalion as customers • Livelihood dependence of	• Electrification of nine villages • Voluntary VEC members • Grid synchronised project • Administration by locals	• All the members of the group are dependent on the project for livelihood • Residents of nearby villages prefer to use oil mill and flour mill at the project due to discounts offered. • Easy accessibility of the project • Travellers are benefitted from

	operator • Lessee/contractor has experience of operating different projects. • Less silt • Easily accessible by road • High capacity utilisation during summers • Involvement of villagers in maintenance of distribution lines.		air compressors and high-pressure water pump • Residents are benefited by discounts offered
Weakness	• Decentralised project. • Low capacity utilisation during winters • Old project with old machines. • No machine to machine synchronisation and load matching issues	• High silting problem • Underpaid operators and their attrition • Technical incompetence of VEC members • Lower income generation • No improvement in livelihood	• Lack of skill among members • Lack of understanding among members

	• Decentralised project even after availability of national grid in the vicinity	options • High silt • No improvement in livelihood options • Too much dependency on government for funds	
Opportunities	• More livelihood dependence can be created. • Can be connected to the grid. • Increasing the capacity • Synchronising with grid	• Can be handed over to a private contractor • More livelihood dependence can be created Ex: -Small scale industries, Improving Irrigation	• A restaurant can be set up, and more employment can be created Or • Small workshop can be opened
Threats	• Availability of grid in the locality • reduces sale of power due to migration of residents • New solar PV policy	• Corruption • Floods	• Variation in water availability. • Reduction in snowfall and rainfall • Floods • Reduction in tourism

	• Migration of residents • Floods • New Solar PV policy • Reduction in snowfall and rainfall		• Reduction in agricultural yield

Analysis of Uttarakhand's MHP policy of 2015

As per the officials from UREDA the policy was framed to empower the local panchayat and stop migration. However, VEC members say that "if UREDA wanted to empower the PRI then they must not have mentioned about the involvement of private developer for forming SPV. Instead, UREDA on its own would have taken the responsibility of electro-mechanical work and civil work might be let to locals".

In the policy of 2015 contractors feel that it is the excess empowerment of villagers. In the policy financial powers are there with VEC which is a hindrance for contractors to work with them. As per this policy, projects up to 2MW capacity can be installed only when the village committee proposes it. If a private developer interested in setting up a project in any village then he has to pursue the village committee to submit a proposal to UREDA. UREDA prepares a PFR and DPR and floats an 'open tender'. The developer who pursued the village committee to submit the proposal may lose in this open bidding; for this reason, private developers are not comfortable with this policy. Contractors also mention that VECs are not capable enough deal with the technical know-how of the project but, just because of their empowerment they will interfere in the project development process. Apart from dealing with UREDA officials contractors have to deal with VECs too. This job of dealing with VEC members increases the burden on the contractor. Because of their empowerment, VECs force the contractor to keep the residents for work and their demand may go on increasing. In projects under this policy, financial power of VEC acts as an impediment for contractors.

Under this policy, VEC is entitled to contribute 10% of the project cost as equity. This 10% can be in the form of money or workforce or material or combination of all of these. Contractors mention that VEC does not take this seriously and they hardly contribute to the project. This further increases the burden on the contractor. Contractors feel that villagers have developed a tendency where villagers think that there is huge money involved in the setting up a small hydropower project. Villagers believe that they must get some share of the money. There will not be any cooperation from villagers unless they will not get any material benefit. Salient features of MHP development policy 2015 are listed in Table 9 in the Annexure.

CONCLUSION AND SUGGESTION

When we look from the perspective of empowering the local people, these VEC managed MHPs appear to be good, as locals are involved in it. However, Micro or mini hydro projects which are installed with the motive of just electrifying small villages and hamlets, where operation and maintenance are looked after by VEC usually run into administrative problems and probably remain financially unstable (seeFigure 17 VEC managed decentralised MHP meeting merely lighting demand Figure 17). In these projects sense of ownership takes a backseat as VEC members are volunteers and they will not get any monetary benefits. When MHP stalls because of technical or environmental issues, VEC members and plant operators face the wrath of users. Also, income generated by these MHPs is meagre, and profitability becomes a challenge. Owning to the cash crunch operators remain underpaid which leads to attrition and dearth of skilled human resources. Due to unavailability of surplus VEC tends to depend on government funds for operation and maintenance. Frequently dealing with all these instances, VEC members tend to become complacent. When all the positives and negatives are weighed, it appears that impediments overweigh the positive aspects in decentralised MHPs managed by VECs. All these impediments pose a serious question on the reliability of MHP.

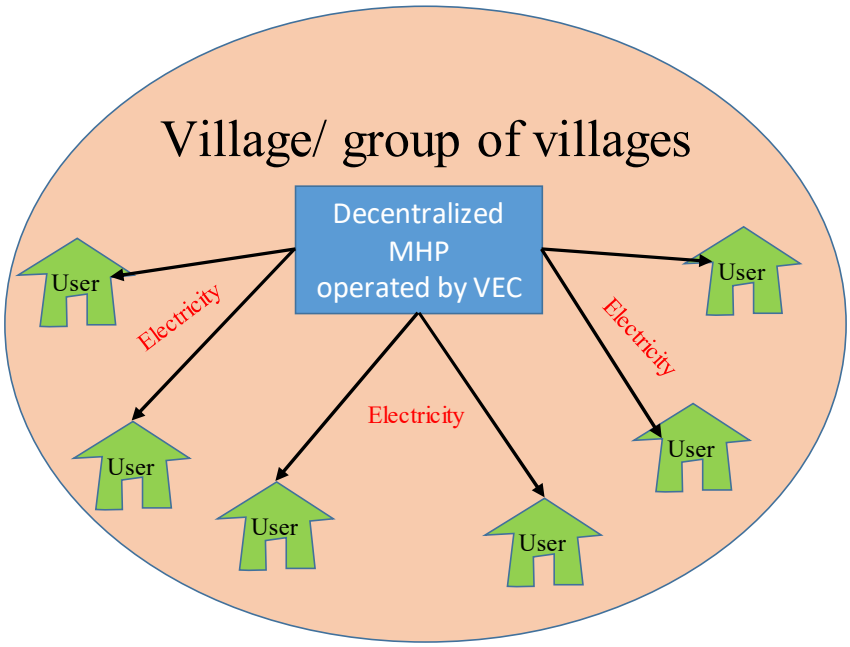

Figure 17 VEC managed decentralised MHP meeting merely lighting demand

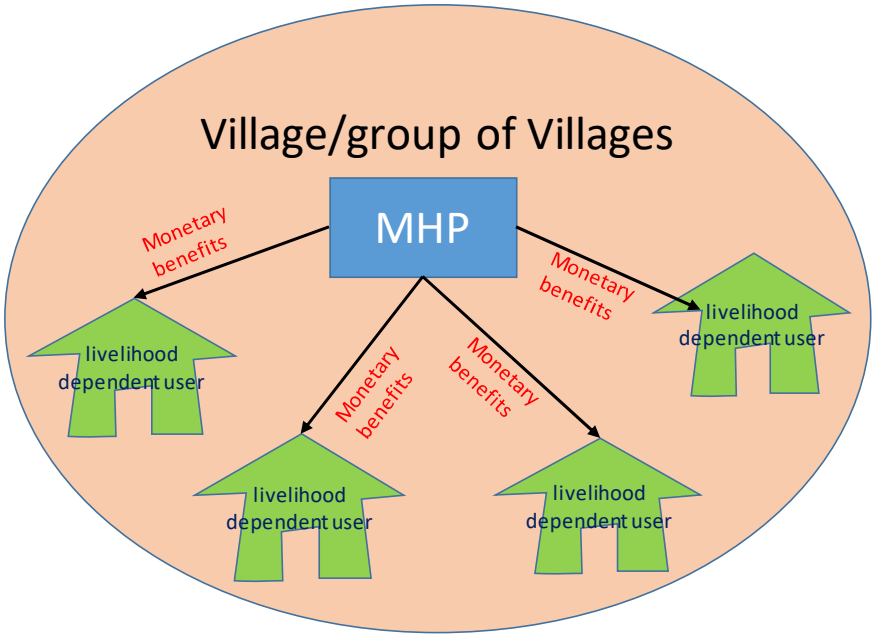

Figure 18 livelihood dependence on MHP

Contrary to VEC maintained projects the projects leased out to a private enterprise have higher utilisation because proprietor's/lessee's livelihood depends on the project. Higher the number of units more is the income. Moreover, the private enterprises are mandated to sell threshold units in a year failing which these enterprises can be penalised. In this model achieving the profits is the motive which brings in the sense of competition and the lessee strives to improve his performance year on year. As these private enterprises have experience of managing multiple projects, they remain self-reliant in technical aspects.

Presently, the governance framework focusses only on solving the energy access problems. Instead, promoting MHPs as an intervention to enrich the livelihood option by which earnings of the dependents/user is enhanced (see Figure 18) will be a more successful model. For example, if agriculture is the primary source of income in the locality where MHP has been setup, then power from the MHP must be utilised in those activities which aid the development of agriculture. Otherwise, it must aid in post-harvest activities, say food processing, cold storage, etc. This dependence will increase the sale of power as a consequence the MHP will generate revenue and become financially stable. In this kind of setup, the state agency will also reap more benefits.

Decentralised MHPs (source) and its users are closely related and are interdependent (see Figure 19). It is a complete circle; source cannot sustain on its

own if the user (sink) are detached from it. That means along with providing the energy the residents must be empowered to use it. A large number of users and reliable administration of the project will create a win-win situation.

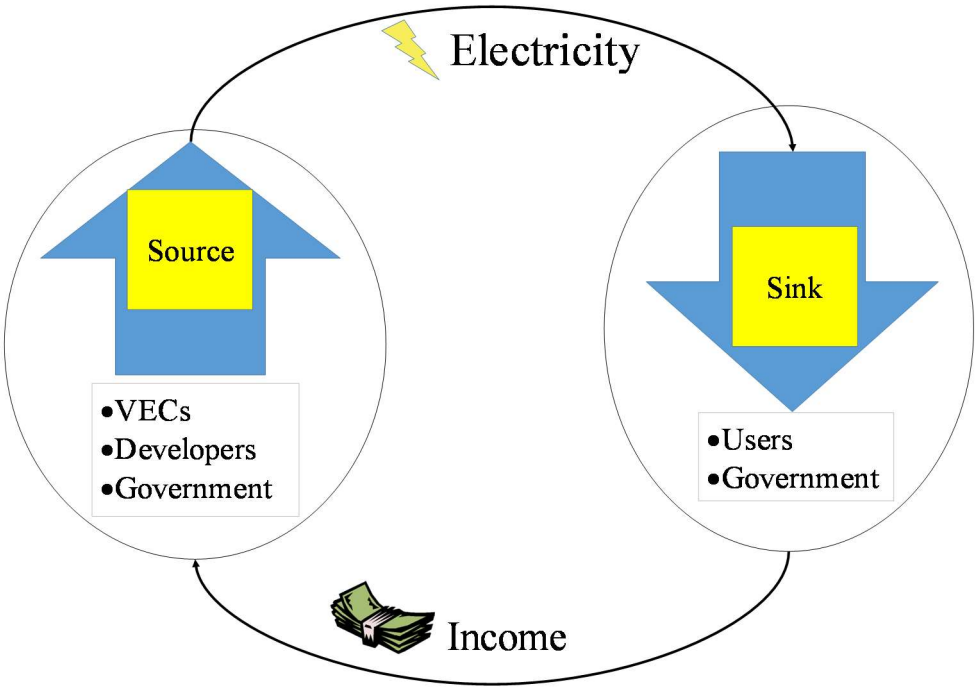

Figure 19 Interdependence of MHP and its users

For example, villages in hills have a severe problem of all-weather roads and unavailability of jobs in winters. These problems force them to migrate to lower lands during winters. This migration of residents results in reduced electricity sales and underutilisation of the capacity.

The present governance focuses only on the source side of the system but, the sink side remains unfledged. This disparity destabilises the side of the source. If MHPs have to sustain for long then both the sides should be developed at the same rate. Hence, governance should focus holistically on all the nuances rather than focussing on energy exploitation issues.

REFERENCES:

AHEC, 2016. Small hydro power data base. , (July). Available at: http://www.ahec.org.in/publ/shp_database/UK_commissioned_projects.pdf.

Buechler, S. et al., 2016. Re-linking governance of energy with livelihoods and irrigation in Uttarakhand, India. *Water*, 8(10), pp.1–22. Available at: www.mdpi.com/2073-4441/8/10/437/pdf.

CEA, 2017a. *ALL INDIA INSTALLED CAPACITY (IN MW) OF POWER STATIONS*, New Delhi. Available at: http://www.cea.nic.in/reports/monthly/installedcapacity/2017/installed_capacity-01.pdf.

CEA, 2016. *Executive summary for the month of December 2016*, New Delhi. Available at: http://www.cea.nic.in/reports/monthly/executivesummary/2016/exe_summary-12.pdf.

CEA, 2017b. *STATE WISE NOTE ON HYDROPOWER DEVELOPMENT*, New Delhi. Available at: http://www.cea.nic.in/reports/monthly/hydro/2017/state_power-01.pdf.

CEA, 2017c. *STATUS OF HYDRO ELECTRIC POTENTIAL DEVELOPMENT*, New Delhi. Available at: http://www.cea.nic.in/reports/monthly/hydro/2017/hydro_potential_region-01.pdf.

ENVIS Center on Himalayan Ecology GBPIHED, The Himalaya. Available at: http://gbpihedenvis.nic.in/indian_him_reg.htm [Accessed February 2, 2017].

Government of Uttarakhand, 2015. *Policy For Development of Micro & Mini Hydro Power Projects upto 2 MW*, Available at: www.ireeed.gov.in/policyfiles/440-Uttarakhand_MHP_Policy_upto_2_MW.pdf.

Government of Uttarakhand, G., 2014. *Uttarakhand Action Plan on Climate Change " Transforming Crisis into Opportunity ,"* Dehra Dun. Available at: http://www.moef.gov.in/sites/default/files/Uttarakhand SAPCC.pdf.

Henao, F. et al., 2012. A multicriteria approach to sustainable energy supply for the rural poor. *European Journal of Operational Research*, 218(3), pp.801–809. Available at: http://dx.doi.org/10.1016/j.ejor.2011.11.033.

IEA, 2015. *Making the energy sector more resilient to climate change*, Available at: www.iea.org/t&c/%5Cnhttp://www.iea.org/publications/freepublications/publication/COP21_Resilience_Brochure.pdf.

INCAA, 2010. *Climate Change and India: A 4X4 Assessment*, Available at: http://www.moef.nic.in/downloads/public-information/fin-rpt-incca.pdf.

IPCC, 2014. *Climate Change 2014 Synthesis Report Summary for Policymakers*,

Kesharwani, M.K., 2006. Overview of Small Hydro Power Development. In *Himalayan Small Hydro Power Summit*. Dehradun, pp. 44–57.

Mishra, M.K., Khare, N. & Agarwal, A.B., 2015. Small hydro power in India : Current status and future perspectives. *Renewable and Sustainable Energy Reviews*, 51, pp.101–115. Available at: http://dx.doi.org/10.1016/j.rser.2015.05.075.

Mittal, S., Tripathi, G. & Sethi, D., 2008. *Development Strategy for the Hill Districts of Uttarakhand*, Available at: http://admin.indiaenvironmentportal.org.in/files/Working_Paper_217.pdf.

MNRE, 2017a. *ANNAUL REPORT 2016-2017*, New Delhi. Available at: http://mnre.gov.in/file-manager/annual-report/2016-2017/EN/content.html.

MNRE, 2017b. *ANNAUL REPORT 2016-2017*, New Delhi. Available at: http://mnre.gov.in/file-manager/annual-report/2016-2017/EN/pdf/3.pdf.

MNRE, 2016a. *Annual Report 2015-2016*, Available at: http://mnre.gov.in/file-manager/annual-report/2015-2016/EN/Chapter 3/chapter_3.htm.

MNRE, 2014. Central Financial Assistance. Available at: mnre.gov.in/file-manager/grid-small-hydro/SHP-Scheme.pdf.

MNRE, 2016b. Small Hydro. Available at: http://mnre.gov.in/schemes/grid-connected/small-hydro/ [Accessed November 10, 2016].

UERC, 2016a. Petition to determine the project specific tariff of Chamoli extension mini hydro power project of capacity 3 MW on cost plus approach. Available at: http://www.uerc.gov.in/ordersPetitions/orders/Misc/2016/nov16/Order dt. 30.11.16 on UREDA's petition for project specific tariff of Chamoli project.pdf.

UERC, 2016b. Tariiff order of UPCL for FY 2016-2017. , p.246.

UJVNL, 2017. The Company. Available at: https://www.uttarakhandjalvidyut.com/details.php?pgid=98&type=03c7c0ace395d80182db07ae2c30f034 [Accessed March 8, 2017].

UREDA, 2017a. About Us. Available at: http://www.ureda.uk.gov.in/pages/display/2-about-us [Accessed March 8, 2017].

UREDA, 2017b. Public Infromation. Available at: http://www.ureda.uk.gov.in/ [Accessed March 8, 2017].

UREDA, 2016. Small Hydro Programme in Uttarakhand. Available at: http://ureda.uk.gov.in/pages/display/131?micro?hydro?projects [Accessed October 12, 2016].

UREDA, 2014. *The Details of Micro Hydel Project*, Dehradun. Available at: http://www.ureda.uk.gov.in/files/Web_Site_Data_for_MH_1.pdf.

ANNEXURE

Table 9 Salient features of Uttarakhand MHP development policy

Policy	**Policy for development of micro & mini hydropower projects up to 2 MW-2015**
Order	**No. 54/I/2015-03/21/2014Dehradun: Dated: 31st January 2015**
Incentives	
Wheeling	i. Wheeling charges are applicable as per the UERC regulations as amended from time to time. ii. Wheeling agreement to be separately done with PTCUL or UPCL or with other networks.
Sale of electricity	i. The project developer may sell the power to any consumer or ii. Can utilise for captive purpose or iii. Can sell the power to UPCL and UPCL is bound to purchase the power from project developed under this policy
Banking	i. Banking is allowed as per the UERC regulations as amended from time to time. ii. Banking agreement has to be executed separately for banking generated power with UPCL.
Evacuation of energy	As per UERC regulations/directions as amended time to time
Detailed project report	UREDA has to prepare the pre-feasibility report and DPR
Allotment	Only PRIs of Uttarakhand are eligible under this policy. Alternatively, PRIs can form an SPV by adhering to the conditions mentioned in this policy.
Royalty	Exempted from all royalties
Period of the project	Projects to be offered for 40 years from the date of award, after that they shall revert to the State government or extended further on mutually agreed terms
Financial closure	Nine months from date of award of the project
Project completion	Within 36 months from financial closure
Project period	40 years from the date of award
Role of UJVNL	To provide training to the interested developer/PRI in executing, operating & maintaining the project.
Role of UREDA	i. Identification of project. ii. Preparing DPR. iii. Calling for bids. iv. Empanelling the qualified design and supervision consultancy firm for providing

	technical assistance to the eligible PRI & SPV partner on payment basis
Role of UPCL	Purchasing power from the developer of MHP by signing the PPA, if the developer wishes to. Support the developer in banking power
Environmental Clearance	As per MoEF's EIA notification-2006, hydro projects below 25MW are exempted, but the developer has to abide by the rules and regulation of CPCB and SPCB.
Clean Development Mechanism	CDM benefits to be shared among project developer and the beneficiary as per UERC regulations[13].

[13] In the first year of commissioning the developer has 100% right to CDM benefits. From second year onwards 10% of CDM benefit is to be shared with beneficiary i.e. the distribution company. The share has to increase by 10% every year till it becomes 50% and beyond which it has to be shared equally between the developer and the distribution company. For tariff calculation, CDM benefits are not considered.