



Summary Report

Technical Assistance for Developing an Enabling Policy Environment to Accelerate Development of Clean Energy Through Mini and Small Hydropower in Nepal



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List of abbreviations

ADB	Asian Development Bank
AGM	Annual General Meeting
AHREP	Andhikhola Hydro Electric & Rural Electrification Project
AVHDC	Arun Valley Hydropower Development Company Limited
BOOT	Build, Own, Operate, Transfer
BPC	Butwal Power Company
BTW	Butwal Technical Institute
CREE	Community Rural Electrification Entity
CREF	Central Renewable Energy Fund
DCS	Development and Consulting Services
DDC	District Development Committee
DEECCS	District Energy, Environment and Climate Change Sections
DOED	Department of Electricity Development
EIA	Environmental Impact Assessment
ETFC	Electricity Tariff Fixation Commission
GIZ	Gesellschaft für Internationale Zusammenarbeit
GoN	Government of Nepal
GWh	Giga Watt hour
IBN	Investment Board Nepal
IEA	International Energy Agency
IEE	Initial environmental examination
IFC	International Finance Corporation
INPS	Integrated Nepal Power System
IPPAN	Independent Power Producers' Association, Nepal
KBC	Khumbu Bijuli Company
KREC	Khimti Rural Electrification Cooperative
kVA	Kilo Volt Ampere
kW	kilo Watt
LEDCO	Lamjung Electricity Development Company
MHP	Micro hydro power
MMHC	Mini/Micro Hydro Cooperative
MOE	Ministry of Energy
MOPE	Ministry of Population and Environment

MW	Mega Watt
NEA	Nepal Electricity Authority
NGO	Non-Government Organization
NHA	Nepal Hydropower Association
NHE	Nepal Hydro and Electric Limited
NMHDA	Nepal Micro Hydropower Development Association
NORAD	Norwegian Agency for Development Cooperation
NPC	National Planning Commission
NRREP	National Rural and Renewable Energy Programme
NRs	Nepali Rupees
O&M	Operation and Maintenance
PPA	Power Purchase Agreement
PPP	Public private partnership
RE	Renewable energy
RERL	Renewable Energy for Rural Livelihood
RET	Renewable Energy Technology
RSC	Regional Service Center
SCECO	Salleri Chialsa Electricity Company
SDC	Swiss Development Cooperation
SE4ALL	Sustainable Energy for All
SHDAN	Small Hydropower Development Association of Nepal
SHDB	Small Hydropower Development Board
SHP	Small Hydropower Project
SPV	Special Purpose Vehicle
TEUC	Taplejung Electricity Users Committee
UNDP	United Nations Development Programme
USD	United States Dollar
VDC	Village Development Committee
WB	World Bank
WECAN	Water and Energy Consultant Association, Nepal
WECS	Water and Energy Commission Secretariat

Executive summary

With a changing economy and increase in electricity demand in rural Nepal, the development of mini and small hydro for power generation is on an increase. However, there are many challenges, especially if these power systems are off-grid - high upfront capital cost, lack of sufficient commercial financing and favourable investment environment in the country, lack of financial sustainability of operational systems, insufficient technical capacity and lack of awareness amongst others. The challenges need to be addressed and technical assistance was sought by the Alternative Energy Promotion Center (AEPC) to understand in greater detail some of the key 'enablers' and investigate what supports and/or hinders each of the enabler, and what business models or approach/es may be best within the current context.

Eight case studies were conducted based upon business model/s, location, grid connectivity or isolated etc. Results are cross-analysed in this overview report but details are presented in a separate report. The report additionally presents the historical development and its policy enablers in the growth of mini and small hydro sector. A short analysis on the major institutions, their roles and jurisdiction in developing mini and small hydros is also provided.

The study was conducted utilising the market mapping system framework structured into three main levels: enabling environment (policies, regulations, and also social and cultural), energy market chain (project design and planning, construction and operation, and management) and support services (inputs, services and finance). Field assessments were carried out in almost all cases including user satisfaction surveys in some sites to understand the perception of consumers and level of services. The projects assessed in the study were:

SN	Project	District	Year	Size	Mini/ Small	Grid connect	Business model
1	Andhi khola	Syangja	1990 (2016 upgrade)	5.1MW, upgraded to 9.4MW	Small	Yes	Private-public (some public investment)
2	Piluwa khola	Sankhuwasabha	2003	3MW	Small	Yes	Private company (from locals within area)
3	Sobuwa khola	Taplejung	1984	125kW-synchronised with 90kW micro hydro	Mini	Connected to NEA's local Grid	NEA owned, leased to community
4	Jugad khola	Jumla	1983	200kW	Mini	No	NEA owned, leased to community
5	PHEME khola	Panchthar	1980	240kW & 150kW	Mini	No Yes	- NEA owned, leased to cooperative - Private
6	Haluwa khola	Ramechhap	2012	400kW	Mini	No but planned	Community/Cooperative (KREC)

SN	Project	District	Year	Size	Mini/ Small	Grid connect	Business model
7	Salleri Chialsa	Solukhumbu	1985 1990	(400kW) - 200kW - 200kW	Mini	No	Shareholder company (community/ NEA/SDC)
8	Rairang	Dhadhing	2004	500kW	Mini	Yes	Owned by private company

The report outline major findings as:

- Small and mini hydro systems connected to grid is reliant on the Power Purchase Agreement (PPA) with the sole national utility Nepal Electricity Authority (NEA). Most of the grid connected plant performances are better with constant revenue generation.
- Community owned mini hydro with full donor support or governmental subsidy with active participation of local people is performing well. The performance was also assisted because of the constant support received post installation - in operations, capacity building and maintenance.
- The performance of mini hydro leased out by NEA either to the community or private companies were poor. The NEA leasing policy was found to be a hindrance which does not allow freedom to the developers/operators in the operation and management, and with little follow on support (such as trainings etc.) as stated in leasing contract.

There is a need to further develop more robust and transparent legal and regulatory framework to promote both public and private sector investments, particularly to achieve the country's planning target for the energy sector. Sustainable off taking arrangements in the form of a creditworthy off-taker or an assured market for the power is needed. Setting out and enforcing a tariff structure that reflects the costs were also felt to be important. Private entities need to be able to establish such a tariff and be legally assured that it can be enforced. The report suggests more analysis and support for:

- Market: Change in PPA structure, broader stakeholder coordination, increase in incentives and subsidy to encourage the demand creation and self-sustainability, standards development to maintain the highest quality and development of business model in changing market context.
- Money: Tariff setting mechanism, monetary risk management with investment during study and construction, development of mini and small hydros as business enterprise.
- Management: Capacity development and technical advisory support to mini and small hydro management, administration and technicians, monitoring of the services and increase in private sector involvement especially in the mini-hydro development.

This report is one of the first attempts in Nepal to analyse mini and small hydro sector through case studies. A major challenge was the lack of detailed data (especially finance, and operations) as most of the systems were built early on and record keeping found to be weak. It is further recommended that AEPC conduct detailed analysis while simultaneously developing the mini hydro sector. A close co-ordinated effort by the key institutions (NEA, AEPC in particular), private sector, communities and co-operatives, financial institutions, and relevant Ministries is essential to develop further the mini and small hydropower sector in Nepal.

1. INTRODUCTION

1.1 The energy context in Nepal

Energy poverty in many developing countries continue to be a major challenge as nearly 1.3 billion people, 19 per cent of the global population lack access to electricity, over 95 per cent living in rural areas of South Asia and Sub-Saharan Africa (IEA, 2011). For many countries, the national grid has been the preferred option to increase the rate of electricity access but this will not be sufficient to meet the goal of universal electrification and an estimated 60 per cent of additional generation will need to come from decentralised off-grid installations, either mini-grids or stand-alone (ibid.).

In Nepal, the National Population Census 2011 has shown that 67 per cent of households have access to electricity (almost 94 per cent of the urban households and 61 per cent of rural households) although the quantity and quality of supply can be erratic. Meanwhile, renewable energy (RE) technologies such as micro hydro (5-100kW), mini hydro (100kW - 1MW), small hydro (1-10MW), solar and wind are providing promising options for off-grid electrification in many rural areas, not only providing modern forms of energy to the large underserved populations but also as a catalyst for socio-economic development.

Nepal has high potential for hydropower development but lags behind in harnessing it. The country is hugely dependent on both traditional fuels (e.g. fuelwood, agricultural residue and animal dung) and fossil fuels. In 2014/15 Nepal imported petroleum products worth NRs 87.87 billion, while total exports stood at NRs 60.97 billion (69% of export earnings). Nepal cannot afford to continue spending its national income on imported fossil fuels that are not only expensive but are equally climate unfriendly, and vulnerable to various risks – political, price fluctuations, and natural disasters. Hydropower development continues to provide the best alternative to developing clean energy, lowering reliance on traditional and fossil fuels in the long term.

Around 2.5 million households are supplied electricity from the national grid¹, wholly owned and operated by the Nepal Electricity Authority (NEA). The grid is powered from a combination of large and small hydro, thermal, and fossil fuels. In 2014, the total installed capacity of all electricity-generating plants in Nepal was about 787 MW, out of which 93 per cent was generated from large and isolated hydropower by the NEA and independent power producers (IPPs), and around 6.5 per cent from thermal power plants. Updated provisional figures from NEA's 2015 Annual reports suggest that out of a total of 5006 GWh of electricity available in Nepal, 2366 GWh was from NEA (~47%), 1269 GWh was from Independent Power Producers - IPPs (25%), 1.24 GWh was from thermal (1%), and 1370 GWh was import from India (~27%).

In addition to the national grid, Nepal has a long history of off-grid electrification mainly in the rural areas where the national utility continues to lag behind in the provision of regular electricity. For many off-grids, micro hydro (under 100KW) has been the main focus. In many of the district headquarters, the NEA played a major role in the early years developing

micro and mini-hydro off-grid projects. Besides the NEA, a few mini-hydro projects were installed with initial grants from donors mainly managed by communities and individually sustained. In the 90's after the introduction of the Electricity Act, localized private companies with support from donors and external support started to develop small hydro projects (between 1-10MW) that would be grid connected, but with equal efforts to provide local communities with electricity. These have been instrumental to develop capacities within the private sector and the growth of IPPs in the development of mini and small hydro in the country.

1.2 The need to diversify energy mix in rural areas – emergence of mini and small hydro sector

For over five decades, the national grid has been powered through large-scale hydro and fossil fuels mainly to serve urban regions; and off-grid rural electrification through pico and micro²/mini hydro or other renewable resources such as solar PV. The trend has been fairly consistent over the past few decades as weak infrastructure access particularly roads and rough geographical terrain made the costs of any power infrastructure expensive. Over the last decade, this dichotomy has been changing as road infrastructure is improving and reaching many rural regions. While in 1951, the country's road network was only 376 km, reaching around 5925 km in 1985, and 62579 km in 2013 an annual increase of around 9.9per cent (Thapa.A.J, 2013).

The earliest development of a mini-hydro was in fact one of Nepal's first and public supported - the 500kW Pharping power plant commissioned in 1911 mainly for the ruling elite followed by a few projects. In 1975, the Small Hydropower Development Board (SHDB) was established to electrify remote district centres through isolated 'small hydro' projects although all were micro-mini hydro (Ghimire H.K, 2007). The establishment of the SHDB was also to prioritise the electrification of district headquarters in the hilly regions. In 1977, the SHDB carried out surveys and investigations on 150 sites. Implementation was difficult with issues of accessibility (road network was weak) and financing.

In 1985, the Electricity Department, Nepal Electricity Corporation and SHDB were merged to form the Nepal Electricity Authority (NEA). The board was integrated within NEA as a separate department – the Small Hydropower and Rural Electrification Department – that managed isolated and few grid connected plants. By the end of 1992,thirty-three (33) micro-mini hydropower plants were in operation out of which 16 were supplying electricity to district headquarters. By 2007, it was managing almost 46 mini and small hydropower plants totalling about 45MW (ibid). Detailed updates on the operational status of these systems are not known.

²Micro-hydro (below 100kW) is not considered in this study as there is already a wealth of information on this topic although challenges such as high upfront cost, low financial income, dependence on large subsidy are on-going. It is felt that mini and small hydro can be better alternatives for Nepal with its higher capacity providing rural populations options for lighting, cooking and productive uses.

A report in 2012 stated that there were nine mini hydros (total 1.55MW) leased and operating off the grid while four mini hydros (total 830kW) were on-grid (Energy Development Services, 2012). NEA (2016) report figures show that seven (five isolated) are currently not in operation and thirteen (ten isolated) have been leased to private entities. NEA leased the plants because the plant's load factor was low and operations costs were high leading to high financial losses. The small hydro department no longer exists at NEA as the institution is focussing on medium and larger hydro, while the communities and/or IPPs are mainly pursuing mini-and small hydro.

Table 1 - Existing mini- hydropower plants(in 2007)

SN	Name of the Plants	District	Capacity (kW)	Year in Operation	Remarks
1	Pharping SHP	Kathmandu	500	1911	Out of Service
2	Sundarijal SHP	Kathmandu	640	1935	Grid Connected
3	Dhankuta SHP	Dhankuta	240	1971	Grid Connected
4	Surkhet SHP	Surkhet	345	1977	Grid Connected
5	Phidim SHP	Panchthar	240	1981	Isolated, DHQ
6	Baglung SHP	Baglung	200	1981	Grid Connected
7	Doti SHP	Doti	200	1981	Isolated, DHQ
8	Jumla SHP	Jumla	240	1982	Isolated, DHQ
9	Jomsom SHP	Mustang	240	1982	Isolated, DHQ
10	Salleri-Chialsa SHP+	Solukhumbu	400	1986	Isolated, DHQ
11	Darchula SHP	Darchula	300	1992	Isolated, DHQ
12	Taplejung SHP	Taplejung	125	1988	Isolated, DHQ
13	Tehrathum SHP	Tehrathum	100	1988	Isolated, DHQ
14	Bhojpur SHP	Bhojpur	250	1989	Isolated, DHQ
15	Khandbari SHP	Sankhuwasabha	250	1989	Isolated, DHQ
16	Bajhang SHP	Bajhang	200	1989	Isolated, DHQ
17	Chaurjhari SHP	Rukum	150	1989	Isolated, DHQ
18	Serpodaha SHP	Rukum	200	1989	Isolated, DHQ
19	Okhaldhunga SHP	Okhaldhunga	125	1990	Isolated, DHQ
20	Bajura SHP	Bajura	200	1990	Isolated, DHQ
21	Arughat SHP	Gorkha	150	1990	Isolated, Villages
22	Surnayagad SHP	Baitadi	200	1991	Isolated, DHQ
23	Rupal Gad SHP	Dadeldhura	100	1991	Isolated, Villages
24	Namche SHP+	Solukhumbu	600	1993	Isolated, Villages
25	Achham SHP	Achham	400	1995	Isolated, DHQ
26	Kalikot SHP	Kalikot	500	1999	Isolated, DHQ
27	Dolpa SHP	Dolpa	200	1999	Isolated, DHQ
28	Syange SHP**	Lamjung	183	2001	Grid Connected
29	Heldung SHP	Humla	500	-	Under Construction
30	Gam Gad SHP	Mugu	400	-	Under Construction
31	Rairang Khola SHP**	Dhading	500	2004	Grid Connected
32	Sisne Khola SHP**	Palpa	700	-	Under Construction

Source: Ghimire, H.K., 2007

+ - Local Company (Community). ** - Private IPPs, DHQ- District Headquarters

Meanwhile, in 1966, Mr. Odd Hoftun, a Norwegian expatriate, established the Butwal Power Company (BPC) to enhance capacity development in the mini and small hydropower sector in Nepal, leading to the first construction of the Tinau power plant (500kW upgraded to 1MW). It was commissioned in 1978, recommissioned in 1983 after repair of flood damage featuring two 250kW turbines and a 500kW unit. The electro-mechanical and transmission system rehabilitation of the project were further supported by the Asian Development Bank (ADB) in 2012 and 2015.

In 1991, the Andhikhola Hydro Electric & Rural Electrification Project (5.1MW) was installed with used equipment from Norway, and was a unique multipurpose project where water was tapped before the penstock for agricultural irrigating 309 ha of land. The BPC upgraded the project to 9.4 MW in 2011 with completion in March 2016 (Chaitra 2072) with additional water available for irrigation increasing the total irrigated area to 599 hectares and an added 30GWh of annual energy generation added to the Integrated Nepal Power System (INPS). The project was financed by the International Finance Corporation (IFC) and Mega Bank Limited, Nepal. ([BPC website](#), accessed 4 May 2016). Details are presented in one of the case studies.

One of the major initiatives in Nepal to support small hydropower came from GIZ from 2000 to 2010, implemented in three phases focussed first on demand, then on markets and third on dissemination. The project worked on grid-interconnect with the small hydropower sites, and feasibility assessments for off grid, as well as small hydro schemes. In addition, training and technical assistance was also provided for policy makers, and private sector alike. In total, over 104 projects, mostly between 1-4MW was supported and in 2009/10 capacity building within AEPC was conducted to enable the institutional takeover of service provider for the mini and small hydro projects⁴.

In the 2000's more small hydro projects were constructed: for example, the Khudi hydro power plant in Lamjung district with a capacity of 4MW came into commercial operation since December 2006. The Khudi Hydropower Limited was established with shares of the Lamjung Electricity Development Company- LEDCO (15%), BPC (60%); and SCP Hydro International, a Canadian hydro developer (25%). The power is grid connected, sold to NEA under a 25 year PPA and with a generation license for 35 years.

The development of mini-hydro by IPPs was initiated in the early 1990s. A few started to develop projects just below 1MW to avoid licensing etc. Currently there are approximately 12 mini-hydros developed by IPPs, only 3 below 500kW and others close to 1MW (NEA list, as per 2 May 2016 from IPPAN website). Out of IPPAN members, only 2 have operational mini-hydros, and another 2 in development stage (See Annex 1 and 2). One of them was the 183kW Syangja mini hydropower plant in Tangring VDC of Lamjung District via the Syangja Bidyut Company Ltd. (SBCL) with electricity generation from 2001 as the first project

⁴ Information derived from Energypedia article – *Small Hydropower Promotion Project (SHPP) Nepal Report* [https://energypedia.info/wiki/Small_Hydropower_Promotion_Project_\(SHPP\)_Nepal_Report#Overview](https://energypedia.info/wiki/Small_Hydropower_Promotion_Project_(SHPP)_Nepal_Report#Overview) (accessed 3 May 2016)

developed by private sector on commercial basis⁵. Some mini hydros that were developed by community/ donor support such as Salleri Chialsa, and Namche are additional but these systems are few and have been operational for over 20 years.

For small hydro, data derived from IPPAN and DOED shows a total of 41 operating projects totalling 174.4 MW, almost 20 per cent of the total hydropower generation in Nepal⁶ currently (See Table 2). Out of these, only 5 are being owned and managed by the NEA with the rest (36) developed by IPPs (see details in Annex 1).

Table 2– Operational small hydro projects in Nepal

Size	Total (no)	Total (MW)
1-3MW	18	39.674
3-5MW	13	58.225
5-10MW	10	76.5
Total	41	174.399

Source: IPPAN membership database and DOED (as of 8 January 2017)

According to DOED data (as of 8 January 2017), the list of issued survey licenses for projects below 1 MW was 171 (with total generation possibility of 121.480 MW). The IPPAN membership database shows a total of 153.155MW worth of projects under development (see Annex 2 for details).

1.3 Technical assistance – objectives and outputs

With a changing rural economy and better infrastructure, particularly roads, coupled with the increase in demand for energy access over the last few decades, the development of mini and small hydro for power generation is starting to be of greater interest especially for the private sector and investors, and for communities alike. The long-term viability of micro hydro in rural areas⁷, especially without sustained subsidy, is an issue that is starting to emerge. Compared to micro hydro projects, mini and small hydro systems are expected to bring economies of scale, faster progress, wider coverage, and/or more income generating opportunities for local people. Moreover, demand is growing especially in towns and district headquarters. In rural areas, if demand is not sufficient but the national grid is within reach, mini and small hydro systems can be connected generating revenue.

However, both the mini and small hydro sub sector development suffer from many barriers, especially if they are off-grid - high upfront capital cost, lack of sufficient commercial financing to cover these costs, lack of favourable investment environment in the country, lack of financial sustainability of operational systems, insufficient technical capacity and lack of awareness amongst others. The 2013 Rapid Assessment and Gap Analysis report brought out by the National Planning Commission's (NPC) highlights similar predominant

⁵<http://ledco.com.np/Page/index.php?PageID=6> (accessed 9th May 2016)

⁶As of 28 December 2016, data showed total of 57 operational hydropower projects = 846.859 MW (DOED)

⁷The AEPC has been mainly promoting micro hydro power (between 5-100kW) till date

gaps such as the lack of an enabling environment conducive to business, the regulating energy pricing mechanism driven by the political agenda rather than economic considerations, and lack of business confidence levels.

The challenges need to be ironed out and to address them, technical assistance was sought by the AEPC to understand in greater detail some of the key 'enablers' and investigate what supports and/or hinders each of the enabler, and what business models or approach may be best to rapidly upscale. One of the main issues in Nepal is that these enablers (mostly for micro hydro, systems below 100kW) were designed in the 80s and 90s, and need a significant change to adapt to current approaches, especially in attracting more entrepreneurial and private investments.

For a country, heavily dependent on a subsidy driven model, the following queries were put forward to be answered through analysis of some mini and small hydro case studies as evidenced from the field:

- Could commercial systems be made viable given the enabling environment in Nepal? And if so, what would be the roles and responsibilities of different stakeholders like the communities, local and central governments, financial institutions, AEPC, and any Special Purpose Vehicles (SPV)?
- What would make mini and small hydropower projects more commercially viable in the long term?
- What enablers – policy, financial and social - are needed to drive the enhanced development of mini-grids through hydropower?
- Can they function independently, or do they need to be grid-connected simultaneously when local consumption is low and to be financially sustainable?

There are many unanswered details to these multiple dilemmas that face the country as it a land locked country completely depending on imported fossil fuels. While the World Bank (2015) has carried out an intensive study on micro hydropower development⁸, there is still significant gap in understanding the existing technical and operational situation and management structure of mini and small hydropower systems (both on and off grid).

Currently, the AEPC is also seeking concrete evidences and suggestions to carry out in-depth study of a number of existing systems, review the experiences from countries that have success in similar implementation, and recommend appropriate institutional structure, support provisions, management arrangements amongst other features, for future projects to be promoted by the AEPC. **Therefore, the proposed technical assistance was being requested for the preparation of a case study of mini-and small hydropower (both off and on-grid) in Nepal to support AEPC in formulating policies and implementation framework to promote mini-hydro projects in Nepal.** The case study will document and share experiences of business models for on-and off grid mini-hydro and small hydro development and explore the various enablers and stakeholder roles to create an enabling environment.

⁸While the report is titled micro and mini hydro, the analysis is reliant on data from micro hydro systems. This report is focused only on mini and small hydro.

It must be noted that in many of the literature, mini and small hydro are used interchangeably but for this study, we maintain mini hydro as those systems between 100kW - <1MW and small hydro as those between 1-10MW.

The **key objective** of the proposed assistance is to *‘analyze factual evidences on the contribution of mini and small hydros for off-grid and on-grid energy and to share the existing best practices derived from the case study between developers, financiers and policy makers to strengthen the enabling environment for scaling up sustainable clean energy models towards energy for all by 2030’.*

The expected **outputs** are:

- A case study outlining the challenges identified and potential policy enablers for developing the mini-and small hydro sector in Nepal (in-depth field case studies + interviews with developer/policy makers and investors)
- A workshop inviting private and public sector developers, policy makers, regulators, utilities and investors in Kathmandu, Nepal to share the findings, as well as best practices from developers.

2. METHODOLOGY

2.1 Approach

Consultations, coordination and meetings were held with relevant stakeholders ranging from the government, private sector, and local implementing bodies to enable greater understanding of the on-going initiatives, identification of gaps in the sector, and recommendations for positive change.

The research uses a market mapping system framework, a systematic approach to categorising each energy market and a set of processes for analysing how each energy market operates and what makes each of them either thrive or fail. It is a useful tool to understand energy market systems and additionally designing relevant interventions. Under this framework, energy market systems are structured into three main levels as follows (see Figure 1):

- a) **Enabling environment** – this includes policies, regulations, and also social and cultural and in Nepal’s context – political factors.
- b) **Energy market chain level** – in this study, taken as project design and planning, construction and operation, and management
- c) **Support system** - Inputs, services and finance

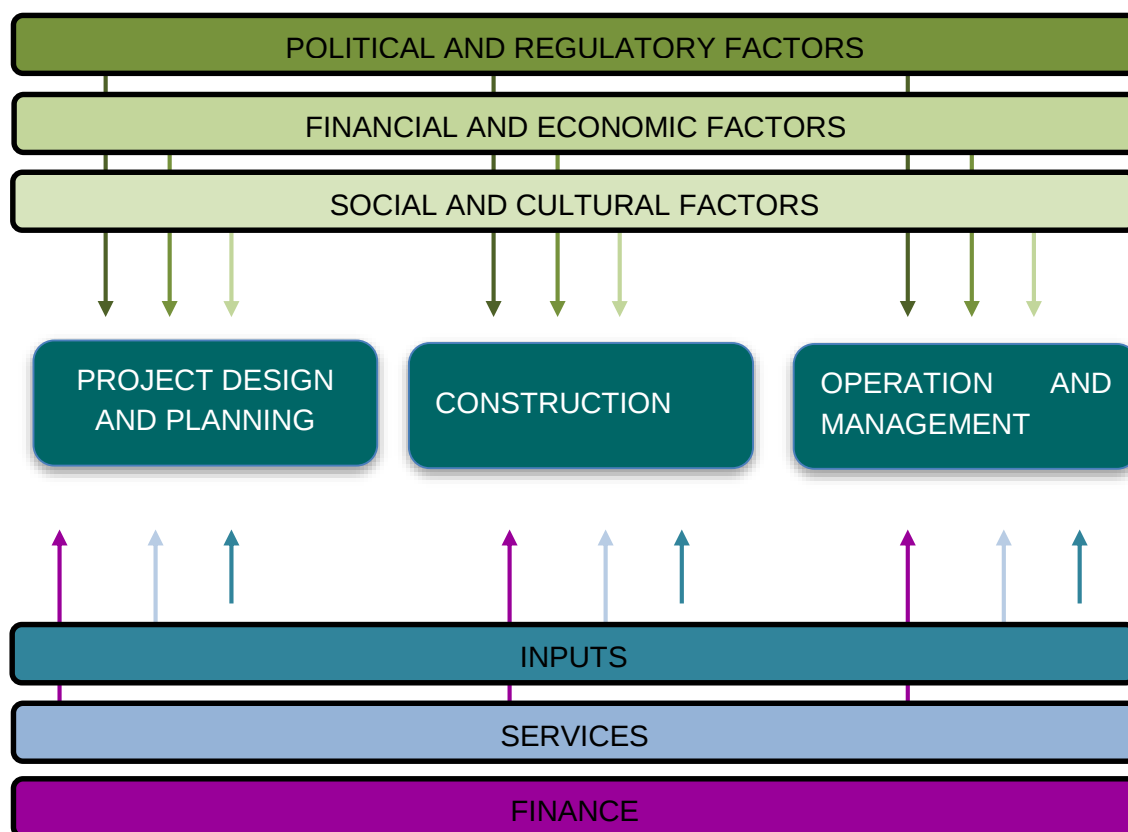


Figure 1: Market mapping approach

The following were the key inputs required for each case study:

1. Enabling environment – political and regulatory factors, social and cultural factors and financial and economic factors.

The enabling environment acts as the “rules of the game”, it often directly affects the process and procedure of project cycle. For example, the political and regulatory factors could be: policies, acts, guidelines, subsidy and grants, tariff structures, regulatory permits and licences, national rural electrification plans, power purchase agreements, and others as applicable. The concept is to understand how these factors create support or hurdles for the mini and small hydro sub sectors in Nepal.

In addition, the social and cultural factors that affect the effective planning, construction and operation and management will be considered in order to understand the social and cultural dynamics of the beneficiaries. The role of consumer awareness over time, including usage would be important factor to consider as it will influence the determining changes in the operation and management of the hydro systems such as tariff structures, revenue generation, end use applications and its development etc. In Nepal, community involvement is central in many off- grid rural hydro based projects, and the pros and cons of community involvement in private investment projects will also be looked into.

Similarly, the financial and economic factors (cost and resource mobilization, and the factors that have supported and/or hindered the commercial financing of the projects) also influence the planning, construction and operation and management of the hydropower projects.

2. The energy market chain (project cycle)

- i. **Project design and planning** – Demand creation and processing, feasibility, risk mitigation and management (socio-economic, political, physical), financing structures (mobilisation included) etc.
- ii. **Construction** – selection of vendors, installation processes including project management, payments, risk management, training workers etc.
- iii. **Operation and management:** governance structure and decision making, tariff/revenue collection/ billing system, technical resources, financial and operational management, benefit sharing mechanisms, ownership structures, risk management, service delivery and consumer satisfaction.

For financing, more details on the following:

- amount of electricity generated
- net sales after losses
- tariffs for electricity/ collection rate/ default rate
- collection costs plus other costs involved in billing consumers
- operational costs including staff etc. employed to run the plant, regular maintenance costs (if any)
- other operational costs related to electricity supply grid (depends if exporting directly to grid or selling to consumers over private wire)
- replacement costs/ reserve funds for major plant and replacement frequency.
- Others...enterprise development. Contribution of electricity supply to success of enterprises and vice-versa.

3. Inputs, Services and Finance

In order for each of the project cycle to carry out its functions effectively and efficiently, they need to access a variety of specific secondary inputs, services and finance. It can be clustered into following three components.

- i. **Community Engagement:** financial inputs and services, support towards risk management (conflicts, trainings for O&M etc.)
- ii. **Fund mobilization and collection:** Bidding processes, technical support, power output test and verifications, transportation, monitoring
- iii. **Other inputs** - Willingness to pay survey, needs assessment and capacity building, after sales services, post construction services, risk management services

2.2 Selection of case studies

Eight field sites were covered as part of the empirical assessment for this report, two were small hydro and six were mini-hydro. However, information on one mini-hydro site (Rairang) was minimal and thus will not be considered fully in the analysis. All case studies are presented in the annexed report. Field visits were conducted between April and August 2016 to gather information of the projects. In some sites, consumers were also surveyed.

The sites were selected based on three key criteria:

- i. **Size – mini or small hydro:** Most small hydro plants are grid connected in Nepal, and the two projects selected – Andhi khola and Piluwa khola have longer history of operationalization and local engagement with the communities in the project catchment area. Andhi khola was also chosen as it was one of the first amongst small hydro systems built in Nepal with major local inputs. This model provided a good learning ground for the private sector developers of both mini and small hydro in the country. Similarly, Piluwa khola project led initial development of small hydropower by the private sector in the country connecting to the national grid. Since then, many small hydro projects have been built or are in the pipeline.
- ii. **Geographical distribution:** To understand the challenges in remoter areas, a wider geographical distribution within the country was sought. Jumla mini hydro is the remotest, and as explained in the case study, the challenges are also fairly high.
- iii. **Ownership, management and operational models:** High priority was provided to find projects that have been in operation for a number of years so that the business models, management and ownership structures can be looked at more closely. The ones selected are amongst the following (Sources: DOED website, 2016 and Energy Development Services, 2012)
 - Government (NEA) projects leased out to communities or the private sector. There are approximately 13 existing projects.
 - Fully subsidised systems but managed and operated independently by forming a shareholder company (private/community). Two (2) systems exist - Salleri Chialsa and Thame in Solukhumbu district.
 - Co-operative owned and managed model. Approximately 2 exist – Jhankre and Haluwa khola
 - Private sector independent hydro grid connected (some are public-private), both mini (approx. 12) and small hydro (34)

Details of the operational status of many of these projects are not very well known because of very poor record keeping and documentation by the proponents. The case studies are meant to expound on the operatives of these models. The following table provides a summary of the projects selected for the study.

Table 3– Overview of case study projects

SN	Project	Location District	Year commissioned	Size	Mini/ Small	Grid connect	Business model
1	Andhi khola	Syangja	1990 (2016 upgrade)	5.1MW, upgraded to 9.4MW	Small	Yes	Private-public (some public investment)
2	Piluwa khola	Sankhuwasa bha	2003	3MW	Small	Yes	Private company (from locals within area)
3	Sobuwa khola	Taplejung	1984	125kW-synchronised with 90kW micro hydro	Mini	Connected to NEA's local Grid	NEA owned, leased to community
4	Jugad khola	Jumla	1983	200kW	Mini	No	NEA owned, leased to community
5	PHEME khola	Panchthar	1980	240kW & 150kW	Mini	No Yes	- NEA owned, leased to cooperative - Private
6	Haluwa khola	Ramechhap	2012	400kW	Mini	No but planned	Community/Cooperative (KREC)
7	Salleri Chialsa	Solukhumbu	1985 1990	(400kW) - 200kW - 200kW	Mini	No	Shareholder company (community/NEA/SDC)
8	Rairang	Dhadhing	2004	500kW	Mini	Yes	Owned by private company

3. STAKEHOLDERS

Hydropower is the key resource for sustainable electricity generation in Nepal, and thus has many stakeholders involved. Some of the key stakeholders are presented in this section.

Table 4 -Key stakeholders and their roles in mini and small hydro in Nepal

S.N.	Stakeholders	Enablers	Market chain	Supporting
1	Ministry of Energy	Policy, planning - small, medium, large hydro	Resource assessment?	N/A
2	Ministry of Population and Environment	Policy, planning – below 1MW, IEE, EIAs	N/A	N/A
3	National Planning Commission	Planning	N/A	N/A
4	Department of Electricity Development	Licensing	N/A	N/A
5	Nepal Electricity Authority	Regulation, tariffs, PPAs	Generation, transmission, distribution,	Training
6	Water and Energy Commission Secretariat	Policy advice	Planning	R&D
7	Alternative Energy Promotion Centre	Policy, standards	Resource assessment, Programme implementation, subsidy channelling	R&D, setting quality assurance guidelines, monitoring, training
8	Local governments including DDC		Registration of schemes	Financing (grants)
9	RE Testing Station	Standards/ quality control test	Certification	
10	Commercial banks	N/A	Provision of loans (debt mostly)	Trainings, monitoring (for own portfolio)
11	Local FIs	N/A	N/A	Consumer loans for productive use, energy equipment etc.
12	Manufacturers	N/A	Mostly turbines, load controllers, hydro mechanical equipment	N/A
13	Developers	N/A	Design, planning, feasibility, construction, ownership, management	Maintenance, monitoring, training
14	Community/ Cooperatives	N/A	Ownership, management (for mostly mini-hydro),	Maintenance

S.N.	Stakeholders	Enablers	Market chain	Supporting
			liaise with local governments	
15	Associations (NMHDA, IPPAN, WECAN),	N/A	N/A	Awareness, lobbying, trainings

Some of the key stakeholders and their main roles are briefly explained below:

- **National Planning Commission (NPC)** and its Secretariat undertake the formulation and monitoring of 3 or 5 years' overall development plan for the country. The plans set by NPC are directed to the respective ministry of the government. As per the government's Work Division (Second Amendment) Rules, 2009 the hydropower sector is categorised into two sections based on the capacity - those under 1MW is under the jurisdiction of Ministry of Population and Environment (MOPE) and those over 1MW is under the Ministry of Energy (MOE). Thus, mini hydro is MOPEs responsibility and small and large hydropower is the MOEs.
- **Ministry of Energy (MoE):** The electricity sector had been the domain of the Ministry of Water Resources for a long period of time, which in 2009 was bifurcated into the MoE and Ministry of Irrigation. The MoE's primary focus on formulation of policies, plan and regulations for construction of larger hydropower (above 1MW), private sector promotion, market development for energy and distribution of electricity in Nepal and coordination with bilateral and multilateral amongst others. In addition, the following are under MOE:
 - **Water and Energy Commission (WEC)** was founded to advance the development of water and energy resources in Nepal and is involved in the formulation of energy systems planning and policy advice and the Secretariat is placed within the MoE.
 - **Department of Electricity Development (DOED):** All licensing of hydropower (survey, generation and commissioning) for RE projects above 1 MW and up to 500 MW both for private developer and NEA are undertaken by the DOED under the MoE. For projects above 500MW, the mandate lies with the Investment Board of Nepal, established in 2011 to promote economic development by creating an investment friendly environment and provide a 'one window' service for potential investors.
 - **Nepal Electricity Authority (NEA)** is the sole agency that is responsible for transmission and distribution of electricity for public. NEA also generates and develops the hydropower project by itself and buys the power generated by Independent Power Producer (IPP) on the basis of Power Purchase agreement (PPA) as per Electricity Act, 1992. Under the same Act, the government constituted a Tariff Fixation Commission to fix the retail electricity tariff.
- **Ministry of Population and Environment (MOPE)** regulates as well as promotes the hydropower under 1MW capacity through the autonomous body, Alternative Energy

Promotion Centre (AEPC). Prior to this, when the AEPC was established in November 1996, it was under the Ministry of Science and Technology.

- **Alternative Energy Promotion Centre (AEPC):** The AEPC is a semi-autonomous government institution mandated to promote and deploy renewable energy technologies. Before establishment of AEPC the micro and small hydropower were developed through efforts of organizations like ITDG Nepal (now Practical Action), IUCN, ICIMOD, Agricultural Development Bank Nepal, NEA and donor agencies. The role of AEPC is varied – policy, planning and strategy formulations, development of large scale multi-year programmes and projects, setting standards and guidelines, and maintaining partnership with bilateral and multilaterals and other donors, as well as all stakeholders. AEPC is also responsible for monitoring, and capacity building for the renewable energy projects below 1MW. AEPC also works with the District Development Committees (DDC) in the promotion or support of the implementation of micro or mini hydro in their districts.
- **Private sector and industry associations:** The private sector is more active in small hydro (between 1-10MW) generating almost 20 per cent of the total hydropower output. However, for mini-hydro, there is lesser number of private sector players. There are three main industry associations relevant to mini and small hydro developers:
 - **Nepal Hydropower Association (NHA)** – established in 1999 as a non-governmental, non-for profit mainly to support the capacity building of hydropower professionals and create the better environment of carefully planned hydro projects in Nepal. In its website (as of January 2017), it lists amongst its membership 14 corporate members, 105 life members, and 18 general members.
 - **Independent Power Producers' Association, Nepal (IPPAN)** – established in 2001 as an umbrella organization of independent power producers, with the sole aim of advocating for an investor friendly environment for power development. Some of the mission activities are to lobby for private sector policies and regulations, build capacity of IPPs and stakeholders, disseminate information and develop linkages for regional co-operation in the power sector. As of January 2017, IPPAN's membership listed 106 corporate members and 38 associate members (financing institutions, legal firms, investors, consulting firms etc.)⁹.
 - **Small Hydropower Development Association of Nepal (SHDAN)**, with the aim of advocating the development of small hydropower projects. This Association is currently inactive.

Some of the major private companies associated with mini and small hydro development are the Butwal Power Company Ltd. (9.4 MW Andhi Khola), LEDCO (Khudi 4MW¹⁰, and 183kW Syangja), National Hydro Power Company (7.5MW Indrawati 3), Arun Valley Hydro Power

⁹Source: IPPAN website (accessed 8th January 2017) - <http://www.ippan.org.np/page/vision/>

¹⁰BPC is a majority owner

Company (3MW Piluwa), Sanima Hydro Power Company (2.6MW Sun Koshi and 7MW Mai Cascade), Alliance Power Nepal (3MW Chaku) and others¹¹. Many companies are established as special purpose vehicles (SPVs) for individual projects.

- **Donor-supported Programmes:** The UNDP-GEF supported Renewable Energy for Rural Livelihood (RERL) project is part of the AEPC NRREP, and aims to develop 10 MW of mini and micro hydropower, 2.5 MW of solar PV systems and establishment of mini grids connecting micro hydro plants of 300kW capacity to pool energy. The project will also support building up capacity of local fabricators, installers & system integrators ([UNDP website](#), accessed 6th May 2016).
- **Non-government organisations (NGOs):** The role of NGOs apart from industry associations is fairly low in the development of mini and small hydro. They are mainly focused on capacity building, research and policy development.
- **Financial institutions** in Nepal are supporting mostly small hydro but very little support for mini-hydro as they do not want to risk financing off grid projects. As per the Nepal Rastra Bank (Nov, 2016), there are 30 commercial banks, 76 development banks and 39 microfinance development banks amongst other types of financial institutions in the country. Locally based micro finance institutions (MFIs) have been known to provide loans for electricity connections to the grid etc. but there is no assessment carried out in detail specifically on the topic. An indication of the commercial and development banks involved in the hydropower financing can be from the IPPAN membership list where a total of 13 banks are listed¹². Two banks that have invested in mini-hydro recently are Civil Bank and Himalayan Bank, both not listed on IPPAN membership.

¹¹<https://nirmaljoshi.wordpress.com/2011/07/29/list-of-small-hydropower-project-in-nepal-2011/> and DOED 2016

¹²As of January 2017, these are Ace Development Bank Ltd., Bank of Asia Nepal Limited, Global IME Bank Ltd, Grand Bank Nepal Ltd., Jyoti Bikash Bank Ltd., Laxmi Bank Ltd., Nabil Bank Ltd. , Nepal Investment Bank Ltd., NMB Bank Limited, Sanima Bank Ltd. , Siddhartha Bank Ltd. , Standard Chartered Bank Nepal Ltd., Sunrise Bank Ltd.

4. CURRENT SCENARIO OF MINI AND SMALL HYDRO IN NEPAL

4.1 Enabling environment

There are some important elements of an enabling environment for mini and small hydropower development. The first is a robust and transparent legal and regulatory framework that needs to promote both public and private sector investments, particularly to achieve the country's planning target for the energy sector. The government's roles and responsibilities include establishing, disseminating and implementing pricing, setting clear regulatory provisions on land rights, clearly setting out the offtake arrangements, and setting and enforcing performance standards. Secondly, there should be sustainable off taking arrangements. This can be in the form of a creditworthy off-taker or an assured market for the power. Setting out and enforcing a tariff structure that reflects the costs are important. Private entities need to be able to establish such a tariff and be legally assured that it can be enforced. In addition, licensing, clearances and permit processes need to be clear, streamlined and transparent. (USAID, 2016). The following sub sections explain some of the components in a time sequence and the applications till date, including challenges.

4.1.1 Planning

The NPC sets up a 3 or 5-year national plan, with often ambitious targets in the energy sector. Some key plans for hydropower development, particularly for mini and small hydro are:

- First five-year plan (1956-61) targeted 20MW of hydropower
- The sixth plan (1980-1985) aimed at systematically undertaking development of small hydro projects in appropriate areas of the hill region by mobilizing local resources, even though the establishment of such infrastructures were not economically feasible.
- The eighth plan (1992-97) provided priority to the energy sector
- The ninth Plan (1997-2002) emphasized the need of mini hydro for economic development and environment protection with policy formulation directives and target (Pokharel G, 2008¹³).
- Thirteenth Three-Year Plan (2013/14 – 2015/16) set a target of 1,373 MW of hydroelectricity generation but at the end of the plan period, the total achieved was 829 MW. No specific targets as per size of projects.
- The latest Fourteenth Three-Year Plan (2016/17-18/19) has set an ambitious target of 2,279 MW of hydroelectricity at the end of the plan period. The Plan has also set a target of developing 11 MW of micro hydropower.

4.1.2 Policies, Acts and Regulations

Hydropower development is at the core of energy sector development in Nepal, and in many of the existing policies, acts and planning for the country. There is no national level energy strategy although a draft has been forwarded to parliament. In **1992, a hydropower**

¹³Pokharel Govinda, Plans and policies for RE development. Accessed from SARI website - http://sari-energy.org/PageFiles/What_We_Do/activities/Renewable_Energy_April_2008/Nepal_Pokharel.pdf (3 May 2016)

development policy was promulgated. Prior to 1990s, there were no policies as such, most of those for mini and small hydropower appended to policies related to larger hydropower development.

The **Electricity Act 1992** opened the doors for private sector investment in hydropower in Nepal. The Act, for the first time, allowed a person or corporate body to carry out survey, generate, transmit and distribute electricity. It provided impetus for the development of mini and small-scale hydro sector in the country. Hydropower plants from 100kW to 1MW did not require licenses but the developers had to inform the government of such development. The Act provides customs duty exemptions but exempts them from royalty payment. It also stipulates that for electricity distribution in isolation of the national grid, the distributor could fix the tariff and charges independent of the Electricity Tariff Fixation Commission (ETFC).

The Act also allowed developers to sell electricity in bulk to the national grid. The Nepal Electricity Authority (NEA) is the only bulk off-taker of electricity from private sector hydropower plants. In 1998, NEA announced that it would purchase electricity from all hydropower plants of 5MW and less at a standard wet season rate of NRs. 3 per kWh and dry season rate of NRs. 4.25 per kWh with the rates to be escalated for the first 5 years at 6% p.a. The power purchase agreement would be for 25 years (Sherchan, 2008). The current PPA rates are NRs. 4.8/kWh (0.05 USD) for wet season and NRs 8.4 (0.08 USD) for dry season.

The Act also has a provision for government to take over plants below 1MW (by paying compensation) for "extensive public use", which is defined as public use more than what is currently being done. Furthermore, it also stipulates that if a hydropower plant is developed in an area where previously a plant 1MW or below is already in operation, the developer should purchase the latter plant, if its owner wants to sell it, through "mutual agreement".

No environment assessments are required for hydropower projects below 1MW. Till lately, projects up to 5MW required an Initial Environment Examination (IEE) and projects above 5MW required a full scale Environment Impact Assessment (EIA). The recent announcements and DOED are as follows:

- up to 1 MW nothing required
- 1-50 MW –Initial Environmental Examination (IEE)
- Above 50 MW –Environment Impact Assessment (EIA)

However, all projects within conservation areas required an EIA regardless of size.

The **Electricity Regulations 1993** describes the details that needed to be submitted to the government by mini hydropower project developers. The regulation stipulates that any party wanting to develop mini hydropower plants (100 to 1000 kW) must submit to a detailed description of the project, map of the project site, source and quantity of water to be utilized and whether the required water resources has already been utilized for another purpose, area where the electricity is to be distributed and estimated number of beneficiaries.

In addition, the **Local Self Governance Act, 1999** has the aspirational provision that VDCs and Municipalities will have the function to generate and distribute (or cause to generate or

distribute) electricity. The Act also has the provision for DDCs to formulate, implement, operate, distribute, maintain and repair mini and micro hydropower projects. The Local Body Resource Mobilization and Management Guidelines, 2013 issued by the Ministry of Federal Affairs and Local Development requires that local bodies also invest in renewable energy. The Ministry has also established a District Environment, Energy and Climate Change Section (DEECCS) in all DDCs. However, specifics of the investment modality are yet to be worked out.

The **Hydropower Policy 2001** has the aspirational provision that electrification of remote rural areas shall be encouraged by operating small and mini hydropower projects at the local level. Furthermore, the policy states that electricity will be supplied to remote mountainous areas far from the grid through small hydropower projects, which will then be handed over to local cooperative groups for operation and maintenance, involving these groups in the development of such projects. However, the specifics of how this will happen have not been spelt out. The policy also clarifies that hydropower projects up to 1 MW need to be registered with the District Water Resources Committee before its commencement and information of the registration need to be provided to the DOED.

The survey/study license of hydro projects up to 10MW shall be issued within 60 days of submission of all details need. While survey/study license are valid for maximum of 5 years, generation licenses are valid for 35 years from the date of issuance, dependent on the nature of the project if internal demand of country is met. Electricity transmission and distribution is for 25 years from date of issuance, but under the hydropower policy it may be renewed for ten years. For systems, higher than 1MW, most are based on the Build, Own, Operate, Transfer (BOOT) model, transferred to government after expiration of the license. In July 2006, the government promulgated an ordinance and made value added tax (VAT) applicable to all hydropower projects above 3MW.

The effort to operationalize the policy provisions through revision of the Electricity Act is ongoing over the last decade.

The **Rural Energy Policy 2006** also has the aspirational provision that rural economic activities will be stimulated through provision of electricity through, among others, development of mini hydro and other off-grid renewable energy systems by the local groups, private sector, or non-governmental organizations. More specifically, it aspires for:

- Provision of concessional loan or on installment basis for local consumer group or cooperative to take over management and ownership of publicly owned small hydro power projects.
- Power purchase agreements and electricity wheeling facilities for projects where the national grid arrives
- Integration of mini hydro projects with irrigation, education, health, drinking water, small-scale industry & ropeways
- DDC and VDC investment in community owned mini hydro projects through the District Energy Fund and Village Energy Fund respectively

Subsidy policy: The Government of Nepal formulated subsidy policy in 1970 which is revised regularly as per the changing market demand. As per the 2006 revised renewable energy subsidy policy, the GoN supported the micro/mini hydro up to 500kW at the rate of NPR 85000/kW (~850 USD), which is approximately 50 per cent of the total project cost depending on the specific site location. It meant that the project developer should mobilise the other half of financial resources in the form of loan, grant and investment. However, in 2010, the subsidy cost/kW was increased to NPR125,000 (~1,250 USD). The latest **Renewable Energy Subsidy Policy 2016** stipulates subsidy for off-grid mini hydro projects based on the actual power generation or consumption. If a mini hydro project has the possibility of both supply to grid and local distribution, subsidy will only for energy consumption by local consumers.

The subsidy amounts are as follows:

Table 5: Subsidy as per 2016 policy

Category	Amount (NPR)			
	Humla, Dolpa & Mugu districts: where only air transport of goods possible	Category "A" regions except Humla, Dolpa and Mugu districts	Category "B" districts	Category "C" districts
A) Subsidy based on project				
Distribution (per HH) ¹⁴	35,500 (~350 USD)	32,000 (~320USD)	30,000 (~300USD)	28,000 (~280 USD)
Generation-Equipment (per kW)	125,000 (~1250 USD)	95,000 (~950 USD)	85,000 (~850USD)	80,000 (~800 USD)
Generation-Civil (per kW)	80,000 (~800 USD)	30,000 (~300 USD)	25,000 (~250 USD)	20,000 (~200 USD)
Maximum distribution + generation subsidy (per kW)	382,000 (~3,820 USD)	285,000 (~2,850USD)	260,000 (2600USD)	240,000 (~2,400 USD)
B) Subsidy based on energy consumption				
Energy consumption (per kWh)¹⁵	55%	50%	45%	40%

The categorization of districts is spelled out in the annex to the policy. For mini hydro projects, solely for productive uses such as for tourism, mining, irrigation, pumping etc., the "generation-equipment" subsidy as described above will be provided.

With the assumption that the institutional structure for managing a mini hydropower project is a cooperative because such a structure provides economic participation of its members, AEPC also developed **guidelines** for a **Mini/Micro Hydro Cooperative (MMHC)** (AEPC, 2013).

¹⁴Maximum 5 households per kW. However, distribution is not a prerequisite to qualify for generation subsidy

¹⁵To be paid to the project developers for 5 years only based on actual energy consumption

MOU Agreement between NEA and AEPC: The agreement was signed in October 2016 between the two government entities - AEPC and NEA with regard to the expansion and management of alternative energy in the country. The agreement states:

- Rural electrification through promotion on mini and small hydro by unified planning and coordination of two organizations.
- Formulation of policy, standards to connect the off-grid alternative energy to the national grid.

The MOU initiates coordination between these organizations in developing renewable energy sector.

4.2 Market chain

In addition to the NEA, private sector developers as well as community/co-operative based companies are emerging in Nepal implementing both mini and small hydro plants. Some of the typical stages in the development of a market chain are outlined in Table 6 below.

Table 6– Stages in a typical mini-small hydro market chain

Stages		Current situation
Project design and planning		
1	Resource assessment	Dependent on government. No detailed hydrological measurement resource data available for all rivers in the country (NHA, 2016). Individual sites are mapped as per hydrological data, specific site feasibility visits/study etc. No IEE or EIA required for mini-hydro or small hydro below 3MW
2	Design and feasibility	Mostly conducted by local engineers, consultants either within the institution/ company. Nepali IPPs are fairly confident of designing small hydro projects. However, within AEPC and smaller developers, there is a felt need that some experience is needed and trainings required for mini-hydros especially stand-alone (AEPC is not mandated to develop the small hydro sector which is under the Ministry of Energy).
Construction		
3	Manufacturing	Most turbines manufactured in Nepal are for micro hydro, and only some for mini hydro. Private manufacturing sector are keen to upgrade capabilities for producing more and larger turbines, and other devices for mini-hydro, although high quality turbines are imported especially for small hydro. Over the last decades, there have been a steady manufacturing sector in micro hydro – approximately 35 but mostly small scale (data from NMHPDA, 2016)
4	Construction/ installation	Both construction of hydro and installations of equipments are possible by in-country experts. For most civil works, AEPC supported subsidised projects rely on communities to provide civil work contributions through labour work, and sometimes cash contributions. This could potentially mean that civil works are not of good quality and take long time to complete. For micro hydro, there are about 70 companies, with a few

Stages		Current situation
		aspiring to install mini-hydro
Operation and management		
5	Operation & maintenance	In community owned systems, local operators are trained to manage the hydro system. However, for those managed by NEA or IPPs, trained staff are available. NEA provides in-house training to its operators. Many are trained on the job, by vendors if specific operation or maintenance is required. These are often requirements within procurement processes.
6	Ownership and Management	Depends on the ownership models (please see section below)

Some of the **common ownership and management models** are:

- **Public sector:** Mostly implemented by the state owned NEA that actively constructed and managed mini and small hydro plants for many decades but is slowly phasing out, and as can be seen from examples of case studies in Jumla, PHEME khola and Taplejung. The NEA is also the sole buyer of electricity from the private developers after signing a PPA. The NEA can create subsidiary companies to develop and operate projects, but most are small, medium or larger scale hydro projects.

The NEA leased out many mini hydros to local companies or beneficiary communities¹⁶(although terminologies used by NEA point these out as small hydro) in the 90s because of low load factor, poor technical performance and poor financial management. The first group were leased out for 20 years in 1993 - Darchula (300kW), Khandbari and Bhojpur (250kW), Jomson (240kW), and Bajhang (200kW) under the terms that there was an annual royalty payment, that tariffs could not go above that of the NEA, and the lessees could provide concessions at their discretion, but then could have their bonds revoked or contracts terminated if they broke contractual obligations or did not supply electricity for more than 3 months. The results turned out to be encouraging leading to the second batch of leased out projects for 10 years in 1999 at Taplejung, Phidim, Terhathum, Jumla, Serpodaha and Chaurjhari (all between 100-200kW). Out of the total lessees, 7 were private firms and 4 were community.

By 2005, eleven of the leased out plants were still operational under original contract with three damaged during the insurgency movement, one was unsigned because of local opposition, and only 1 lessee defaulted. These leasing was considered successful as the lessees were running it well, consumers were getting better reliable services leading to economic activities in the areas. The model did not go without its fair share of problems such as unmanageable cost of responsibility (the NEA taking major role but slow in response), the unequal relationship and weak monitoring, challenges for lessees to get additional financing as they did not own the plants and remote sites meant human resources to be stationed were not easily available (Kharel G, 2005). Some of the case studies (Jumla, Paanchthar, Taplejung) are remnants of this model.

¹⁶The NEA does not construct these mini hydro systems anymore

In addition to the NEA, for hydro below 1MW, the AEPC is supposed to be a one stop institution that channels donor funding in most instances, develops policies, and implements programmes and plans, including monitoring. It is also responsible for developing quality assurance standards and guidelines. The focus of AEPC is mostly rural, although it is currently also starting to be involved in peri-urban and urban areas. A one window government programme, the National Rural and Renewable Energy Programme (2012-2017), is operational funded by all major donors, and includes mini-hydro amongst its programmatic activity although the focus is mostly on micro hydro handed over to communities to own, maintain and manage.

Until recently, before adoption of Subsidy Policy 2016, the AEPC supported only community-owned micro-hydro plants up to 100 kW size, with the following process:

- i. Communities made aware about MHP and its benefits through the Regional Service Centres (RSCs) are implementing partners of AEPC) and District Energy, Environment and Climate Change Sections (DEECCS).
- ii. Interested communities then submitted application to AEPC expressing willingness to construct MHP for their community.
- iii. On behalf of AEPC, the RSC conducts pre-feasibility study of the site for initial assessment of technical and socio-economic viability of the project.
- iv. If pre-feasibility report is satisfactory, AEPC selects a competent private firm through public call to perform detailed feasibility study of the project. The study will include technical design, financial estimations and social evaluation.
- v. After initial verification of the report, RSC forward the report to AEPC, which is finally screened by AEPC's Technical Review Committee.
- vi. A satisfactory project will be conditionally approved for subsidy and the community user's committee will be informed to complete financial closure for the project.
- vii. Upon achieving the financial closure by the user's committee, AEPC calls bid from qualified companies for supply of components and construction of the plant in line with the Public Procurement Act and Regulation.
- viii. Upon receiving approval from the Central Renewable Energy Fund (CREF), AEPC selects the lowest bidding vendor.
- ix. The vendor installs the system, which is tested and commissioned by AEPC, RSC and DEECCS. A hired third party will do power output and consumer household verification. Only after one year of testing and commissioning the project is handed over to the user's community.

AEPC will use the same process for mini-hydro development. Small hydro is currently not under the AEPC, but falls within the domain of Ministry of Energy.

- **Private sector:** The private sector is starting to be more active in developing the mini-and small hydro sector. They can be funded through domestic or international investors. Nepal's IPPs have started significant contribution to the electricity grid by developing mini and small hydro (~20 per cent) but limitations of active engagement because of unstable political climate, slow changes in power development acts and regulations, low PPA rates, and weak governance are common. Most companies are set up to own, operate

and manage projects with only a handful having more than one or two operational projects. Private-public partnership has been few and far between with private sector requiring active change in governance, and the enabling environment. The AEPC-RERL programme aims to demonstrate success of public private partnership for development of mini hydro projects through facilitating investment environment amongst others.

- **Communities and co-operatives:** Nepal's hydropower policy encourages community, cooperatives and local bodies to be active in developing smaller hydro projects. Many of the early mini hydro systems such as Salleri Chialsa and Namche in Solukhumbu district were built with much support from the communities who are involved in managing the system, mainly being trained in various aspects of project delivery, operation and management.

Brief elaboration within the market chain for mini and small hydro power plants are outlined below:

- **Feasibility:** There are many IPPs that are starting to specialise in the design and implementation of small hydro projects, although not many have forayed into mini hydro projects, not for lack of capabilities but because there are not too many bankable projects being developed as many of these systems are considered highly risky by financial institutions and investors. There is no clear plan or mapping on potential for projects to be developed (for on and off grid), and thus most feasibility assessments are conducted by developers who have obtained survey licenses on a first come first served basis. The former Clean Energy Development Bank (now merged into NMB Bank) had established a USD 3 million development fund to conduct feasibility studies for small- and medium-sized projects, as these projects often suffer from an early-stage financing gap (Bergner 2013) This fund is institutionalised into the CEDB hydro fund (<http://chf.com.np/>). While the government supports the idea of private sector investment and entry in the sector, and to communities, in reality the insufficiency of enabling conditions does not make it entirely feasible specially to make it financially attractive. Many micro hydro developers are keen to hone their knowledge and skills and upgrade their work on the development of mini-hydro.

Mini-hydro still provides a good option for the nation in the short to medium term for rural electrification as it will bring the populations not only electricity but also better opportunities to initiate small enterprises, and better communication facilities. In addition, it also provides better option in terms of environmental assessments, as they are less likely to have major negative impacts.

- **Costs:** General literature reviews show that small hydro (not much information on mini-hydro) is more attractive than medium hydro. Bergner (2013) refers to the World Bank's Power Development Project (PDP) that showed 4 small hydros (2.2-5MW) had economic internal rate of return (EIRR) of 30per cent each, whereas 2 medium scale projects had estimated 12 and 13.4per cent. The World Bank analysis recommended minimizing construction costs and improving plant efficiency to make these projects more viable.

For most mini-hydros, average costs could be between USD2500-4000/kW and potentially more depending on the remoteness of sites. Bergner (2013) looked at 17 hydro projects, with installed capacity between 0.1 and 10 MW results showing a weighted average cost per kW of USD 2,450 in comparison to 13 medium-scale projects, ranging from 12 to 70 MW with the weighted average cost per kW installed determined to be USD 3,635.

- **Operation and management:** Mostly dependent on the type of delivery model (public, private or community). Nepal's hydro sector has developed consistently over the last few decades with an increasing number of graduates in renewable energy including hydropower. For mini-hydro that is off the grid in remote areas, the problem may continue with a need for newer management models such as SPVs. Lessons can be learnt from the community run mini hydro projects, but for this the communities need to be trained appropriately and significantly.

Technically, for the governance of mini-hydro that is off grid, the challenges are even more. For instance, tariffs in rural areas for electrification via stand-alone systems are often fixed either per connection or the number of light bulbs being used. Load switches are used by some to limit the connection in the household. One of the reasons why the assumption that mini-hydro may be more sustainable than micro hydro especially in densely populated areas or towns is that consumptive loads are growing whereby people want to use more electricity for TV, fridges, and other electrical appliances. Some mini-hydro systems that are operating for a while such as in Salleri Chialsa and Namche bazaar in Solukhumbu district are utilizing energy based tariffs, whereby users are paying for the actual energy they are using via meters. This increases management costs and responsibilities, but with the advance of smart meters, such issues can potentially be overcome. On the other hand, this significantly increases the revenues for the project.

4.3 Supporting services

4.3.1 Financing

Hydropower projects in Nepal can be developed by the national utility NEA, IPPs, communities/cooperatives, and also through foreign direct investments (FDIs). The scale of projects is important for financing and the following provides an overview for mini and small hydro.

4.3.1.1 Financing mini-hydro

Mini-hydro is financed currently through two main models:

- **Public/ donor supported:** The AEPC for many years have pursued micro hydro development mainly through a subsidy led model. However, the interest to build projects over 100kW is on an increase, and the subsidy policy 2016 incorporates this. The AEPC has started to receive expression of interest to seek subsidy to develop mini hydro. One of the first supports was for the 400kW Haluwa Khola project (one of the case studies). A recent study for RERL recommends that AEPC should provide 50-70per cent subsidy to all off-grid projects depending on remoteness, facilitate soft loan to developer from

banks and the developer to invest equity of 15per cent (Energy Development Services, 2015).

The Central Renewable Energy Fund (CREF) was established under the AEPC as ‘the core financial institution responsible for the effective delivery of subsidies and credit support to the RE sector’ (AEPC website, 2016). The fund is structured with government and development partner contributions, managed by a commercial bank and through a competitive system, a number of partner pre-qualified banks. In November 2010, the government of Nepal and the German International Cooperation reached an agreement to set up a micro hydro power (MHP) debt fund and by 2015, NRs 63m in credit has been disbursed supporting 1,105kW capacity. As of August 2016, CREF had channelled loans for 40 MHPs (Rai, 2016). However, the MHP Debt Fund is currently providing loans to projects between 10kW and 100kW that are community owned/managed. It is envisaged that the same modality will be used for mini-hydro projects in the future as CREF have three mini hydro projects in the pipeline awaiting bank finance¹⁷.

- **Private/Community:** the private developers along with communities are also utilising their own capital combined with loans from local banks to develop mini-hydro (in addition to subsidy). However, financing institutions are hesitant to finance smaller projects, especially mini-hydros that are off grid for various reasons – lack of in house technical expertise, high costs of monitoring and follow up, and other risks. This is evident as there is record for only two mini hydro projects being financed through commercial banks. As per CREF, the Himalayan Bank financed a NPR 7.5million loan to 100kW Midim Khola project in Lamjung and a recent NPR10m loan approval by Civil Bank for a 200kW mini hydro project in Rukum. One of the most important issues for investment is the lack of an assured cash flow of projects without PPAs. Analysis by Oshin Power Services (2013) for nine micro hydro projects (ranging from 12-40kW) have shown that while some make operating profits (covering salary, operation and maintenance, but not depreciation and service of loans), all of them fail to make net profits¹⁸ (World Bank, 2015).

In addition, developers in rural areas lack financial mobility due to the underdevelopment of project areas, and requirement of higher investments. Nepal’s commercial banks are willing to provide loans with a payback period upto 8 years only (Rai, 2016). There is also the demand for collaterals and guarantees for repayment of investment by financial agencies.

4.3.1.2 Financing small hydro

Private hydropower projects are largely debt financed. Equity is usually difficult to raise in local community and with private developers, crucial for financial institutions and investors to be attracted to. However, with conservative policies of the Nepal Rastra Bank and single obligor limitations imposed on financial institutions renders the loan financing by commercial

¹⁷Confirmed with CREF in January 2017

¹⁸Such analysis for mini hydro or small hydro have not been published yet

banks to be cumbersome with group of banks forming consortiums to finance even small hydropower projects (Sherchan 2008). As mentioned above for mini-hydro, financial institutions in Nepal have been exceedingly risk averse and rather prefer to invest their funds in safer loan products, like houses, land and cars. Banks, therefore, demand high interest rates with a short repayment period as well as non-project guarantees or collaterals for loans. It must be noted that project financing is relatively new with collateral and personal guarantee backed lending (Shah, 2008)

Most hydropower finance is considered attractive if a PPA is guaranteed. This is more common to small hydro projects (largely grid connected) in comparison to mini-hydro (mostly stand-alone) as revenues are pre-determined. Commercial banks in Nepal are forming consortiums to finance SHPs. In 2016, the Sunrise Bank Ltd. led one including Siddhartha Bank Ltd., Nepal Credit and Commerce Bank Ltd. and Janata Bank Nepal Ltd to finance NPR 1.60 billion (USD23.7 million) for the 10-MW Langtang Khola hydropower project in Rasuwa district. The total project is estimated to about NPR 2.17 billion (\$32.16 million) (Point Dexter, 2016).

The bankability of projects is also affected by four main risks – currency risk (for international financing), power purchasing risk, political force majeure risk and regulatory risk (Neupane A, 2013). In Nepal, slightly bigger hydro projects can also face resistance and demands from local communities, which is a risk that financial institutions want to be clear of (Shah, 2008). As approvals and licenses are needed for various stages of project development, and with the lengthy decision making process translating into time and cost over-runs, many small hydro financiers consider it as a serious issue. This is because banks fix commitment of finance and loan repayment tenure during financial closure, and any rescheduling attracts higher provisioning as per regulations of central Bank (ibid).

4.3.2 Social awareness pre and post installations

A major risk is to not have the local community to support the development of the project. For small hydro project developers who want to connect to the grid, this support is even more essential. Supporting the communities to initiate productive uses is a programme component under AEPC, but this is usually done after a power plant has been installed, and for those below 1MW only.

Community awareness, sensitization and handover, including management post project installations are all weak for mini-hydros as the focus is highly on the power output, rather than on the post installation process. This problem has been aggravated with massive migration of youths for foreign employment leaving only elderly adults and children behind in many villages. While some of the earlier projects such as Salleri Chialsa implemented with donor support have spent considerable time and effort into these processes, the same does not hold true for government initiated and supported projects, and private developers often do not have the budgets or human resources to take this on board.

4.3.3 Capacity enhancement

There are very few institutions that support capacity enhancement in the mini-and small hydro sector. There is an urgent need to build up capacity at the community, developers, and across the value chain for mini-hydro development, particularly off grid. Skill upgrading may not often be technical, but also on management. An analysis in 2016 of the skilled technical staff in the micro-hydro sector was estimated to be approximately 617 in total from public, private and NGO sector (268 engineers, 349 technicians). With the confidence achieved, both AEPC and Industry want to build on existing skills to develop mini-hydro (up to 1MW as per Government definition) subject to projects starting on time, and good subsidy process management (Rai, 2016). In addition, there is a continual need for training locally based operators and managers, as well as local decision makers (ibid).

Current skills need to be upgraded for mini-hydro engineers and technicians as there are not many specialised companies in this sub sector. In addition, new skills need to be imparted to developers on financing, and policy makers for additional policy and regulatory aspects. A study by the NHA (2016) also found a need to train developer's management team to coordinate and manage all project components, taking into account project construction and future operation activities.

The WECAN and IPPAN are the major source for training in mini and small hydro. Trainings on mini hydropower design, seminars on mini hydro development are also being supported by AEPC and RERL.

5. CHALLENGES AND ENABLERS FROM THE FIELD

This section will analyse some of the key features, challenges and opportunities in the mini and small hydro sector based upon the case studies (details presented in a separate report). The section will follow the market-mapping framework with the field based information from the case studies.

Table 7– Overview of case study project consumers

SN	Project	Business model	Consumers
1	Andhi khola	Private (but with some public investment)	BPC distributes electricity locally in 27 VDCs and 2 Municipalities in Syangja district and 5 VDCs and 1 Municipality in Palpa district. It also sells electricity to NEA through the national grid. As of May 2016, BPC had 32,375 local consumers supplying about 25 GWh. Shortfall for 2 to 3 months/year during which period it buys electricity from NEA.
2	Piluwa khola	Private company (from locals within area)	The 3 MW power plant generated about 20 GWh annually. All the generated electricity minus self-consumption is supplied into the national grid.
3	Sobuwa khola	NEA owned, leased to community	2500 households (+750 by synchronised Chimal micro hydro). Connects to Phugling bazaar (enterprises)
4	Jugad khola, Jumla	NEA owned, leased to community	Serves about 2,594 domestic customers residing in 11 of the 15 wards of Chandan Nath Municipality
5	PHEME khola	NEA owned, leased to cooperative	Serves a total of 5,147 customers, 95 per cent of which are households. Also, to major enterprises (Tea, vinear ply, crushers, etc.).
6	Salleri Chialsa	Shareholder company (community/ NEA/SDC)	1640 households electrified with two more electricity consumer committee (150 HH) in progress. Approximately 40 enterprises also connected.
7	Haluwa khola	Community/Coperative(KREC)	8,520 domestic consumers and 181 industrial consumers.

Note: To read in association with Table 3 that provides other details

5.1 Enabling environment

The policies discussed mostly have aspirational provisions that do not provide specific policy or regulatory incentives especially for mini hydropower promotion in Nepal. Some of the findings from the case studies are presented in this sub section.

The **Electricity Act 1992** provides the only meaningful regulatory provisions till date. It allows private sector participation, de-licenses mini hydropower plants and has "exit" provision for mini hydropower plants where the national grid arrives. As a reflection from the case studies:

- i. **Pre-Electricity Act 1992** – Most mini and small hydro was developed by the national utility NEA (e.g. Sobuwa khola, Jugad khola, Pheme Khola) or through active donor/external plus government support (eg. Salleri Chialsa, Andhi khola).
- ii. **Post Electricity Act 1992** – There has been two main impacts.
 - a) Increased private sector interest in the development of small hydro in comparison to mini hydro as total numbers of projects developed/ or under development suggest. The main motivation is to sell power to the grid (eg. Puluwa khola) and not to the rural communities whereby subsidies are still sought.
 - b) Mini hydro projects do not need license for generation, transmission and distribution. Thus, when subsidies are available, local community/entrepreneurs are initiating development of such projects. The NEA has moved away from developing mini hydro projects leaving it to the private sector or communities. The micro/mini hydro systems that exist owned by NEA are being leased out (e.g. Sabuwa khola, Jugad khola and Pheme khola projects).

Despite some progress, the operationalization of policy and regulatory provisions are still needed as can be seen below:

- The **Subsidy Policy 2016** has opened the doors for eligibility of private sector led mini-hydropower projects for government subsidy. The subsidy is meant to cover about 40 per cent of the project costs. The subsidy policy shows a distinct shift of AEPC to focus on energy services as paramount rather than power generation and non-utilization. This shows a strategic direction towards market-based RE promotion (business model) rather than the traditional subsidy-driven approach in Nepal. The implementation success of the new subsidy policy for mini hydro has yet to be tested.

None of the case study projects received the AEPC government subsidy because they were built before the policy was developed. However, many of the projects early on were built with large grants ranging from 60-85 per cent from donors and government support as documented, although in reality they were fully subsidised. Exact figures are not known although project financing cost for Sobuwa khola showed 63 per cent forex, Salleri Chialsa by Swiss Development Cooperation at 85 per cent, and Andhi Khola by Norwegian government through UMN at 60 per cent. Haluwa Khola, a relatively recent project was fully funded through the KIND project, which was over 80 per cent funded by the Norwegian Government, and remaining by HPL. It must be noted that grant levels were high for these systems as they were all initial pioneering work in the sector for isolated standalone systems.

There is no subsidy currently for small hydro projects. Most small hydro and larger grid connected mini-hydro systems built by IPPs are thus not subsidised. The grid connected Puluwa khola project is an example where financing was originally set for 30 per cent equity and 70 per cent loan, later once operational, the company floated 30 per cent of shares to the public.

Subsidies are provided to projects to reduce the upfront capital cost of hydro projects. One of the main challenges in its implementation is the complex bureaucratic procedures and extensive paperwork required for subsidy processing that often leads to inordinate delays and high "transaction costs". Thus, while this one-off subsidy may reduce the upfront cost, the delays in subsidy disbursement and the high transaction costs partially offsets this benefit, solving part of the problem that it tries to address.

- **Power Purchase Agreements:** Although the Electricity Act has provision of sale of electricity by mini hydro projects to the grid, obligation of NEA to purchase plants where grid comes in and right of developers to fix commercially viable tariffs, effective implementation of these provisions has still not been realized. There has also been a general reluctance by NEA to sign new PPAs because it claims to have excess power during the monsoon and severe power shortage during the dry season since all power plants coming online are run-of-river, which mostly add to the excess energy during the wet season but does not contribute much needed dry season power. Project developers were negotiating with NEA on a case by case basis. In one of the mini hydro site - Rairang, there has been no provision of price revision over the entire period of the PPA. However, the NEA has published posted rates for all project upto 25 MW.

In 1998 a standard PPA rate of NPR 3.0/kWh for the wet season and NPR 4.25/kWh for the dry season, with a 6 per cent annual escalation for 5 years was finalised for small hydropower projects between 1MW below 5MW. This led to the signing of PPAs with private developers, and galvanising small hydropower developers to look for feasible projects. The case of Piluwa Khola shows that success of grid connected hydropower project hinge on a sound PPA that is standard, just and one that protects the interests of both parties.

In Andhi khola, the BPC had negotiated three times (1991, 2003 and 2014) and have added few special clauses. The latest PPA took about two years to negotiate. An outstanding issue under discussion is the rate at which BPC will buy electricity from NEA, an issue not currently covered by any policy. A similar case exists in Haluwa khola whereby to address load shedding, the project expects to purchase power from NEA but the absence of any guideline or regulatory provision means that NEA is treating it as a normal consumer and not offering a conducive rate.

- **Tariffs:** Tariffs are varied for all systems depending on the size (mini or small), or the business model (NEA leased, private etc.) as presented in Table 8 and subsequent descriptions. It may be noted that most tariffs for off-grid mini-hydro projects are modelled along NEAs tariff structure but with slight variances in pricing. There has been no published study on tariffs for mini or small hydro.

Table 8 -Tariffs of the case study projects

SN	Project	Current tariffs
1	Andhi khola	7 tiers of monthly tariff with lowest (0-20kWh) to highest (>400kWh). Each range has a demand and energy charge for 5Amp, 15Amp, 30Amp and 60Amp. Details in case study. Close to NEA.
2	Piluwa khola	Not applicable. Sells to the grid as per fixed government rate.
3	Sobuwa khola	As per NEA tariffs
4	Jugad Khola, Jumla	As per NEA tariffs
5	PHEME khola	As per NEA tariffs
6	Salleri Chialsa	Set independently at 5 different levels (detail provided below and in case study)
7	Haluwa khola	Set independently at various levels, close to NEA (detail provided below)

Following is a brief description of each:

- In **Andhi khola**, the tariffs are tiered as per usage, following closely the NEA tariff structure. However, as revenue per unit from local distribution is lower just under NPR 4/kWh (~USD0.04) against revenue from sale to NEA estimated to be over NPR 5/kWh (~USD0.05), the rural electrification component is a loss for the Company BPC. As of June 2016, the ETFC approved a significant tariff rate increase for BPC in Andhi Khola similar to the NEA tariff structure and is envisaged it will eventually be made the same as that of NEA. An important lesson to learn is that IPPs for this reason prefer not to carry out extensive rural electrification although it leads to strong socio-economic development in the project area such as enterprise development, improved irrigation, adult literacy etc. as seen in Andhi khola.
- **Piluwa khola:** The Arun Valley Hydropower Development Company Limited (AVHDC) signed a PPA with NEA in January 2000. Power supplied to the grid, and the government sets rates.
- **Sobuwa khola, Jumla, and PHEME khola:** The tariff has been set in accordance to NEA's tariff. The current NEA tariff provisions with effect from 1 Shrawan 2073 (July 2016) are shown in Table 9 and Table 10 below. Note that even in remote areas such as Jumla, there are no special tariff considerations for poor people.

Table 9 - Domestic consumers - service charge and energy tariff: single phase (NEA)

kWh	5 Ampere(NPR)		15 Ampere(NPR)		30 Ampere(NPR)		60 Ampere(NPR)	
	Service Charge	Energy Tariff	Service Charge	Energy Tariff	Service Charge	Energy Tariff	Service Charge	Energy Tariff
0-20	30	3	50	4	75	5	125	6
21-30	50	7	75	7	100	7	150	7
31-50	75	8.5	100	8.5	125	8.5	175	8.5
51-150	100	10	125	11	150	11	200	11
151-250	125	11	150	12	175	12	225	12
251-400	150	12	175	13	200	13	250	13
400+	175	13	200	14	225	14	275	14

Table 10 - Service charge and energy tariff: single phase up to 400 Volts

kWh	Up to 10 kVA (NPR)		Above 10 kVA (NPR)	
	Service charge	Energy tariff	Service charge	Energy tariff
Up to 400	1100	12	1800	12.5
Above 400	1100	14	1800	14.5

For those mini hydropower plants not connected to the grid but independently owned and managed, tariff rates are fixed locally as can be seen from the following two:

- **Salleri Chialsa:** Tariffs are independently set taking into consideration consumer usage patterns, encouragement to industries during off peak hours, and allowing for sufficient revenues to meet the financial requirement. Tariffs are set at five different levels set at different load limits - 0.1kW at level 1; 0.5kW at level 2; 2kW at level 3; meter with a load limit of approx.8kW at level 4;and a level 5 for industries for off peak. Details provided in the case study.
- **Haluwa khola:** Unlike the above, Haluwa khola has a different tariff system and is a case where there is a strong pressure from local consumers to keep the tariff as low as possible. The main consideration for tariff setting is meeting the operation cost including repair and maintenance. A non-spelled consideration is that the tariff remains at par with the NEA tariff structure. The tariff structure is occasionally reviewed considering inflation and other price hikes. The latest revision was made in 2014 as reflected below.

Table 11: Electricity tariff in Haluwa khola

SN	Consumer type	Min.charge (NPR)	Exempted unit (NPR)	Unit charge (NPR)
1	Domestic	80(0.8 USD)	20(0.2 USD)	6(0.06 USD)
2	Industry with single phase connection	400(4 USD)	80(0.2 USD)	5.5(0.055 USD)
3	Agro-based industry with three phase connection	480(4.8 USD)	80(0.8 USD)	8(0.08USD)
4	Other industry with three phase connection	520(5.2 USD)	80(0.8 USD)	8.5(0.085 USD)
5	Communications tower with three phase connection	600(6 USD)	80(0.8 USD)	9(0.09USD)
6	Drinking water	80(0.8 USD)	20(0.2 USD)	2.50(0.025 USD)
7	Irrigation	80(0.8 USD)	20(0.2 USD)	3(0.03USD)
8	Connection through 11 kVA line	As per Management Committee decision		

NEA leased mini-hydro: Before the enactment of the Electricity Act in 1992, the NEA took a lead in the development of mini and small hydro in Nepal. However, as their focus shifted to larger scale hydropower development, leasing was the option chosen for the mini hydro systems it owned. Initially, NEA had leased out its plants to private companies based on open bidding. The private companies employed technicians to look after the plant. In the meantime, the demand in the district headquarters increased dramatically and the plants

were able to meet demand partially, resorting to blackouts and load shedding. The consumers of electricity in these isolated systems in general were not satisfied with the supply, quality and services. Meanwhile, with many leased out plants being destroyed during the insurgency, the plants were subsequently taken over by Users' Groups comprising of beneficiary households. Even though the leasing generally led to better quality of electricity (better voltage and less downtime), delay by NEA in providing its share of costs for major repairs, lessee's short term focus on investment recovery rather than long term sustainability, ineffective monitoring, lack of adequate financing for lessees and reluctance of technicians to serve in remote areas are some of the problems that have dogged these leased plants.

Some of the examples from the case studies continuing issues encountered are:

- In Taplejung, the lease contract is a mixture between a management contract and a lease contract, creating confusion. The contract period of 20 years shows that a "management contract" type of agreement was to be preferred. Currently, one of the major challenges is the provision of sharing/ providing repair costs from the income of the plant. The contract is a lease contract with ownership resting with NEA unwilling to put any funds. The Taplejung lease has seven years left, but grid is expected soon.

In Jumla, the 10-year lease agreement allows the users committee to invest on the plant for restoration and improvement of the plant capacity with due information provided to NEA. However, there is no specific guideline on how the committee may undertake such an action. The committee is liable to deposit NPR200,000 (~2000 USD) at a non-operative fund annually. This fund may be used for reconstruction of the powerhouse and the substation and increasing capacity of equipment, expansion of the extension line within the district, increasing capacity or replacement of electromechanical components, and, during any loss due to force majeure situation.

This is similar for PHEME khola where any major repairs need to be done with permission of NEA and often, the inability of NEA in quick decision-making means that plant has to be shut down for long period of time. The same situation in Taplejung had meant loss of supply to customers and reduced income. The lessee's feel that the vast difference in size between the two contracting parties means that the bigger party (NEA) is often in a position to get its way at the expense of the smaller party. Although recourse to law is available, it is not taken as lessee's feel they would be at a losing end.

- Most of the time, the projects are barely kept afloat financially and there is a need to sort out maintenance clauses in the contracts to ensure that there is reliable supply of power for people to invest in industries or appliances for the home. Although monitoring is part of a lease contract, this is not effectively carried out in practice. A regular monitoring process allows for a lot of problems to be foreseen and acted upon before it has a negative effect on the quality of service.

It was also found that there is no clarity on the reasoning behind the lease agreement – whether it is an easy way out for NEA to lease it, or whether communities/cooperatives will be able to create some business from it if successful. One challenge is that as the mini-

hydro infrastructure belongs to the government, the option of outright sale would bring many political, legal and administrative issues that would have to be resolved and would take a long time.

Socio-cultural - ensuring local community participation (mini and small hydro): A major enabling factor is assuring local community participation in hydropower projects and to generate social capital for smooth project implementation. In addition, if locals were to have more shares in the company, the sustainability of the project and its impact will be even greater. For example, many promoters of Piluwa khola small hydro project are locals or have roots locally. This is true in the case of Salleri Chialsa mini hydro project.

Similarly, most of the NEA leased mini hydro projects are being managed by Users' Committee representing the users. One of the positive factors is in the resolution of community conflicts or disagreements. For example, in Taplejung, most of the customers perceive that as it is a government led project, that the tariffs should be less. However, as the members of the community are involved in management, there is ownership and the willingness to resolve issues within themselves. In Jumla, as the NEA leased mini hydro has not been able to satisfy consumers' demand for reliable electricity, the management launched an LED lamp campaign to address the issue. The LED lamps were distributed free of cost to the consumers and messages communicated as consumers visited the project office to pay the bill and through the local radio stations.

In Haluwa khola, the annual general meeting is used as a platform to educate its general members on various issues of electricity and operation. The technicians deployed in each VDC are also sources of awareness messages for the general consumers. They serve the consumers ensuring that supply will be resumed at earliest in case of local faults. The company KREC also organized mass safety awareness campaigns during construction of the power plants. Despite such effort, it was reported that general people show ignorance on safety aspects. For instance, they grow tall plants touching the distribution lines. Such issues need continuous awareness to consumers.

In successful projects, majority of local people participated during construction, post construction, management, decision making and ownership through inclusion in working committee, board etc. This has ensured local people to take ownership of the projects as well as allow the mitigation of various operational problems such as tariff setting, revenue collection, maintenance etc. However, with a constant dynamic of outflow of young workers in rural areas, local participation may not remain the same in current times.

Visionary leadership (small hydro) In addition, for small-hydro, in the early years of private sector development, there were a few visionary leaderships that pushed the sector forward. In the Andhi Khola project, Odd Hoftun's vision shaped the conceptualization, development and implementation of the project. Similarly, the founder of the Arun Valley Hydropower Development Company Limited also had a vision to develop small hydro projects in Nepal and was a strong driving force for the development of projects such as Piluwa khola, and is known as one of the most successful hydropower developers in Nepal.

5.2 Market chain

This sub section outlines findings from the seven case studies along the market chain from project planning and construction to operation and management.

5.2.1 Project design and planning

Small and mini hydro projects were designed by a combination of national and international experts and for larger schemes such as Andhi khola and Piluwa khola mainly international experts. In the 80s and 90s, the Development and Consulting Services¹⁹ (DCS) in Butwal had developed technical capacity in design and supervision. For the Andhi khola project, a technical arm was initiated by BPC, called BPC Hydro Consult which later spun out into an independent company, Hydro Consult Engineering Limited (Svalheim, 2015). In Piluwa khola project, the risk of feasibility assessment was absorbed by the Nepal office of Winrock International on a cost share support of about 50 per cent with a written understanding that if the project was feasible and the company went ahead with project development, the company was obligated to return Winrock's assistance, with interest. This arrangement was successful as AVHDC repaid the amount to Winrock once it proceeded further with project development. ENTEC, AG from Germany reviewed Piluwa Khola's feasibility study and helped optimize the project, which included the civil structures, penstock calculations etc.

For the NEA leased mini hydro projects, design and feasibilities were conducted by the utility itself or through vendors or donors. The Taplejung mini hydro project was initially designed for 100kW; however, the final design was approved for 125kW just before the construction was initiated because of availability of water in the river for greater production. Local consultants were hired to prepare the project reports including detailed engineering designs. No community engagement was sought as they were treated as energy consumers until 2004 when community members were involved for managing the project in the lease contract agreement.

Similarly, the NEA carried the feasibility study and construction of 240kW Pheme khola plant. The detail information on project design and planning were not available from NEA nor from the cooperative. The 150KW plant was built through feasibility study carried out by Butwal Power Company (BPC). But the demand assessment of the area was not included in feasibility study.

In Salleri Chialsa, ITECO, Switzerland carried out the detailed feasibility study and was also assigned for construction work. Before planning, ITECO conducted a "Conceptual Input Study" in which issues and experiences generated from case studies of small hydroplants were generalized. In the Haluwa khola project, AEPC approved consultants conducted feasibility assessment. The feasibility study also looked at potential of productive use of energy.

¹⁹One of Nepal's premier consulting services on renewable energy and training, stopped operations in early 2000s

Overall, feedback from the case studies have shown that appropriate and skilled resources are required particularly for the design and detailed feasibility as it is one of most important phase. Productive uses, load demand needs to be an essential element of feasibility assessments especially for the off-grid mini hydros. The GIZ had prepared a small hydro guideline; and while the AEPC has developed a micro and mini hydro guideline, the focus is more on micro hydro as mini-hydro has not yet been a priority for AEPC.

5.2.2 Construction

Local companies and contractors mostly carried out all construction efforts. In the Andhi khola project, a company Himal Hydro set up by Mr.Odd Hoftun conducted the civil works, and locals were trained and hired. Another company, the Nepal Hydro and Electric Limited (NHE) also founded by Hoftun focused on turbine refurbishment as well as manufacturing(Svalheim, 2015).

On the other hand, the Piluwa project with the advice of Winrock and Small Hydropower Promotion Project (SHPP- a GIZ project), priority was given to quality of equipment and thus, international companies were also selected as vendors. They selected Marusini Sitaka Construction Ltd, a Nepal-Japan joint venture company as the civil contractor and Wasserkraft Volk AG (WKV) from Germany as the electro-mechanical equipment supplier. The civil contractor also became an equity partner. The mechanical equipment supplier was Machhapuchhre Metal and Machinery Works Pvt. Ltd from Pokhara, Nepal. From 2001 to 2003, Winrock International in collaboration with the GTZ/ SHPP also provided technical support during the design and construction phases of the project especially for critical aspects of the project design such as penstock pipe, selection of civil contractor, selection of equipment supplier and on-site construction supervision.

In contrast to small hydro, most mini hydro projects were constructed majorly with national level expertise although equipment and specialised services if needed came from outside the country. In Taplejung, the construction works were carried out by the NEA through contractors. Most of the electromechanical components were imported from China, transported on helicopters to the site. As most of the construction materials and equipment had to be imported, project costs tended to be high. The project also had shortage of technical manpower during construction and the project construction was reported to be delayed by a year although cost overruns were not available. Similarly, in PHEME khola, locally based companies were involved in civil construction (Ramechhap Sherpa Construction Company) and electrical transmission works (Sanima consulting services). A foreign firm Ingen Holding Consulting Company was in charge of construction supervision. The electro-mechanical equipment for PHEME khola and Haluwa khola projects were imported from China.

In Salleri-Chialsa, Swiss technicians and engineers were directly involved during the construction phase although majority of construction materials were procured within Nepal and from India. Electro-mechanical equipment was supplied by the German Company Ossberger. The equipment and materials were transported to Salleri from Kathmandu in helicopters as there was no road network to Salleri. The local technicians were also trained in operation of hydro-mechanical and electro-mechanical components of the project.

In Haluwa khola, construction was undertaken by three different companies and the community as per UNDP-REDP implementation modality. While civil works were mostly done by the local Functional Group set up, distribution network was installed by a local company and headrace pipes were installed by another local company. The hydro-mechanical and electro-mechanical equipment including the switchyard were supplied and installed by a Chinese company. All the companies were selected through bidding process.

Some of the lessons learnt were:

- **Quality of electro and hydro mechanical equipment essential:** A major factor that has contributed to the success of projects such as Piluwa Khola is the quality assurance of the equipment used and the workmanship. Small hydropower developers are often tempted to purchase lowest cost equipment to save on construction costs. Time and again, it has been seen that such decisions, even though they may have short term gains, will, on the long term, prove much costlier for the company because of increased maintenance cost and more importantly, significant loss of revenue from increased plant downtime
- **Geological condition and risks:** As Nepal is a seismic zone and has recurring landslides, there is a need to design robust structures. Insurances will be essential in mitigating the geologically induced risk.
- **Availability of technical manpower:** The major problems in the development of the mini hydel project were mainly-shortage of technical manpower especially in the early days. However, currently there are more experts who have been trained on hydropower in Nepal and many have gained expertise through 'learning by doing'.
- **Imported equipment:** In PHEME khola and Haluwakhola projects, Chinese companies were selected to provide electro mechanical equipment. This often proved problematic especially for maintenance purposes. Stronger measures for quality control and after sales support were reported to be a need.
- **Allow demand growth:** An emerging issue is the shortage of power especially with mini-hydro as demand increases. In Haluwa khola, demand for power is increasing at rate of 10 per cent per annum and is often contributing to the issue of load shedding during peak hours. Purchasing of power from NEA grid is an option. In Jumla, there is continual pressure on the users committee for electrification of the non-electrified areas of the Municipality. There is the alternative possibility of purchasing power from a proposed 210kW hydropower plant (Giri Khola Sana Jalvidyut Ayojana) to be constructed at Hanku VDC. This will allow electrification of part of the area in the Municipality, which is un-electrified till date. However, this will not solve the power shortage issue. In Taplejung, the addition of diesel was far too expensive, and a micro hydro was additionally developed to meet the demand.

5.2.3 Operation and management

A major determinant to the success of any project is the operation, maintenance and management aspects. Below are the experiences from the case studies:

- **Operation and maintenance:** For the small hydro projects (Andhi khola and Piluwa khola), the companies had trained technicians to operate and maintain the power plants and distribution systems. A majority of the employees in Andhi khola were locals trained

at the Butwal Technical Institute (BTI) and slowly graduated to senior positions at site. In Piluwa, as quality equipments were installed, maintenance was lower although regular inspections and annual maintenance is conducted. The set of two turbines have been changed twice since the plant came into operation almost 13 years ago.

For the mini hydro NEA leased sites, the operation and maintenance cost were found to be high for most projects for various reasons. In Taplejung, the political instability and civil war in the 1990s caused the project to collapse as the electromechanical equipment was damaged in a blast. This resulted in overall blackout for more than a year. Later the local people of the district headquarter formed the Taplejung Electricity Users Committee (TEUC) and under took the project as lease from the NEA in February 2004. Local technicians were trained in operation and maintenance so that there would be fewer problems in recruiting staff. External funds from VDC, DDC, Member of Parliaments and other funds are mobilised for supporting the major repair and maintenance cost.

In Haluwa khola, KREC has a technical division to look after repair and maintenance and powerhouse operation. KREC also has a repair and maintenance fund currently around 10 million rupees in balance.

- **Ownership and management:** Small hydro projects have a much formalised management system with well-trained staff. In Andhi khola, the BPC has adopted the philosophy of incentivizing people who want to stay rather than trying to attract people who have no intention of staying. A competitive salary package, annual performances incentives, staff bonuses have helped retain most staff. However, BPC reported that salaries and benefits have not been kept pace with the market trends and that qualified and experienced staff are retained on a contract basis. BPC has also operationalized an Enterprise Risk Management System. This includes identification, assessment, mitigation and monitoring of risks. An updated risk register with risk ratings is maintained and a Risk Management Committee has been formed.

In the NEA leased project in Taplejung, the TEUC has an experienced group who had already worked in the plant during the management phase of NEA including the plant manager. In Jumla, the users committee is membership-based entity with a membership base of around 500. An executive committee is elected by the general assembly every three years and represents the entity for daily management. The executive committee comprises of 10 males and 1 female members. There are few sub-committees to look after specific tasks under the executive committee. The current salary for managers and technicians are in the range of NPR 15,000 (150 USD) and NPR 10,000 (100 USD) respectively. Reportedly, the committee has been good at conducting the meetings and organising general assembly in time as per the committee's constitution.

In PHEME khola, the cooperative and developer B.K. Power Company together established a JV company to operate and manage two systems. Currently, there are 21 full time staffs comprising both technical and non-technical personnel. Revenue collections are done through manual meter reading and collection of payments from the local offices. About 70 per cent of the households pay their bills regularly with cases of

delay charged as per NEA's late payment policies. Provisions for power-cut are available if customers do not pay their bills for 3 months. Customers in the remote regions are provided with bulk meters and are required to pay their bills collectively.

In Salleri Chialsa, there is a Board of Directors of 9 members - 6 from promoter group (3 from SDC and 3 from NEA) and 3 from general public, who are elected once every 4 years. Board meetings are held at least 6 times a year in accordance to the Company's Act whereas interactions through emails and telephones are maintained as and when required. The Board is also actively involved in the Financial Committee, Technical Committee and Personnel Committee. The Salleri Chialsa Electricity Company (SCECO) has a lean management with 12 staffs to manage and maintain the system to the required standard. Additional staffs are hired as and when required. A few employees have been associated with SCECO since its inception almost 25 years ago. The customer has to pay electricity bill and any other charges (e.g. reconnection fees, late payment surcharges, etc.) during the first 15 days of the next month. Otherwise company will charge a late payment fee, which increases with time.

In Haluwakhola, KREC is the first fully independent, democratically operated and locally managed rural electric cooperative in the country. The total membership base of KREC has reached to 8,520 who are also the electricity consumers of the cooperative. The highest body of the cooperative is a General Assembly, which periodically elects a Board comprising of 11 members, one from each VDC. The General Manager supervises day-to-day operation of the cooperative and is member secretary of the Board. An administrative unit and a technical unit are the two main divisions of the organisation. The Board is further supported by a Finance Committee, which helps in maintaining financial rules and regulations in place and controls fiduciary risks. On need basis, the Management Committee creates temporary sub-committees to handle emerging issues. Being a shareholder cooperative, KREC can distribute 20 per cent of its profit to shareholder members. A household can have only one member as shareholder.

- **Risk management, service delivery and consumer satisfaction:** In all the projects, it was also felt important within the Nepal context to address risks, service delivery and consumer satisfaction.
 - In **Jumla**, users' satisfaction level was found to be generally low as electricity was irregular. A quick survey of consumers showed that electricity supply is safe and not expensive but service was not reliable. The per customer power output is about 77 W only even if the plant generates at full capacity as after almost three-decades, the plant produces only in the range of 180 kW. Moreover, the power output drops to 150 kW during dry season, which means power availability per customer households drops well below 77 W. In this scenario even when there is electricity, consumers are unable to run electrical gadgets. The LED campaign was a response to address concerns of the existing customers.
 - **PHEME KHOLA:** Since the project started with cooperative but a private oriented model was practiced, the community attitude towards company is not positive. The health and safety issue of the aging equipment is also perceived as a risk to the operators. The company intends to mitigate the community dissatisfaction through improved

community engagement activities, a pre-notice through local FM station is conveyed before the power cuts and insurance on machinery and personnel are adapted to minimise the risk due to equipment.

- **Salleri** -The users' satisfaction level is satisfactory. Since the tariff is allocated according to the system and income level of the customer, the collection ratio of tariff collection is nearly 90 per cent. The company reckons providing regular and reliable power supply will increase the consumer satisfaction. Services are provided from 4am to 10pm upon receiving complaints from consumers through the available service hotline. Company also mitigate the risks through the governing board where representation of all stakeholders is present.

Some of the lessons learnt are:

- **Managing demand and pilferage:** In Jumla, the users committee has faced with instances of electricity pilferage – there are un-connected households in the electrified area who extend connection from nearby connected households. In order to check over use of power by consumers, circuit breakers (MCBs) have been installed on distribution poles so that heavy items such as heater, iron or inverters could not be operated.
- **Retention of staff:** The trend in recent years shows that retaining employees has posed a challenge owing to the salary scale, difficult terrain and harsh weather conditions especially in more remote sites such as Jumla.
- **Need for regular training:** Clearly the projects that have well trained staff also shows better retention. This is not so common for the NEA leased projects where capacity building events organised for the staff members on technical, managerial or social aspects are not reported. In Jumla, maintenance of transformers, generator, house wiring as well as account keeping were found to be top priority. The low motivation of the staff members was observed as there is no incentive in terms of salary increase or training.
- **Need for financial planning for managers:** Although important, this was lacking in some of the mini hydro plants although maintenance funds were set aside.
- **Set aside maintenance/emergency fund:** In Jumla, a maintenance fund of about NPR 2,000,000 (20,000 USD) is being maintained. The Users committee deposits NPR200,000 (2000 USD) per annum in the non-operative fund as per the lease agreement. Similarly, in Salleri, reserve funds of NPR 37,762,704 (377,627 USD) has been maintained as of FY 2015/16 often used for operation, maintenance and management of the project and during emergencies.

5.3 Supporting services

5.3.1 Community engagement

Community engagement is not compulsory for development of mini or small hydro, but it is usually very important in the rural context. Only one out of the seven case study projects has shown less engagement of communities during project initiation and construction. This was

the Piluwa Khola power plant that was developed and constructed during the Maoist insurgency period (1998 to 2003) and the security situation did not encourage public and community engagement. However, the company reported that there have not been any significant conflicts with the locals as they remained careful not to provide any promises or raise expectations that could not be fulfilled. Furthermore, the local community embraced the project as a “local development” effort. This helped the project gain local social capital. One area that the company worked on was to educate the locals that part of the royalty paid by the project came back to the DDC. The company also worked to ensure that the funds did flow to the Sankhuwasabha DDC.

In Piluwa khola, AVHDC also reported that there has not been any local demand for shares and that there may not be many locals who have bought the public shares of the company. In Andhi khola, BPC has not considered providing shares to locals, even though there is constant demand for it. An issue regarding providing shares is that there is no separate SPV as BPC owns both Andhi Khola and Jhimruk plants. However, BPC shares have been offered to the general public, and the company has subsequently issued right shares to its shareholders. BPC pays royalty to the Government for the electricity it generates.

During the construction of the 5.1 MW power plant in Andhi khola, there were no formal requirements of public hearings and thus none were held. However, consultations were held with the public by the project staff informally and in meetings. Motivators hired by the project also carried out awareness and education programmes in the project area. However, during the upgrading, formal public hearings were held and also meetings were conducted with the local communities as required. Local issues were mostly related to land acquisition, though there were also other issues of dispute. Though a lot of negotiations took place, BPC reported that there were no major disputes. The project had hired a prominent local person as the public relations officer and all local BPC staff functioned informally as public relations officers.

For the NEA leased plants, as the mini hydro power plants were constructed by NEA with the aim to manage and operate by it-self initially, no major community engagement was entertained during the construction period. However, after lease, communities have been engaged closely. No notable conflicts with consumers were reported in the case study sites particularly because engagement is minimal with the NEA itself. Communities are consulted when the services provided by the management committee are not of standard or there is a need to discuss issues related to maintenance, management etc. At times, conflicts are resolved through political connections.

For private sector led projects such as in Haluwa khola, initially, getting people's cooperation for launching the project was a challenge as there existed conflict among the various stakeholders. During construction of the project, the Functional Group mobilised local community members for transportation and erection of poles and distribution lines. The Functional Group was instrumental in lessening the local conflict that existed in earlier years. KREC also worked hard to garner community ownership of the project through 309 women's community organisations and the same number of men's community organisations formed

under the project. The community organisations were mobilized for promotion of toilets improve irrigation systems, schools and water supply systems.

A successful case with active local community engagement is the Salleri Chialsa project as the ownership also rests with them. The engagement is assured through three elected members of public in the board of the company. Apart from board meetings, member of community are also directly involved through yearly Annual General Meeting (AGM).

5.3.2 Fund mobilization and collection

For the NEA leased projects, financial support came from the Government of Nepal (GoN). There was no fund mobilization from commercial banks for the loan and from the public in the provision of shareholders. However, after leasing, users committee have been found to mobilise funds from DDC fund or other local funds for maintenance or rehabilitation processes. For example, in Sobuwa the DDC fund for rehabilitation of the headrace canal damaged by landslides normally every year.

In Jumla, for the power upgrading plan, the Users committee has explored technical feasibility from an India-based company – no bidding process was followed in hiring the party. There is also no plan for raising funds from local people for financing the upgrading plan.

The Haluwakhola MHP was built with funding support from NORAD, Himal Power Limited and Alternative Energy Promotion Centre. The project construction followed AEPC's procedures for bidding and power output verification.

5.3.3 Other inputs – capacity building, services (financing)

In Andhi khola, both Nepali and expatriate engineers and managers "learnt the hard way through innumerable frustrations, misunderstandings and blunders. So, it was basically, "learning by doing" (Svalheim, 2015). Now, BPC has a robust human resources development program because it believes that the competency of its human resources will enable the organization to grow (BPC, 2015). BPC prepares a yearly training schedule for staff capacity building. Management and finance related training is usually provided within Nepal. The company also has an annual performance review, where staff members are evaluated based on personal and department performance. Evaluation is done by one's supervisor as well by oneself. Employees are evaluated on work performance and also personal traits and behaviour.

For NEA leased projects, no study has been conducted to know willingness to pay or other social, economic aspects of the project. The user committee in Jumla had not received orientation or training on managing the electricity business. In PHEME khola, operators are employed after six-month training. The hydropower also has provision of support staff responsible for acting upon the issues and complaints of service delivery registered through the 24-hour hotline. Upon the establishment of the plant, the operators, then, were provided training on the site by Chinese experts. Since then the operators have been passing on the knowledge and expertise through in-house training regarding the operation, maintenance and management of the plant, intake and headwork to the new operators. Needs for further

technical trainings regarding operation and management trainings regarding financials are felt to be important.

In Salleri Chialsa, extensive trainings have been provided by the Swiss government in the early years. Trainings of practical assessment have been provided in the past to the employees in Europe for a month in 1994 and also in 1998 May-June. Electrical training was provided to the employees under the support of SDC. Currently, assistant operators are hired after a 5-month training period. The technical operators are capable in competent operation of the plant.

Financing: In almost all the cases (except those constructed by NEA), there was a significant element of financial assistance from external funds. For example, the Andhi Khola project was supported by the Norwegian government especially for capital investment that helped the project become viable. Similarly, financial assistance of NPR 480,000 was provided by Winrock to carry out the feasibility study in the Puluwa Khola project. In the early days, pre-investment support seemed to be crucial to bring smaller investors to the small hydropower sector.

Financing mini-hydro is a major issue, especially if it is in remote rural areas. Commercial banks still consider mini-hydro a high risk, although few have started to invest in small hydros that have PPAs with the NEA. Lending rates of the banks are still high, and financial institutions want high level of incentives from the government. Currently, guarantee through donor funds are available for micro hydro, but not for larger systems.

For leased out systems such as Taplejung, due to the nature of the contract it has not been possible to obtain finance to carry out improvements or make investments to improve the quality of service. Banks in Nepal are reluctant to provide corporate finance and insist on hefty collateral for the loan. As the property belongs to the NEA it cannot be put up as collateral. In a normal business the assets under the control of a company are mortgaged to obtain finance but it is not possible in this case.

The case of Puluwa Khola has shown that small hydropower projects, given the right conditions, can be commercially attractive. With potential economic linkages, these projects can contribute to capital market development, domestic manufacturing and repairing capabilities, and indigenous hydropower development and operation skills, thereby significantly contributing to the development objectives of our country. Thus, ensuring such projects have available strong and investment friendly financial instrument is equally important.

6. RECOMMENDATIONS

The sustainability of the mini and small hydro sector in Nepal is based upon the success of 3Ms for sustainable projects – market, money and management. Recommendations for key enablers for the three are provided accordingly²⁰.

6.1 Market

The first precondition for sustainability of hydro projects is to have **a sufficient and sustained market for the generated electricity**. This can be achieved if the following are being addressed:

- **Increase coordination among key stakeholders [enabling environment]:** There is no clear jurisdiction amongst key stakeholders – NEA, DOED (under Ministry of Energy) and AEPC (under Ministry of Population and Environment) on the development of mini and small hydro in country. The Electricity Act and MOU signed between NEA and AEPC stressed on coordination between NEA and AEPC but remains to be strengthened. An efficient coordination between these organizations for development of mini and small hydro through a joint coordination committee/unit is highly imminent.
- **Need for long term PPA agreement, grid connect [enabling environment]:** The case studies have shown that the projects that are more financially sustainable are those that are connected to the grid and have a long-term PPA for a sustained assured revenue flow. In line with this, a consistent feedback from the private sector is it's disinterest in developing mini or small hydro if there is no grid interconnectivity or have the potential to grid connect the systems within 2-3 years. Thus, the potential of grid connect is absolutely crucial for private sector or even community/co-operatives to invest. Simultaneously, a predicted market growth as per various regions, expansion plans of NEA, resource assessment, consumer demand etc. is equally needed.

In addition, power exchange balance during buying and selling are not exercised from NEA when needed (such as in Haluwa Khola during load shedding in local distribution) and is not standardized. This is an equally important to consider in moving the sector forward. Developers suggested that PPA with power exchange provision should be introduced so that surplus energy can be supplied to NEA and vice versa, increasing the viability of the system. [SEP]

- **Need to establish a mechanism to review PPA rates [enabling environment]:** A mechanism should be established to regularly review the PPA rates based on some objective parameters. A study would first be needed to establish these parameters, and to define differentiation according to size of hydropower plants.
- **Review/revise tariff structures [enabling environment]:** There are various levels of tariffs set for different mini hydros. Recommendation from developers during the feedback consultation workshop in July included the following:

²⁰Some of the recommendations added were from a feedback workshop held in July 2017 in Kathmandu

- Reasonable tariff rates need to be set up and also constantly monitored. A major issue is that if loans are taken, what are the reasonable rates of tariff to be designed? More analysis is needed to understand tariffs for mini hydro development in Nepal.
 - Developers feel that tariff setting for the off-grid electrification system should be considered differently for rural areas, and not the NEA national rates. In leased systems, tariff cannot be higher than the NEA rates (e.g. In Jumla, as per clause 9 of lease agreement). Although policy allows off grid systems to set their own tariffs, it is difficult to charge above NEA tariffs. Political and social issues are a hindrance for the developers in setting the tariff. A review study will be needed further.
- **Increase availability of subsidies and other financial incentives [enabling environment]:** The majority of the projects amongst the case studies were constructed through high levels of upfront grants mainly as it was initial pioneering work for developing slightly larger mini and small hydro in the country. There is need felt by developers that subsidy should be increased, and at least 80 per cent is required for mini hydro to be viable²¹. As data is limited on subsidy impacts for mini hydro, reference can be made from experiences of the micro hydro sub sector. Subsidy for micro and mini hydro upto 1MW is approximately set at 40 per cent, with a 40 per cent soft loan and a 20 per cent community contribution. However, a study showed that internal cash generation is not enough to service the 40 per cent debt of project costs to pay loans and interests and recommends a revision of subsidy 'appropriately' (Chhetri P.K 2016). Capex data from 58 micro hydro plants in 2013-14 by a World Bank study (2015) showed that 35 per cent was from subsidy, but an additional 27 per cent came from other GoN/ DDC and VDC support.

A key recommendation would be to conduct rigorous financial/economic analysis with data from current feasibility studies of mini and small hydro systems, projecting it against tariff structures, operational and management costs etc. to come up with more realistic models for subsidy and credit. Regular monitoring and analysis of all financial data by the AEPC from recent operational plants would be essential to initiate such a task.

In addition, as bank loans are expensive, credit facilities with minimal interest spread as well as risk guarantees even for grid connection are proposed. Incentives for working capital and enterprise development (productive end uses) are also needed.

- **Simplify subsidy processing [enabling environment]:** There is a clear need to reduce the processing time of subsidy. The tender procedures for mini hydro are extremely lengthy. AEPC could initiate a mechanism for bulk tendering process to simplify the

²¹It must be noted that justifications for continuation of similar level or increased subsidy are mainly for isolated systems that benefits communities significantly through better services and increased income generation through productive uses. The World Bank study (2015) recommends subsidies only in cases where communities are directly benefited and not for IPPs that develop mini hydros for grid connected systems as they are profitable.

process. In addition, number of household should not be criteria for the subsidy but the geographical reach and poverty should be emphasised²².

- **Reduce gap in AEPC's policy for post installation support of mini hydros [enabling environment]:** Currently, there is no intensive support from AEPC for mini hydro projects. For example, weak operation and maintenance of the existing mini hydro projects is starting to be an issue. If AEPC initiates more mini-hydro projects in the future, post installation support mechanism including periodic maintenance, trainings to technicians and managerial capacity development should be established for better performance. Support for end-use is also required.
- **Construction, equipment and maintenance standards [enabling environment]:** Majority of case studies suggested that constant maintenance is required especially for civil components and distribution systems. Standards and guidelines on civil construction and equipments developed by AEPC should be enforced in developing these projects. In addition, guidelines for repair and maintenance should be developed and regulated by AEPC.

6.2 Money

Many hydro projects have suffered from non-availability of funds. Even projects that have received subsidy take a long time to close their finances because of non-availability of the rest of the funds required. Thus, ready availability of affordable capital in the form of credit will go a long way in ensuring hydro projects are constructed in time. Some of the important criteria to attract investments are:

- **Increase investment for initial study and construction [market chain]:** The investment on initial study and construction should be higher such as in the Piluwa khola project, which will decrease the risk on poor quality of civil and mechanical structure resulting to lower maintenance during operation. In addition, financial analysis needs to be detailed. It is common to calculate cost/kW, which might make smaller projects financially unattractive. An alternative approach on calculation based on cost per kWh may be more practical. The rigour for financial analysis is still lacking especially for mini-hydro project investments, and needs increased support especially to developers.
- **Set basic parameters for profitability and bankable projects[enabling environment/market chain]:** For investments as well as entry of the private sector, projects need to make profit to keep the plant sustainable or sufficient for sustenance. To do this, the following are absolutely important:
 - Plant reliability: invest in operations. For example, operators need to be compensated and trained well. Examples can be seen from most of the cases such as Andhi khola for small hydro, and Salleri for mini-hydro. Trainings both at local and international level were provided not only for operators but also management. Long-term technical training (6 months plus) has also proved to be highly effective.

²²These recommendations were made by developers from the consultation workshop held in July 2017

- Potential for grid connects in near future (say after 5 years) will give much confidence to the investors. Grid connection can be win-win – for the mini hydro will gain if it sales excess energy, or it will gain again if it purchases at bulk rate from NEA and sales to the community as per NEA tariff. However, as pointed out by a developer during the feedback consultation workshop in July 2017, technical issues of connecting mini hydro to the grid (stability for instance) needs to be resolved.
 - Productive end uses/enterprises using electricity (if off grid) is extremely important as in the case of Salleri Chialsa in comparison to Jumla that has only few. Special tariffs are also set for off-peak hours in Salleri to catalyse productive uses.
 - Bank interest are also higher (10 to 12%), provision of soft loans, ease on Environmental issues (EIA or IEE over 101KW system) especially for conservation zones are needed for development of the sector. [Notes: a)Nepal does not require IEE or EIA for <1MW except in conservation areas; b) recommendation from consultation workshop, July 2017].^[1]_{SEP}
 - For small hydro that will be developed by private sector or IPPs, site selection such that there is easily accessible transmission lines will be important to attract investments, and also to attain PPAs with the NEA.
- **Promote commercial model/s of mini-hydro development [enabling environment]:** Currently mini hydro in Nepal is developed as service basis model. There is a need particularly for mini hydro to be developed either as semi-commercial model or fully commercial model. They should be developed as business enterprises through which private sector investment can be generated.
- If a legal entity is set up locally to own and manage a mini or small hydro system, it is important that community members will have the opportunity to invest anticipating an monetary return on the investment. For instance, in cooperative ownership model, the cash and labour contributions from community members should be capitalized as share in the investment. Any financial support from local governments or similar parties can be considered as share capital and not grant. For example, NEAs contribution is considered investment in Salleri with a share between 10-15 per cent. Grants can be government subsidies (AEPC) and donors. For this, a special purpose vehicle (SPV) in the form of a limited company may be desirable.
- **Remodel or cease NEA leased plants[enabling environment]:** The majority of NEA's leased out mini hydro were found to be underperforming. One of the chief reasons is also due to NEA policy on lease out. NEA did not provide any technical assistance after leasing out; also no incentives were given to stakeholders. As the ownership is with NEA, the communities cannot upgrade the systems, and commercial banks or investors would not provide loans. In addition, NEA leased plants cannot set their own tariffs, thus at times leading to greater defaults, and with no financial incentives to stakeholders, the interest was lost. Thus, this model of delivery needs to be re-modelled or ceased. Leasing could also be to private sector with incentives.
- **Financing (for leased projects) [market chain]:** The lessee will need a source of finance if he is to provide a high quality service and is also to contribute significantly to

developing the infrastructure and increasing access. This could range from provision of an overdraft to long-term loans for extending distribution.

- **Establish transparent tariffs for grid connects[enabling environment]:** It is a proven fact that tariff rates are the one key enabler or dissuader for both small and mini hydro. It is important that the government establishes a transparent and scientifically determined tariff rate with suitable escalation to attract more investment in grid connected mini and small hydropower development.

6.3 Management

The third essential ingredient for a sustainable hydro project is management. Projects managed by an adequate team of professionals seem to be present in projects owned by the private sector as in Piluwa Khola and Andhi Khola. Secondly, projects managed by active local representation in a company such as in Salleri also have a strong management that can cost effectively operate and maintain power plants to a reasonable standard. The projects that seem to have the lowest levels of managerial competences are projects that are managed by communities that are remote, not well trained and have no ownership such as the NEA leased systems. The Jumla project is a prime example of this.

For sustainability of both mini and small hydro, the following are important considerations towards better management:

- **Need for practical and reasonable contracts (for leased projects) [enabling environment]:** As this is the most important document it must be given the most consideration and the implications of all the clauses right up to the end of the contract need to be derived. The emphasis must be on how to reach a mutually acceptable solution that addresses the common goal of providing the best possible service to the people. For example, mechanisms for resolving issue and, if necessary, modifying the contract must be built into the contract. This prevents all issues being regarded simply on its legal merits. Recourse to legal redress should only be considered as a last resort.
- **Effective monitoring of performance and quality of services required (for leased projects):** Regular monitoring and evaluation is essential. This can either be from the NEA, AEPC or a self-assessment system. If a self-assessment system is adopted a detailed and transparent system needs to be established.
- **Private sector with professional team is needed [market chain/supporting services].** Although it is important that communities are engaged, it is not necessary that user's management committee be set up for sustaining a project. It is absolutely important that a professional operational and management team is in place. Management needs to also provide incentives for qualified technical manpower to serve in a remote area. An example is that of KREC whereby staff are appointed with permanent status with provision of provident fund.
- **Develop capacities for management, administration and technicians [supporting service]:** There is major lack in governance and management especially of mini hydro in the country. The stakeholders neither have incentives nor there are trained in proper

management leading to improper management and unsustainability. It was common that many of the community leased out plants did not receive capacity building inputs. The community or cooperative often undertook the responsibility of the electricity service without an analysis of electricity demand, financial planning and future need of investment. Economic incentives and technical assistance for governance including training management and administrative staff can mitigate this problem. In addition, taking the lesson from Haluwa khola, KREC rolled out training for technicians in addition to accounting for management, also supported by AEPC. Training centres need to be established to serve upcoming developers.

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ANNEX 1: List of private sector mini and small hydro projects in operation

S.N	Company	Project	Type	Output -MW	District	Source
1	Unique Hydel Co. (P.) Ltd.	Baramchi Khola SHP	SHP	4.2	Sindhupal chown	IPPAN/ DOED
2	Synergy Power Development Pvt. Ltd.	Sipring Khola Hydropower Project	SHP	10	Dolakha	IPPAN/ DOED
3	Shuvam Power Limited	Lower Puluwakhola HEP	MMH P	0.999	Sankhuwa sabha	IPPAN
4	Sayapatri Hydropower Pvt. Ltd.	Daram Khola 'A' HEP	SHP	2.5	Baglung	IPPAN/ DOED
5	Sanima Hydropower (P) Ltd.	Sunkoshi Small Hydropower Project	SHP	2.5		IPPAN/ DOED
6	Rairang Hydropower Company Co. Pvt Ltd	Rairang Hydropower	MMH P	0.5	Dhadhing	IPPAN
7	Radhi Bidyut Company Ltd.	Upper Radhi Small HEP	SHP	4.4	Lamjung	IPPAN/ DOED
8	Nyadi Group Ltd.	Siuri Khola Hydropower Project	SHP	5	Lamjung	IPPAN/ DOED
9	Mailun Khola Hydropower Co. Pvt. Ltd.	Mailun Khola Hydropower Project	SHP	5	Rasuwa	IPPAN/ DOED
10	Lamjung Electricity Devt. Company Ltd.	Syange	SHP	1.5	Lamjung	IPPAN
11	Khudi Hydropower Ltd.	Khudi Hydropower	SHP	3.45	Lamjung	IPPAN/ DOED
12	Daraudi Kalika Hydro P. Ltd	Daraudi A SHP	SHP	6	Gorkha	IPPAN/ DOED
13	C.E.D.B. Hydro Fund Ltd.	Kasuwa Khola HEP	SHP	9.2	Sankhuwa sabha	IPPAN
14	Butwal Power Company (BPC)	Andhi Khola	SHP	5.1	Syangja	IPPAN/ DOED
15	Bhairabkunda Hydropower Pvt. Ltd.	Bhairabkunda Khola SHP	SHP	3	Sindhupal chowk	IPPAN/ DOED
16	Ankhukhola Jalvidhyut Co. Ltd.	Ankhukhola 1 HEP	SHP	7	Dhadhing	IPPAN/ DOED
17	Alliance Power Nepal (P) Ltd.	Chakukhola Hydropower	SHP	3	Sindhupal chowk	IPPAN/ DOED
18	Nepal Electricity Authority (NEA)	Roshi	SHP	2.4	Panauti	DOED
19	NEA	Seti	SHP	1.5	Kaski	DOED
20	NEA	Tatopani	SHP	2	Myagdi	DOED
21	NEA	Tinau	SHP	1.024	Palpa	DOED
22	NEA	Puwa khola	SHP	6.2	Ilam	DOED
23	National Hydropower Company Pvt. Ltd.	Indrawati -III	SHP	7.5	Sindhupal chowk	DOED
24	Arun Valley Hydropower Development Company Pvt. Ltd.	Piluwa	SHP	3	Sankhuwa sabha	DOED

S.N	Company	Project	Type	Output -MW	District	Source
25	Thoppal Khola Hydropower Company	Thoppal khola	SHP	1.65	Dhadhing	DOED
26	Gandaki Hydropower Development Co. P. Ltd	Mardi khola	SHP	4.8	Kaski	DOED
27	Ridi Hydropower Development Co P Ltd	Ridi khola	SHP	2.4	Palpa	DOED
28	Himal Dolkha Hydropower Co Ltd	Mai khola	SHP	4.5	Ilam	DOED
29	Barun Hydropower Development Co. Pvt. Ltd	Hewa khola	SHP	4.455	Sankhuwa sabha	DOED
30	United Modi Hydropower Pvt. Ltd.,	Lower Modi 1	SHP	10	Parbat	DOED
31	Bhagawati Hydropower Development Company	Bijayapur-1	SHP	4.54	Kaski	DOED
32	Nepal Hydro Developer Pvt Ltd	Charnawati Khola Hydroelectric Project	SHP	3.52	Dolakha	DOED
33	Bojini Company (P.) Ltd	Jiri Khola SHP	SHP	2.4	Dolakha	DOED
34	Laughing Budha Power Nepal	Middle Chaku Khola	SHP	1.8	Sindhupal chowk	DOED
35	Aadi Shakti Bidhut Bikash Co. P. Ltd	Tadi Khola (thaprek)	SHP	5	Nuwakot	DOED
36	Electrocom and Research Centre	Jhyari khola	SHP	2	Sindhupal chowk	DOED
37	Api Power Company Pvt. Ltd	Nau Gad khola	SHP	8.5	Darchula	DOED
38	Ruru Jalbidyut Pariyojana Pvt. Ltd	Upper Hugdi	SHP	5	Gulmi	DOED
39	Sanima Mai Hydropower Limited	Mai cascade	SHP	7	Ilam	DOED
40	Khani Khola Hydropower Company Ltd	Tungun - Thosne Khola	SHP	4.36	Lalitpur	DOED
41	Khani Khola Hydropower Company Ltd	Khani Khola	SHP	2	Lalitpur	DOED
42	Joshi Hydropower Co. P. Ltd	Upper Puwa 1	SHP	3	Ilam	DOED
43	Chhyandi Hydropower Co. P. Ltd	Chhandi Khola	SHP	2	Lamjung	DOED

Source: derived from IPPAN membership information and DOED (as of January 2017)

ANNEX 2: List of private sector mini and small hydro projects in development (Source: IPPAN)

S.N.	Company	Project	Type	Output -MW	District	Stage
1	Upper Mai Hydro Devt. Pvt. Ltd.	Upper Mai A Hydroelectric Project	SHP	2	Ilam	Development
2	Triyog Energy and Development Pvt. Ltd.	Middle Gaddigad HEP	SHP	3.5	Doti	Development
3	Terathum Power Company (P) Ltd.	Upper Khoranga Khola SHP	SHP	7.5	Terhathum	Development
4	Super Mai Hydropower Pvt. Ltd.	Super Mai HEP	SHP	6.9	Ilam	Development
5	Sikles Hydropower Pvt. Ltd.	Madkyu khola HP Project	SHP	10	Kaski	Development
6	Shikhar Hydropower Co. Pvt. Ltd.	Yangdeli Khola SHP	SHP	7.5	Taplejung	Development
7	Sanvi Energy Pvt. Ltd.	Jogmai Khola SHP	SHP	7.6	Ilam	Development
8	Salankhu Khola Hydro Power Pvt. Ltd.	Salankhu Khola HEP	SHP	2.5	Nuwakot	Development
9	Sagarmatha Jalbidhyut Company Pvt. Ltd.	Super Mai A HEP	SHP	9.6	Ilam	Development
10	Ru Ru Jalbidhyut Pariyojana Pvt. Ltd.	Upper Hungdi HP Project	SHP	2.625	Gulmi	Development
11	River Falls Power Ltd.	Down Piluwakhola Hydropower Project	SHP	9.5	Sankhuwa sabha	Development
12	Rara Hydropower Devt. Co. Pvt. Ltd.	Upper Parajuli Khola Hydropower Project	SHP	2.15	Dailekh	Development
13	Puwa Khola One Hydropower Pvt. Ltd.	Puwa Khola One HEP	SHP	4	Ilam	Development/Construction
14	Pashupati Energy Dev. Co. (P) Ltd.	Khani Khola & Tungun Thosne	SHP	6.4	Lalitpur	Development
15	Panchakanya Mai Hydropower Ltd.	Upper Mai HEP	SHP	4.2	Parbat	Development
16	Nimrung Hydropower Co. Pvt. Ltd.	Nimrung Khola Hydropower Project	SHP	4.28	Gorkha	Development
17	Muktishree Pvt. Ltd.	Palmumki Khola SHP	SHP	1.6	Hetauda	Development
18	Ambeshwor Engineering Hydropower Pvt. Ltd.	Molung Khola HEP	SHP	7	Okhaldunga	Development
19	Lohore Khola Hydro Power Company Pvt. Ltd.	Lohore Khola HEP	SHP	4.2	Dailekh	Development
20	Kalanga Hydro Pvt. Ltd.	Upper Gaddigad HEP	SHP	1.55	Doti	Development
21	Jumdi Hydropower (P) Ltd.	Jumdi Small HEP	SHP	1.75	Gulmi	Development
22	IDS Energy Pvt. Ltd	Khoranga Khola	SHP	2.8	Terhathum	Development
23	Idi Hydropower Company Pvt. Ltd.	Idi Khola SHP	MMH P	0.975	Kaski	Development

S.N.	Company	Project	Type	Output -MW	District	Stage
24	Hira Ratna Hydropower Pvt. Ltd.	Tadi Khola HP Project	SHP	2.8	Nuwakot	Development
25	Himalaya Urja Bikas Co. Ltd.	Upper Khimti II	SHP	7	Ramechhap	Development
26	Energy Engineering Pvt. Ltd.	Upper Mailung A Khola Hydropower Project	SHP	3.6	Rasuwa/Dhadhing	Development
27	Eastern Hydropower (Pvt.) Ltd.	Pikhuwa Khola SHP	SHP	2.5	Bhojpur	Development
28	Dovan Hydropower Pvt. Ltd.	Junbesi Khola HEP	SHP	5.2	Solukhumbu	Development
29	Chirkhwa Hydropower Pvt. Ltd.	Chirkhwakhola Hydropower Project	SHP	5	Bhojpur	Development
30	Chhyangdi Hydro Pvt. Ltd.	Chhayndgi Khola Small Hydropower Project	SHP	2	Lamjung	Construction
31	Cemat Power Dev. Co (P) Ltd.	Ghalindi Khola HP	SHP	1.9	Myagdi	Development
32	Ambeshwor Engineering Hydropower Pvt. Ltd.	Kali Gandaki koban HEP	SHP	6.8 & 7.6	Kaski&Lamjung	Development
33	Bhujung Hydropower Pvt. Ltd.	Upper Midim HEP	SHP	7.5	Lamjung	Development
34	Barahi Hydropower Public Ltd.	Theule Khola HEP	SHP	1.5	Baglung	Development
35	Annapurna Renewable Energy (P) Ltd.	Kiche Khola	MMHP	0.5	Lamjung	Development
36	Ankhu Hydropower (P.) Ltd.	Ankhu Khola HP Project	SHP	5	Dhadhing	Development

Source: derived from IPPAN membership information (as of January 2017)