TAAS-0045: Adaptation to Climate Change in the Hydro-electricity Sector in Nepal

Private Sector Engagement

Submitted by:

Nepal Development Research Institute (NDRI)-Nepal

in collaboration with:

Practical Action Consulting (PAC), Nepal

Global Adaptation Partnership (UK) Limited (GCAP)

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This project, TAAS-0045: Adaptation to Climate Change in the Hydroelectricity Sector in Nepal, is being undertaken at the request of the Government of Nepal, and is supported by Climate and Development Knowledge Network (CDKN).

The work is led by Nepal Development Research Institute (NDRI)-Nepal in collaboration with: Practical Action Consulting (PAC), Nepal and Global Adaptation Partnership (UK) Limited (GCAP).

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Acronyms

CC:	Climate Change
CCD:	Climate Compatible Development
CDKN:	Climate and Development Knowledge Network
CIAT:	International Centre for Tropical Agriculture
CMIP5:	Coupled Model Intercomparison Project
GCAP:	Global Climate Adaptation Partnership
GCM:	Global Circulation Model
GoN:	Government of Nepal
KM:	Knowledge Management
MWRHIS:	National Water Resources and Hydropower Information System
NDRI:	Nepal Development Research Institute
PAC:	Practical Action Consulting
SI:	Strategic Intent
TA:	Technical Assistance

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1. Introduction

1.1 History of Private Sector Involvement in Hydropower sector

The development of hydropower in Nepal started after the inception of Pharping Hydroelectric project of 500 KW in 1911. Nepal government led significant development of hydropower from 1965 as an essential for modernization of the country. Although there are number of smaller projects developed other than government, Tinau Khola hydropower (1MW) built in 1966 was significant in involvement of private sector in Nepal. The major events of private sector involvement in hydropower in Nepal are shown in Figure 1-1:

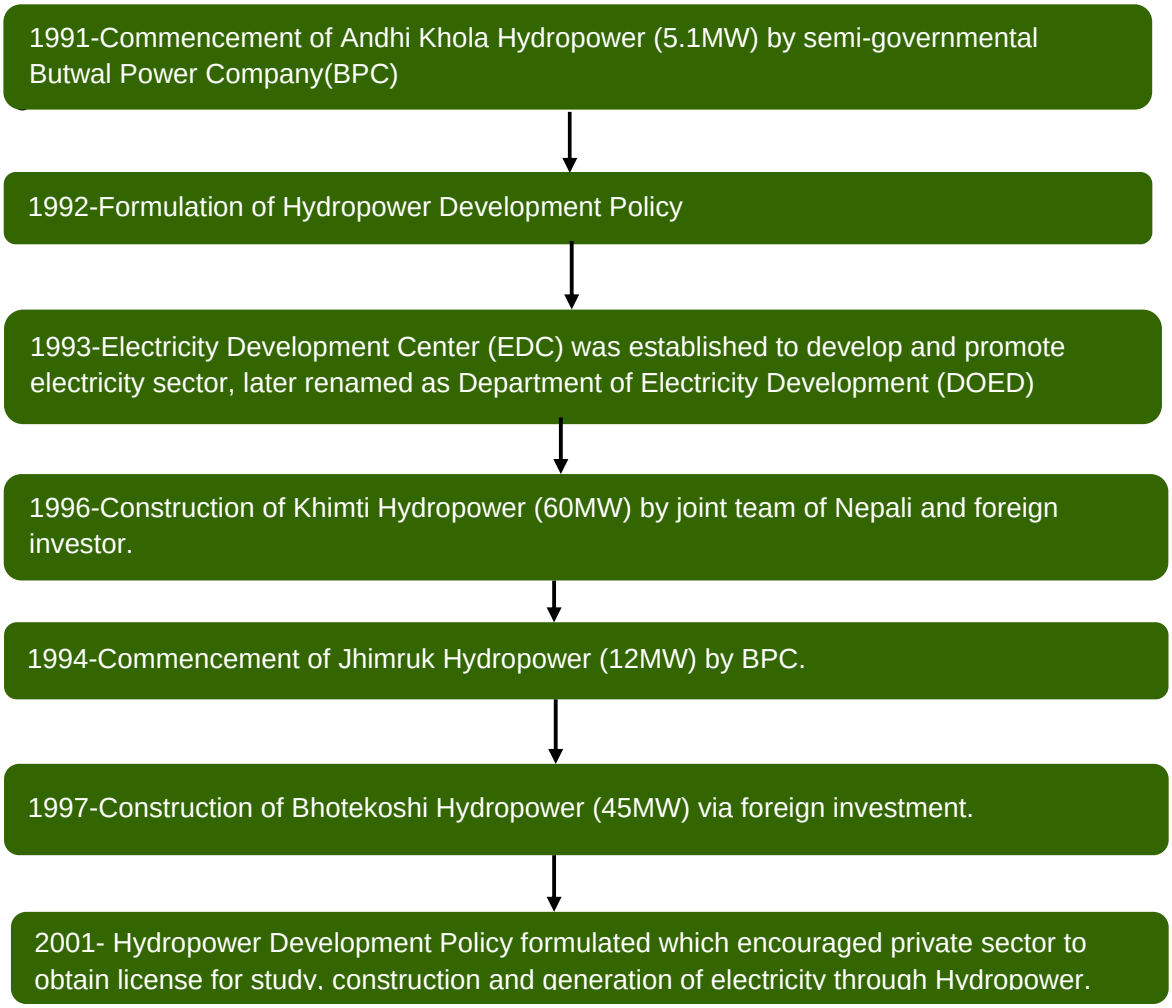

Figure 1-1: Involvement of private sector in hydropower development

Since 2001 the hydropower market share of private sector has increased. Up to the year 2014/15, a total of 733.557 MW of hydropower has been produced, of which 255.647 MW has been generated through private sector investment. Some 83 projects with an installed capacity of 1,521.28 MW are in the construction phase. In addition to these, 33 hydropower projects of 532.542 MW installed capacity are in different stages of development.

Private sector has significantly contributed in development of hydropower in Nepal and continues to increase its participation in future as well.

1.2 Key role of Private sector in Climate Change Adaptation (CCA) in hydropower sector

Recent researches and findings have indicated that climate change is definitely going to impact the hydroelectricity sector. Therefore we need to adapt to these climate changes in order to mitigate the potential risks of generating hydroelectricity.

The aim of engaging private sector to adapt to climate change in hydroelectricity sector is to encourage the involvement of the private sector in the wider adaptation community. The unique expertise of the private sector, its capacity to innovate and produce new technologies for adaptation, and its financial leverage can form an important part of the multi-sectoral partnership that is required between governmental, private and non-governmental actors.

While many businesses are already taking action to mitigate climate change by reducing their carbon footprints, so far much less has been done by the private sector to address adaptation to expected climate change impacts. The difference between these two approaches is defined below.

Adaptation: Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

Mitigation: Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks.

1.3 Project objectives and scope

The objectives of this research project 'TAAS-0045: Adaptation to Climate Change in the Hydro-electricity Sector in Nepal' are:

- Develop a solid evidence base on the vulnerability of the hydro-sector to climate change;
- Identify viable adaptation options that enhance resilience;
- Understand and address the challenges of mainstreaming adaptation in the sector;
- To build capacity and help enable adaptation action amongst policy makers and the private sector.

2. Approach and Methodology

2.1 Climate Risk Assessment (CRA)

Assessing the future impacts of climate change on the hydro-electricity sector in Nepal is very challenging due to the complex climate and hydrology, as well as the very large changes in elevation that occur across the country. Projections of future climate change show very high uncertainty, with large differences across future scenarios and between climate models.

To address this problem, the study has used a Climate Risk Assessment (CRA) methodology based on a "bottom up" decision-scaling approach. The Climate Risk Assessment (CRA method does not follow a traditional top-down, scenario-led impact assessment, i.e. where a climate model produces a future projection, which is used in a hydrological model and then in a water resources system or impact model to quantify future impacts, and finally to consider potential adaptation responses. Instead it uses a methodology based on a "bottom up" decision-scaling approach. This starts by assessing the sensitivity of Nepal's present hydropower systems – and their performance - to the current climate and then assesses how future climate change could affect this.

The method identifies key performance indicators (PI) significant for hydro-energy generation that may be sensitive to climate and thus puts the initial emphasis on understanding how the present meteorological and hydrological variability affect current operations and planned investments. This has the advantage of focusing the analysis on what matters! It can then look at future climate change, including uncertainty, and see how important future changes could be and how these key PI are affected.

The decision-scaling approach used in CRA is a bottom-up, robustness-based approach to water system planning, making use of a stress test for the identification of system vulnerabilities, and simple, direct techniques for the iterative reduction of system vulnerabilities through targeted design modifications. It makes the best use of the available climate information, which is typically highly uncertain, and focuses on key areas that are likely to be of high relevance for policy. Available climate projections generally demonstrate a large uncertainty in individual climate projections and it is thus important to consider all available GCM projections, rather than building this CRA on the projections of only a few selected GCMs and RCMs. The CRA approach therefore considers preparedness for a range of possible futures, an important ideological shift from previous scenario based approaches, which tend to focus on a small subset of defined future scenarios and models.

The CRA has then been linked to an iterative adaptation pathways approach, to use this risk information to build up possible adaptation responses under uncertainty.

Critically this has adopted a policy centred approach, which aims to provide information for policy makers and the private sector to implement near-term adaptation. It has also included a strong consideration of the economic justification for adaptation, noting the challenges of uncertainty and discounting.

The method has identified three types of adaptation where decisions (or policy) will be important over the next five to ten years, and provides information to help address both current climate variability and long-term climate change. These are

1. Immediate actions that address the current risks of weather and climate extremes (the adaptation deficit) and build resilience to future climate change. This includes early low- and no-regret actions, which provide immediate economic benefits as well as future benefits under a changing climate. These activities are focused on current hydro-power plants.

2. The integration of adaptation into immediate decisions or investments with long life-times (climate smart planning), focusing on the new (planned or candidate) hydro-electric plants that will be built over the next decade or so. These plants will be exposed to future climate change but these changes are in the future and uncertain. This therefore involves a greater emphasis on low cost design or flexible or robust options that perform well under uncertainty.

3. Early monitoring, research and learning to start planning for the future impacts of climate change. This includes the investing in information and learning, to help future decisions (through the value of information and option values and learning).

The three interventions can be considered together in an integrated adaptation strategy, often termed an adaptation pathway or portfolio.

To capture uncertainty, the CRA uses multi-model climate projections ensembles and looks at the impacts of climate change on water resources. It can therefore consider preparedness for a range of possible futures, and provide information that includes uncertainty.

This is fed into the adaptation analysis, which considers the possible options to address the current and future risks (and the impact on PIs), and then prioritises these based on the costs, benefits and other key criteria.

As the focus of the study, is on providing information to enable adaptation action amongst policy makers and the private sector, the study has also built up an extensive understanding of the current policy landscape with institutional mapping.

2.2. Private sector consultation and engagement plan

Climate change is likely to impact Nepal's hydropower production capacity over the next few decades by affecting river flow especially during the dry season. The Vulnerability Assessment carried out under the project however showed that climate induced hazards, extreme floods, sediments and other geo-hazards such as glacial lake outburst floods (GLOFs) and Landslide induced dam outburst floods (LDOFs) are more important risks for the hydropower sector in Nepal. Participants realized and expressed that the impact of climate change on Nepal's hydropower production and safety will lead to the need for more investment for meeting the country's hydroelectricity demand by 2050.

The private sector engagement to adapt to climate change in hydroelectricity sector is essential to catalyse the involvement of the private sector in the wider adaptation community. The unique expertise of the private sector, its capacity to innovate and produce new technologies for adaptation and its financial leverage can form an important part of the multi-sectorial partnership that is required between governmental, private and non-governmental actors.

2.2.1 Public Private Partnership

Public-Private Partnerships (PPPs) has become a new buzz phrase with respect to tackling infrastructure crisis but we also need to ensure more PPPs in tackling climate change. Over coming years, but more likely hundreds of billions of dollars of investment funds will be focused on the climate adaptation and resilience activities.

One potential area of engagement is as a provider of risk reduction mechanisms, insurance, climate resilient infrastructure, communication and information sharing of hydro met information.

2.2.2 List of key players engaged as private sectors

In the hydropower sector, stakeholders face different incentives and constraints to adapt to climate change, and their ability to adapt and/or influence adaptation vary. The key private sectors involved in hydropower development for climate change adaptation are as follow:

A. Project Designing Consulting Companies: They influence adaptation at the design stage. They decide on the plant's capacity and technological designs, which in turn affect how well the facility is adapted to climate change. They can decide on applying safety factors (e.g. design for larger than normal loads or conditions), or build in flexibility features that allow for potential future modifications as climate change unfolds.

B. Developers, Owners and Operators: They have the greatest ability to affect adaptation during design, construction and operation. The owners (including shareholders) ultimately decide on what level and type of risk the project is willing to stand; and during the negotiations of the concession agreement (Project Development Agreement PDA, in Nepal) and Power Purchase Agreement (PPA) negotiate with Governments on who bears the risk and responsibility for managing those risks. Operators will be responsible for taking adaptation decisions during the life of the project. The Government being the ultimate owner of hydropower projects in Nepal is the only actor having a long-term interest (>30 years) in the good functioning and safety of individual plants and the system as a whole.

C. Financing Companies: They are also vested parties so far as they face the same following risks as that of the project owner.

- The project being delayed or cost overrun,
- The project not operating at its full capacity,
- The project failing to generate sufficient revenue to service the debt,
- The project prematurely coming to an end.

Debt usually starts with the mobilization for construction after financial closure and debt period generally ranges from 10-12 years. Financiers have the ability to affect the economics of the project. Like regulators, financiers can impose environmental and social safeguards requiring design changes that ultimately may reduce the vulnerability of the project's performance to climate change.

D. Insurance Companies: They are vital for minimizing the risk associated with the climate change for private developers. Although most of the events due to climate change are covered by insurance, the wider adaption of Loss of Production (LOP), insurance could better position the developers and banks in minimizing and risk sharing the consequences of Climate change in hydropower projects.

In context of Nepal the key domestic private players are as follow:

A. Domestic Developers: According to the NEA (2014), by the end of fiscal year 2013/14, 148 PPAs have been signed. Upon projects' completion, these would generate nearly 2,000 MW of installed capacity. In 2014, the total number of IPP-owned projects that were in operation was 39 with a combined installed capacity of 255.65 MW.

B. Independent Power Producers' Association, Nepal (IPPAN): Independent Power Producers' Association, Nepal is a non-profit, non-government autonomous organization that was established in 2001 to encourage private sector investment in hydropower in Nepal. One of its main purposes is to act as a link between the private sector and government organizations involved in developing hydropower in the country. Besides this, the organization also helps exchange technology, expertise, knowledge, financial and management information among the independent power producers in the country.

C. Nepal Hydropower Association (NHA): Nepal Hydropower Association (NHA) is an association of individuals working in hydropower sector such as students, engineers,

lawyers, economists, professors, and environmentalist. NHA's major objectives are to lobby and advocate on helping create better enabling environment for hydropower development; provide capacity building support to hydro professionals, and investors. NHA can be one of the entry points to advocate on adaptation measures in hydro sector in Nepal.

2.2.3 Private Sector Engagement Process

Phase 1: Research and preparation

In this phase our focus was on to find out the objectives for private sector to engage themselves in climate change adaptation in hydro sector.

We conducted a research in order to find out the various hooks and incentives to encourage private sector to invest their time and resource in climate change adaption. We know for the fact that the primary function/objective of any private sector organization is to make profit but we need to make them realize its importance and engage them in the whole process for market system development highlighting the benefits they will receive from their engagement. Therefore we felt that we need to be able to answer the following questions to empower them for their active engagement. After the research the key questions raised by the private sector were:

- Why private sector need to consider Climate Change Adaptive measures in Hydro Sector?
- What benefits/returns will the private sector get from their investment?
- Is there any climate investment fund or subsidies available to endorse climate change adaptive measures in hydro sector, will it be incorporated in PPA?

On the basis of these key questions we evolved around the whole private sector engagement process.

Phase 2: Private Sector empowerment process

In this phase we conducted the Awareness Workshop where we invited private sector organizations to participate in a workshop where we can highlighted the economic impact of climate change in hydro sector then discuss in detail the benefits/advantages of engaging in climate change adaptation in hydro sector. The workshop created a platform to build awareness among the private sector organization of the various ill effects of climate change and how their investment can insure sustainability in the long run.

The topic of the workshop was **"Engaging the Private Sector in Adaptation to Climate Change in the Hydro-electricity Sector in Nepal"** was organized by Nepal Development Research Institute (NDRI) in partnership with Practical Action Consulting (PAC) and GCAP on 31 August 2015 in Kathmandu, Nepal. The objective of the mini-workshop was to create awareness on the various adverse effects of climate change and on how private sector's investment can ensure sustainability in the long run. For detail information please refer Annex 1.

Outcome of the Workshop on Private Sector Engagement in Adaptation to Climate Change in the Hydro-electricity sector in Nepal

- **Why is private sector engagement necessary?** A conducive environment is necessary for the required synergies to emerge as private sector investment in Nepal's hydropower sector is set to increase in the coming years. As the hydropower sector is highly vulnerable to the risks of climate change, private sector investment is

key to addressing the challenges of adaptation and must be engaged to encourage major climate finance mechanisms; greater awareness, assessment and management of climate change risks by the private sector is becoming increasingly important.

- **What are the climate change risks to hydropower?** Changes in water availability, intense rainfall landslides and flooding, landslides leading to high siltation, longer dry spells and higher rates of evaporation impacting water storage are some the climate impacts to hydropower that are worrying investors. Such worries have serious implications for Nepal's power generation capacity, management of peak supply and demand, and dam safety, warranting additional investments and impacting the profitability of the private investors.
- **How does the private sector view adaptation?** The private sector is quite aware of the risks that climate change poses, with many institutions engaged in assessing current and future climate change impacts as part of a general risk assessment. There are several examples of organisations implementing low-cost, no-regret measures to address current uncertainties that arise either due to data scarcity or climate uncertainties. But not all have undertaken risk management measures or implemented adaptation actions.
- **Why is the private sector not investing as much as it should in adaptation?** The reasons are manifold; lack of scientific evidence of location and business specific impact of climate change could be the main cause of the reluctance of private sector to invest in adaptation measures. In addition, the uncertainty of future climate impacts and the short-termism used in many private sector business planning processes is another reason for this reluctance to invest. Institutions are also reluctant to commit to significant up-front investments given uncertainties around the extent of end benefits.
- **Collaboration between the private sector and policy makers** can help incentivise and enable adaptation, with Research and Development (R&D) helping facilitate decision making and encouraging adaptation. Private/public sector partnerships, scientific organisations and academia can build research-based adaptation by providing companies with guidance, information and shared capacity to help them adapt to climate uncertainties. The Government of Nepal is the key; it needs to play a more active role in encouraging scientific research, facilitating technology transfer, developing human resources, and collaborate and incentivize when necessary. On the other hand, the private sector should share both risks and resources with the government and other partners, and work towards understanding, assessing and managing risks.

In conclusion, private companies' vulnerability, adaptive capacities and incentives for actions are influenced by the markets and regulatory envelope they operate in. Accessibility and affordability of climate proofing technology and the prices of the product will enable the private sector go for adaptation. For this, access to research-based information and support to the private sector for adaptation will provide incentives to adapt. Right polices are the key to influence both markets and regulatory environment to enable private sector to adapt to climate change in the hydro-electric sector in Nepal and elsewhere.

Phase 3: Private Sector Engagement Process using Participatory Market System Development approach

Stakeholder meetings and focused group one to one meetings: A series of flexible meetings bringing diverse groups of market actors together and one to one meetings were conducted. The objective behind this was to increase the understanding of market actors about how their market system works. To make this successful we spoke with various market actors in hydro sector such as hydro power developers, NEA, financial institutions, Insurance companies etc. in order to understand the linkages between the actors and also understand the bottlenecks in this market system. The team was in frequent touch with the Independent Power Producers Association of Nepal (IPPAN), an association of power developers in Nepal and Federation of Nepal Chamber of Commerce and Industries (FNCCI), for engaging with the private sector. Financing institutions like Clean Energy Development Bank as well as engineering consulting firms involved in hydropower development and key academic institutions involved in hydropower and climate change education and research in Nepal were consulted.

This enabled private sectors to understand their role in this market system and also help them to understand how their engagement can be fruitful. Incentives of the private sector are the reasons and driving forces behind their behavior. Hence we gathered information on the incentives and motivation of each actor that needed to engage. After collecting information from various private sector organizations, incentives need to be unpacked into the following elements to be able to empower them for engagement.

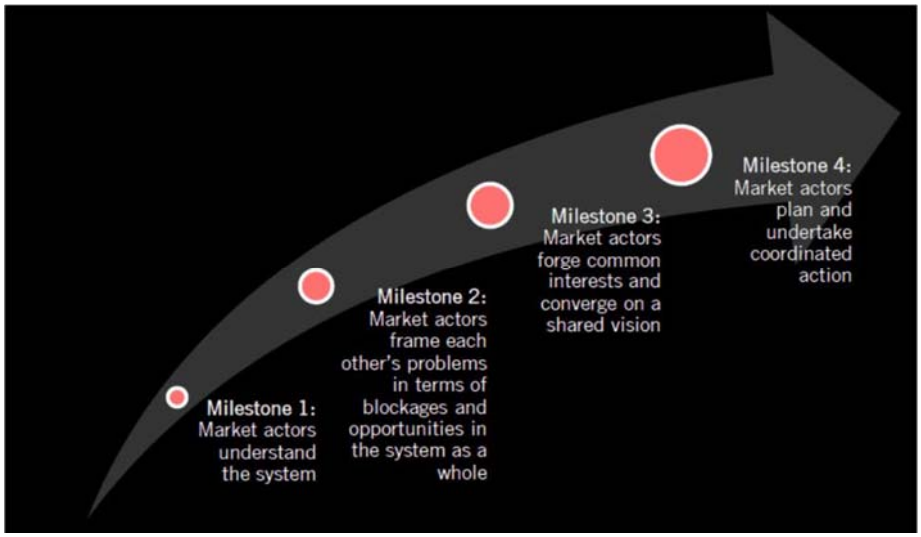

Figure 2-1: Role of private sectors in market system

Interests: What private sector wants or need to improve their business by implementing climate change adaptation options?

Motivations: Positive and negative factors that affect the choices private sector make.

Influences: Identify and engage influential actors who have an attracting or repelling effects on others but who are not linked through formal hierarchies

Drivers: Individuals and companies who are keen to join the process and drive change to implement climate change adaption options. To empower the key market actors (hydro power companies) were the focus group with an objective to increase the understanding of market actors and how their market system works for implementing climate change adaptation options.

Hydro Market System Map

Studying the whole Hydro Market System we have come up with the following map (Figure 2-1) where we have considered Pvt. Hydro Companies/Independent Power Producers as a key market actor.

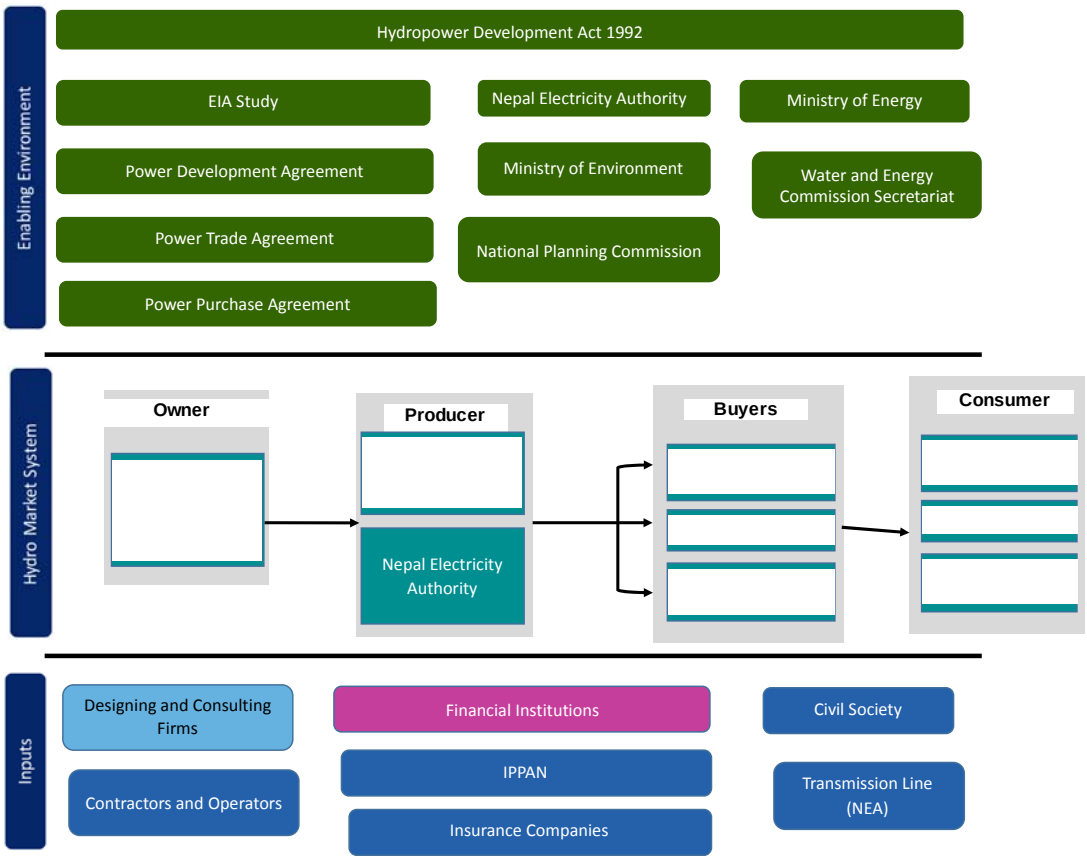

Figure 2-2: Hydro Electricity Market System Map

In the above Hydro Electricity Market System map at the centre of the market system is the market chain, which describes the channels through which the hydroelectricity is generated, sold and consumed. All the hydropower plants are owned by Nepal Government, the private sectors or independent power producers develop the hydropower for at least 30 years. The power generated is either sold to NEA or exported to India (proposed but not implemented) and/or distributed within the isolated grid (eg. Andhi Khola).

Level 1: Market chain functions

As indicated in **Figure 2-2**, the market chain has been divided into broad functions, which are the most important stages of delivery of hydroelectricity:

Function 1

Owner:

Government of Nepal, Department of Electricity Development issue a license for independent power producers to construct the hydropower and generate electricity for at least 30 years. After the end of concession period (30 years), the plant is handed over to DOED.

Function 2

Producer:

Generation: This involves the conversion of energy from hydro to electricity for hydro power generation technologies, or the production of products for energy generation and conversion. In case of Nepal the key power generator are Nepal Electricity Authority and Independent Power Producer.

Distribution: This involves the establishment of new,or use of existing, distribution networks to allow the energy services to be transported throughout a country or region, or even internationally.

Function 3

Buyer: In case of Nepal, we have three key buyers; NEA, Independent grid and export. At present, NEA buys almost all the electricity produced by the independent power producers. There are few independent grid which produce power and distribute/sell locally for example Aandhi Khola (now connected to national grid). Beside, NEA and independent grid there is a provision to export the power directly to India which is on the process of being approved by the parliament.

Function 4

Consumer: This involves the use of energy, from households, industries and institution to acquire the required services for lighting, cooking, heating, processing and manufacturing, etc.

Level 2 Inputs, services and finance

In order for each of the hydroelectricity market chain actors to carry out its function(s) effectively and efficiently, they need to access a variety of specific secondary inputs, services and finance which are grouped into Level 2 of the market system. These inputs and services may have their own value chains, including the actors and organisations that provide each one of them.

Inputs: Many of the market chain actors require a range of specific inputs, including the physical materials and products required to effectively deliver their function and develop the energy products or services before passing them on to the next market actor in the chain. Such inputs include the electrical equipment for hydro-power developers, and hired labour for infrastructure development.

Services: A wide range of services are needed by market chain actors to better produce, and sell hydroelectricity. These services are provided by different actors, including private sector companies, government departments (eg. Transmission lines) and community- based organisations (eg. benefit sharing mechanism, and upstream the soil conservation work). Services may include product design, market research and quality control and product testing procedures and need to be delivered sustainably and effectively. Educational services are also required to increase knowledge and technical understanding of a range of energy service markets.

Finance: Different financial services are needed across the market chain to construct the hydropower. This includes loan, equity investment and insurance at different stages of hydropower development.

Level 3 Enabling environment factors

Level 3, the enabling environment, is located above the market chain level in the diagram and covers the diverse set of factors that act as the “rules of the game”, shaping how the market chain and inputs, services and finance operate. Such an environment is often generated by institutions (national and local authorities and research agencies) and comprises policies, regulations and cultural practices.

These enabling environment factors often directly affect the specific functions and market chain actors within the energy market system. However, they can be influenced by specific market system actors (or external facilitators) and interventions, which are defined later on within this framework. It is a key feature of this document to go beyond the general importance of enabling environments for market systems and highlight exactly where specific elements of the enabling environment affect the market chains.

Involving the above mentioned Stakeholders of Hydro Electricity Market System the stakeholder consultation was carried using above mentioned PMSD approach on February 2015 to identify the interventions to implement climate change adaptation options in hydropower by private sector to streamline the hydro electricity market system and to make them more sensitive and resilient to climate change. Discussing key issues, concerns and priorities of different stakeholders with respect to climate change adaptation we came up with the following intervention strategy (Table 2-1).

Table 2-1: Intervention Strategy

Intervention Type	**Intervention Description**	**Intervention Outcome**
Awareness Raising support	Prepare key performance indicators and its vulnerability to climate change to deepen understanding of private sector on what a well climate adapted hydropower sector means.	Adaptation Pathways (portfolio of prioritize, phased adaptation options in hydro sector) which is already developed by the study team.
Policy Level and technical support	Initiation to be taken by Ministry of Energy to share information and findings regarding the adaptation options/pathways to climate changes with a view to help private sector to reduce uncertainty and get a better understanding of what decisions are urgent with respect to climate change adaptation	Decision making framework and information sharing mechanism on climate change adaptation options to private sector.
Technical Support	Research and consulting firms to investigate and refine entry points for climate change adaptation in	Climate change adaptation entry points and barriers.

	the current regulation, processes and practices	
Technical Support	To help different stakeholders understand the costs and benefits they will bear by undertaking different adaptation options	Cost and benefit analysis of different adaptation options (which is already prepared by the study team)
Technical Support	To develop practical tools that are tailored to different users' needs.	Hydropower design guidelines which include climate resilient infrastructure design. Climate risk assessment guideline.
Financial Support	To develop financial funding mechanism to implement climate change adaptation options for hydropower plants.	Financial schemes

Phase 4: Private Sector Engagement Report and Knowledge Product

After empowering and then subsequently engaging private sector to invest their time and resource in climate change adaptation in hydro sector, knowledge products were developed and circulated a detailed report documenting all the activities performed and the outcomes and discussions that took place while conducting the above mentioned workshops.

In addition to this, we developed a knowledge product that documented the lessons learnt and key outcomes of the workshops. This will then enable us to disseminate and share our experience and learnings, which will aid others in complementing this approach.

Expected outcome:

- Awareness on economic impact of Climate Change and prioritized adaptation pathways in Hydro Sector Input in policy documents and master plan Input for Hydro investment board
- Recommendations on action plan for way forward
- Knowledge product for wider dissemination

3. Adaptation Matrix- Role of Private Sector

Role of private sector to implement the adaptation options are more on the hard measures for both existing and new plants. Following are the adaptation measures that private sectors should get involved into following aspects:

1. Flood risk:

Flood related risk for hydropower will be extreme flow during monsoon season. In order to minimize the risk, Hydropower Company should adopt the following adaptation options. The below mentioned options may not be applicable to all types of hydropower; it will vary with RoR, PRoR and storage based hydropower.

1. Raising the dam crest/dam heighten
2. Construction of new auxiliary spillways, or through changes on the existing spillways to increase their discharge capacity.
3. Install gates, fuse gates, or fuse plugs to keep the same full supply level or even to raise it.
4. Increase protection for vulnerable structure (eg. Intake structures).
5. Enhanced flood warning systems to shut-down.
6. Awareness campaigns, e.g. on risk of floods, to improve disaster risk-preparedness.
7. Reducing reservoir levels before the heavy rain/flood season (although this might result in generation losses),
8. Developing operating rules that optimise storage/generation and flood attenuation benefits

2. Sediment risk:

During monsoon season, there will be high flow of sediments in the river however the amount of sediment flow will vary from river to river. In order to minimize this risk, the following adaptation options may be useful.

1. Removing sediments to increase reservoir capacity (dredging, flushing)
2. Retrofitting to improve sediment management (build sediment trapping structures, and sediment routing structures) or continuous flushing device
3. Check dams, debris basins/traps or reservoirs upstream to trap eroded sediments
4. Retrofit of turbines before end of turbine lifetime (40 years) if damaged by sediments or to respond to higher flows.
5. Re-coating turbines.
6. Retrofit turbines (or upgrade replacement)
7. Increasing storage: dam heightening or increasing the full supply level (e.g. through installation of fuse gates)
8. Divert some flows from an adjacent watershed into the reservoir (diversion and water conveyance structures)
9. Sediment monitoring will be important to optimise the operation and design of future plants.

3. Low Season Flow:

Hydropower plants not only suffer during the wet season but also during dry season when water flow in the river goes really down i.e. low season flow.

1. Reservoir management
2. Run turbines at lower/higher capacity based on runoff; or for less/more hours if the reservoir can provide some storage

Almost all the options mentioned above will have some additional cost which will definitely increase the capital investment. Therefore, private sector has mixed kind of reaction on the above mentioned adaptation options. First, they agree that the options are relevant and this will help in sustainability of the plant. But, they have doubt that the cost of the intervention may increase making the project financially not feasible under uniform rate of PPA. If it is adjusted on PPA then there shouldn't be any problem.

4. Geo-hazards - GLOFs and LDOFs

Technical:

1. Siting
2. Protect key infrastructure, e.g. intake structure, power house
3. Set back or raise structure
4. Smart tailrace gates (close when GLOF warning)
5. Underground power house (.e.g. Upper Tama Koshi)
6. Glacier Lake dewatering (e.g. Imja Lake) and Landslide induced dams dewatering and controlled breaching before burst in case of occurrence

Non-technical:

1. Detailed geo-hazard risk mapping and assessment
2. Early warning and forecasting
3. Upstream watershed management (including green engineering in roads and other interventions)
4. Insurance

3.1 Private sector as entry point and key barriers

Key Entry Points

Who – From Stakeholder mapping

Stakeholders differ in the way they are exposed to climate change impacts (current variability and future climate change), as well as in their ability to influence climate change adaptation. Further, their incentives and influence to adapt will vary depending on when they expect to bear the risk of climate change impacts. For example, developers are mainly concerned with current climate variability and have incentives to deal with climate risks that might materialise during the duration of the concession period (i.e. up to 35 years). Conversely, the Government is interested in the good life-performance of individual power plants and the system as a whole; hence its interest is to support adaptation to long-term climate change (beyond 35 years). Our engagement plan will mainly focus on those stakeholders who are highly exposed and have high ability to influence climate change adaptation in the hydropower sector.

Developers: The consultation during the inception phase revealed that developers are mainly concerned about current climate variability, and therefore take all the necessary measures to build plants that are able to ensure healthy margins for the investors. Based on the available hydrologic information, they build safety factors into the design and take measures to maintain project performance throughout the concession agreement period.

These include carrying out optimisation analysis and physical flood simulations (to ensure that the hydro project generates energy under a range of hydrologic conditions, and that penalties for not meeting PPA obligations are minimised), and using insurance mechanisms to manage the risk of extreme events (e.g., floods and landslides causing damage to the plant). During the consultation, it became clear that higher standards and design safety factors are built into small and medium (1-100 MW) as well as larger plants (>100 MW), whereas micro plants are not subject to the same level of scrutiny nor due diligence.

***Financiers*:** Financiers are important stakeholders. Commercial lenders can influence adaptation mainly through their social and environmental policies and their approach to project financing. The Equator Principles represents the environmental and social risks management framework for commercial financial institutions, and are drawn from IFC performance standards. Having recognised the need for an extended scope of environmental and social assessment to include climate impacts over project's operating life, the World Bank Group has been developing climate change risk assessment tools to be embedded into project financing decisions. A typical commercial debt repayment period for hydro project is 10-12 years; hence financiers will be most likely interested in projects being performing during that timeframe. IFIs have typically longest repayment periods.

Insurers: Insurers currently offer policies to hydropower developers for extreme events that cover damage to assets. Premiums are worth 1% of project costs during construction and 2% of capital cost during operation. Insurers' premiums may go up in the future if they are adjusted to incorporate climate change risks.

Table 3-1 : Private Sector – Entry points and Barriers

Decision Making Phase	Barriers	Relevant Stake-holders	Regulations	Entry Points [note: to rank and prioritise after further consultation]	Comments
Design [This phase covers the period of negotiations of main contractual docs, condition precedents for concession agreement]	Misaligned incentives Institutional barriers Behavioural barriers Adaptive capacity	NEA/ private Developers MoSTE IFIs IBN IPPAN	Environmental Protection Regulation 1996,1997 Nepalese EIA's guidance IFIs Safeguards PDA PPA Loan Agreement Insurance contracts	Environmental and Social Safeguards update EIA Guidance for developers and government who scrutinise and approve projects Update DER/Safety standards and harmonise them for small and large hydropower plants Hydrologic risk sharing addressed in PPA obligations IPPAN seminars and training courses, IPPAN becoming a knowledge sharing centre on climate change risks for IPPs. Insurance premiums	Climate risk screening already in WBG's obligations, which apply only to projects where the Bank is financier. Similar climate screening should be also embedded and mainstreamed into Nepalese regulations. Safety standards for new dams to be updated every X years when uncertainty unfolds In PPAs, financial penalties generation under- performance should better reflect climate risks Insurance premiums should reflect hydrologic risks PPA rates on a cost plus basis might be hard to negotiate as tariffs for consumers

Decision Making Phase	Barriers	Relevant Stake-holders	Regulations	Entry Points [note: to rank and prioritise after further consultation]	Comments
					would not increase proportionally for
Construction	Misaligned incentives Institutional Barriers Governance Barriers Behavioural Barriers Adaptive Capacity	NEA Developer IFIs Insurers	PDA obligations Loan agreement obligations EPC contract Insurance contract	Enforcement and monitoring of obligations laid out in PDA agreements and other contractual agreements EPC and insurance contracts to include climate change risks	Climate change risks should have been incorporated into the contractual agreements in the previous phases. Monitoring and compliance with obligations should be monitored.
Operation & Maintenance	Misaligned incentives Regulatory Framework Behavioural barriers Adaptive capacity	Developer Local Communities NEA (as off- taker) Insurers	PDA obligations Insurance contract PPA rate and conditions	Local communities benefit sharing plan/PES/W atershed management schemes National/local DRR strategies and plan, early warning systems Hydrologic risks managed effectively through PPAs and innovative risk management mechanisms (e.g. risk fund) Financial penalties for generation under- performance revised to reflect climate risk	Part of the royalties could be used to fund activities to improve monitoring and management of the watershed National/local DRR strategies and plan, early warning systems need to serve hydropower safety as well

Decision Making Phase	Barriers	Relevant Stake-holders	Regulations	Entry Points [note: to rank and prioritise after further consultation]	Comments
				Monitoring of extreme event risks improved Better data collection of hydrologic variations Funds set aside for adaptation (e.g. part of royalties, or windfall form generation planned) revenues extra- beyond	
Post- Handover	Misaligned incentives Institutional barriers Governance barriers	Private Developers Government of Nepal (NEA, IBN, MoE) Local Communities	PDA obligations IFI environmental safeguards	Stringent conditions in the PDA Long-term approach in IFIs safeguards and Equator Principles PES/Watershed Management schemes/local benefit sharing plans taken over by Government	Fiscal space is necessary to continue paying for PES/watershed management schemes; and adaptation measures

4. Cost Benefit Analysis: Key tool to attract Private Sector to follow Climate Change Adaptation Pathway

The study used a spread sheet based cost benefit analysis (CBA) model to undertake a financial analysis of the impacts of climate change on energy generation, hence revenue, and of the additional adaptation costs on the economics of individual power projects. As key performance indicators (PIs) of interest to private developers are related to returns on their investment (measured by the Internal Rate of Return (IRR) and Net Present Value (NPV) of benefits), the analysis was a useful tool to analyse the climate risks on investment. It was therefore used for the adaptation analysis considering possible options to address current and future risks.

First, the impacts of climate change and the adaptation benefits primarily arise in the future. Upfront costs to address medium- to long-term risks are difficult to justify as benefits arise later. As the discount rate in Nepal is much higher than in developed countries, benefits arising in the future are discounted and worth much less in the present value of benefits compared to upfront costs for early adaptation. Second, climate change is uncertain and hence it is difficult to plan exactly what to do when. The adaptation options hence need to attempt to ensure that we do not adapt too soon or too late, or spend too much or too little.

It was not possible to categorically conclude that there will be substantial reduction in energy generation in terms of water availability as the climate models are uncertain on future changes. While some models project reduction in precipitation, and thus flows, majority of models project increase in average precipitation in the future. Climate models project increase in temperature in the future but the magnitude of change varies widely from one model to another and from one greenhouse gas scenario to another. The impact of rise in temperature on water availability cannot be generalized for all catchments and they varied according to the elevations of the catchments. It was however more certain that future climate change will have most impact by increasing climate induced hazards, i.e. sediment, floods and GLOFs and LDOFs, rather than average generation.

This makes it difficult to justify early investment (upfront) to address future climate change. Developers are mainly concerned with current climate variability and have incentives to deal with climate risks that might materialise during the duration of the concession period (i.e. up to 35 years). Conversely, the Government is interested in the good life-performance of individual power plants and the system as a whole; hence its interest is to support adaptation to long-term climate change (beyond 35 years).

One simple option for adaptation would be to over design the plants in the design stage, for example designing larger spillways to handle higher floods or designing larger settling basins to handle large sediment loads. This however is difficult to justify in economic and financial terms as the benefits arise towards the end of their economic lifetime. Hence, the cost-benefit analyses were carried out for different options, using (i) upfront adaptation cost and (ii) phased adaptation costs. The latter would entail a more flexible design in the design stage that can be upgraded at later stages of the economic life of the project when more information on the climate change impacts are available and when impacts are more evident.

A general finding of the CBA was that the impact of climate change was modest relative to other uncertainties in Nepal, such as cost over-run, electricity pricing, discount rate and other regulatory uncertainties. The main reasons for the modest impact of climate change on project economics are two-fold. First, the financial assessment period for hydro projects is 30-35 years (typical concession period). Second, the real impacts, and thus the benefits, of climate change arise only towards the end of this period which are discounted at a high discount rate in Nepal.

However, the risks to safety of hydro projects from low probability, high impact events like extreme floods and sediment, cannot be ignored as this can entail catastrophic financial problems to developers due to damage and loss of life and property. Case study of Upper Bhotekoshi hydropower is shown in the box. Climate risks and adaptation costs/benefits are very much location and scheme specific and, hence, it is not possible to generalize the most appropriate adaptation option for all schemes. It is however clear from the CBA that the best adaptation options are not necessarily hard, structural options but a combination of hard, soft and regulatory measures. Soft measures like insurance or changes in power purchase agreement regime may better offset economic risks to developers than hard measures.

Case Study: Upper Bhotekoshi Hydropower

Upper Bhotekoshi Hydropower is situated at Sindhupalchowk district in Central Nepal. The construction of the project commenced in 1997 and was synchronized to the National grid on 2001. Salient features of the project: [1]

Project Type	Run of River
Plant Generation License	45 MW
Number of Generating Units	2
Average Annual Energy	293.2 GWh

Rock fall triggered by Earthquake in April 2015 damaged the water conveyance (penstock) pipe of the hydropower which halted the power production. In July 2016 flood in the Bhote Koshi River triggered by heavy rain across the border in China wreaked havoc to the headworks and powerhouse of the hydropower. The wall on the right side of the settling basin (Desander) of dam collapsed and the spillway gates remain blocked by big boulders, rocks and mud [2].

Upper Bhotekoshi HEP Headworks before Flood and After Flood (Pic. Mr.Subas Chandra Sunuwar and Er. Kapil Dhital respectively**)**

As per plant officials, if the power house remains un-operational for a year, it loses about 236 GWh of energy, which translates into US $30 million in monetary terms. The power production from the plant is halted since and repair of the damages induced from flood is yet to start.

References

[1]B. Pvt, "Bhote Koshi power company pvt. Ltd,"2010. [Online]. Available: http://www.bhotekoshi.com.np/faqs.php.

[2] "String of disasters curtail upper Bhotekoshi's capacity," Nepal Energy Forum, 2016. [Online]. Available: http://www.nepalenergyforum.com/string-of-disasters-curtail-upper-bhotekoshis-capacity/.

5. Conclusion and way forward

- The private sector expresses an urgent need to unbundle NEA, which is currently regulator, generator and only off-taker in the sector. Also, the private sector recommends improving the efficiency of the market by allowing tariffs to be determined by the market operating under a multi-off taker regime.
- A transmission line Master Plan is also needed to help developers plan for future investment.

- There is a need to review the tariff system of PPA, which currently comprises of only two flat tariffs for dry and wet season.
- Lengthy approval process needs to be made much simpler and smoother.
- Developers are particularly concerned about any new regulation on climate change adaptation that could result in increasing costs to them. The Government has recently introduced an obligation for them to spend up to 5% of their net profits for PES. Climate risks and adaptation costs/benefits are very much location and scheme specific and, hence, it is not possible to generalize the most appropriate adaptation option for all schemes. It is however clear from the CBA that the best adaptation options are not necessarily hard, structural options but a combination of hard, soft and regulatory measures. Soft measures like insurance or changes in power purchase agreement regime may better offset economic risks to developers than hard measures. Recommendation that came from cost benefit analysis needs to be well taken into consideration and try to implement.
- Under the current tariff regimes, developers have little or no incentives to build peaking (storage) plants. They call for a revision of the tariff regime.
- Developers have the obligation to handover the project to the Government in good operating conditions, which means that during the concession period they must deal with sedimentation issues. However, reservoirs conditions after 30-35 years are not known and not accounted for in any economic, or environmental analysis by the developers nor by government agencies.
- Costs of adaptation and extreme events during the generation licences are solely borne by developers. The Government will need to better understand the scale of these costs before the project's handover.
- Following the three tier framework developed by Organisation for Economic Co-operation and Development we can say that hydro power sector needs to follow the risk awareness, risk assessment and risk management mechanism as mentioned below which help them to minimize the climate induced risk.

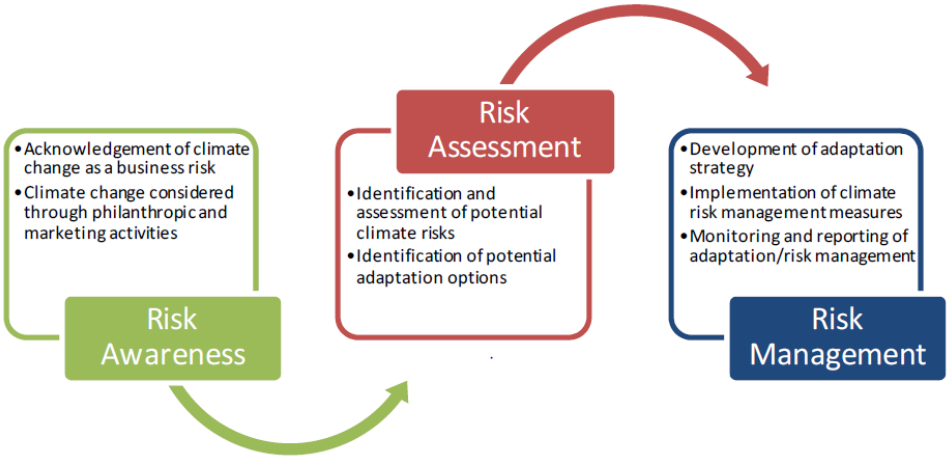

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Figure 5-1: Three Tier Framework developed by Organisation for Economic Co-operation and Development

- Intervention Strategy needs to be well analysed and proposed to concerned departments to take it further. Once all the intervention strategy is developed capacity building and dissemination plan needs to be prepared.
- Adaptation options and its entry points has been identified which needs to be well

communicated and build capacity for implementation

- Under the uncertainties of climate change private sector will be able to design and construct climate resilient infrastructure which will minimize their risk and their investment will be secured.
- When the share of the hydro company is floated to the public and investors they can highlight climate resilient infrastructure as a robust infrastructure needed to cope with impact of climate change and minimize their climate related risk.
- For a bank financing during the due diligence process the climate resilient project will be screened and approves given special consideration and its process will be faster.
- It is very clear that in order to motivate and engage private sector to invest in climate change adaptation in hydro sector, there definitely needs to be some form of incentive or return on in investment.

6. APPENDIX

Annex 1

Adaptation to Climate Change in the Hydro-electricity Sector in Nepal

Mini- Workshop on "Private Sector Engagement in Adaptation to Climate Change in the Hydro-electricity sector in Nepal"

Date: 31st August 2015

Location: Hotel Shangrila, Lalitpur, Nepal

Time: 2 p.m-5p.m

Agenda: Discussion on Private sector engagement

- **Welcome:** *Ms. Moushumi Shrestha, Private Sector Engagement Specialist, Study Team, Practical Action Consulting*

- Expounds the main purpose of today's workshop. For this study, interaction with the researchers, academicians have taken place but as there was need of private sector's input as well, this workshop is conducted. She reckons this workshop to be an interactive one.
- She assures to consider the points raised in today's discussion and incorporate it in the recommendations/findings/conclusions to be derived from the study. She brings in the main objectives of the study that are:
    1. Develop a solid evidence base on the vulnerability of the hydroelectricity sector to climate change
    2. Identify viable adaptation options that enhance resilience
    3. Understand and address the challenges of mainstreaming adaptation in the sector
    4. Build capacity and help enable adaptation action amongst policy makers.
- She rationalizes the areas that today's mini workshop will be addressing i.e. awareness among private sector regarding climate change, benefits and returns that private sector can get from their investment and economic impact of climate change in the hydro sector.

- **Potential for Hydropower Development in Nepal till 2050 under Different Economic Scenario:** *Professor Emeritus Ram Manohar Shrestha, Asian Institute of Technology (AIT), Thailand*

- He illustrates three economic scenarios reflecting different GDP growth rate using AIM/ Enduse model. Scenario 1: High growth rate (assuming Nepal is to graduate to the label of "developing nation" from "least developed nation")
  Scenario 2: Medium growth rate
  Scenario 3: Low growth rate (assuming the current growth rate is to continue in the coming)

GDP growth rate (%)					
	2010-2014	2014-2022	2022-2030	2030-2040	2040-2050
High[1]	4.3	9.7	9.0	8.5	8.0
Medium[2]	4.3	5.56	5.56	6.0	6.0
Low	4.3	4.3	4.3	4.3	4.3

Source: NPC[1] (2014) and WECS[2] (2010)

- He further elucidates his assumption with additional data on the energy consumption in different economic scenarios.

Low economic scenario	**Medium economic scenario**	**High economic scenario**
– **Total primary energy consumption increases by 0.8 times in 2050** – **Hydro increases by more than 14.4 times** (7,700 MW) – **Fossil fuel use increases by 3.5 times** – **Biomass consumption would decrease slightly**	– Total primary energy consumption increases by 1.1 times in 2050 – Hydro increases by more than 20.8 times **(10,800 MW)** – Fossil fuel use increases by 4.5 times – Biomass consumption would decrease slightly	– Total primary energy increases by 3.1 times in 2050 – Hydro increases by 42 times **(22,200 MW)** – Fossil fuel use increases by 14 times – Biomass use would remain almost same – Other fuels will substitute the use of biomass

- If this scenario is to be true, **12.9 billion USD, 19 billion USD and 46.6 billion USD** investment will be required in hydroelectricity sector in low, medium and high economic scenario respectively.
- Similarly, he focused his presentation on high electrification and medium economic growth (HEME) scenario in the coming future. The following are his assumptions under HEME.
    - Electric cooking: 10% penetration of electric cooker in 2025 and increasing its share to 60% in the Residential and Commercial Sectors by 2050.
    - Electric irrigation pump: 25% share of electric pump in 2025 in irrigation and increasing its share to 80% by 2050.
    - Electric Cars and Motorbikes: 10% share of electric cars and electric motor bikes in Kathmandu Valley and Terai in 2025 and increasing its share to 30% by 2050
    - Electric railways/MRT: 15% share of MRT in passenger transport service in 2025 in Kathmandu Valley and Terai and increasing the share to 30% by 2050. 10% share of electric railways in freight transport in Terai in 2025 and increasing the share to 50% in freight by 2050.
- Based on his assumption, under (HEME) 3.6 GW of additional hydro capacity is required in 2030 and 12.8 GW of additional hydro capacity is required in 2050.
- He concludes revealing other additional revenue stream for hydroelectricity sector. One of them being carbon revenue, where the company gets paid.

❖ **Linkage between Private Sector and Policy Maker:** *Prof. Dr. Govind Nepal, Member, National Planning Commission*

- Dr. Govind commences with the importance of private sector for Nepalese economy, especially for hydropower sector. Private sector is crucial in addressing the climate change issue, hence involvement of private sector is pivotal.
- Climate change may lead to changes in the flow of snow-fed river, higher rate of evapotranspiration impacting reservoir water, intense rainfall inducing landslides and flooding, landslides leading to higher siltation and longer dry periods. This will have serious implications on power generation capacity, management of peak supply/demand and dam safety, thereby warranting additional investment and impacting company's profitability
- He highlighted that the private companies are aware of the risks that climate change poses to their business and some of the companies are engaged in assessing current and future climate change impact. However, most of the companies consider existing climate risks as part of general risk assessment. Nevertheless, there are very few companies implementing no-regret measures and have undertaken risk management measures or implemented adaptation actions.
- It is also clear that private companies are reluctant to invest in adaptation because
    a) There is no scientific evidence of location and business specific impact of climate change
    b) The uncertainty of future climate impacts and the short-term horizon used in many private sector business planning processes might have reduced companies' incentives to adapt
    c) As companies' investment decisions are based on assessments of costs vs. benefits, they may be reluctant to commit to significant up- front investments given uncertainties around the extent of the end benefits.
- Private sector and policy makers are interdependent upon each other. Policy makers achieve their national objective through the acts of private sector, whereas private sector can act only in a better policy environment created by policy makers. Private sector partnerships with the public sector, scientific organizations and academia can facilitate research based adaptation by providing companies with guidance, information and shared capacity to help them adapt. Government on the other hand should carry out scientific research, sensitise findings, facilitate technology transfer, develop human resources, help manage financial resources, collaborate in innovative projects, and incentivise when necessary.
- In order to incentivize private sectors, it's important for the regulatory mechanism and market to run well. The policies influence both markets and regulatory environment. Therefore, private sector and policy makers need to go hand in hand for involvement of private sector in investment and adaptation process.
- He concluded his presentation with the following highlights:
    a) Companies' vulnerabilities, adaptive capacities and incentives for action will be influenced by the markets and regulatory contexts they operate in.
    b) Accessibility and affordability of climate proofing technology and the prices of the product will make able private sector to go for adaptation
    c) Access to research based information and support to the private sector for adaptation will provide private sector incentive to adapt

Question: Who's responsible for demand forecast? Currently, Nepal's Electricity Authority is solely responsible for stating the demand. Private sector need to follow that only. They provide electricity depending on wherever lines are present. Pay or Take money only after

2026. Efforts are not put in to explore new areas and serve the unmet demand in rural area. Actions need to be taken to solve this issue.

Response: While, forecasting demand it is essential to include various uses of energy. Demand simply cannot be determined based on the deindustrialized trend. Hence, study is required in these aspects to come up with gaps and recommendations to be included in the policy.

- **Sharing of experiences and challenges of "Private sector in Adaptation of Climate Change in Hydroelectricity Sector in Nepal":** *Mr. Khadga Bahadur Bisht, President IPPAN*
  - He starts his session with the basic issues and challenges that the current hydropower producers have been facing in the country. Load demand forecast is a major issue hindering the growth of hydroelectricity sector. NEA being the only entity responsible for production of electricity shouldn't be involved in forecasting. Instead, Water and Energy Commission Secretariat (WECS) should independently study demand factor and be accountable for its forecast. End user study, substitute, seasonal rate during wet season are some of the areas, which need to pondered upon and action needs to be taken accordingly.
  - The private sector has observed the cloud bursting phenomenon in many hydropower plants. The excess rainfalls for few hours followed by no rainfall for a week. This phenomenon has resulted in landslide and high sediment flow in the catchment area of hydropower. He further highlights that they have been observing rainfall related disaster from couple of years, but they are not aware or have any evidence on whether it is caused by climate change or is a natural phenomenon. It is a known fact that rainfall variability is happening because of changing climatic conditions. Under this condition, we are not is position to reflect the impact of climate change especially for small hydropower projects between 5-10 MW. The small hydropower lacks the historical data and use various hydrological methods to assume the change in water flow in the river. The lack of accessibility of precise data leads to various problem in power generation as a result of which, some companies falter on the promised amount. This has made them pay penalty. Global warming is becoming an issue for the hydroelectric projects but the fact is, climate change needs to be categorized and should be included in the design manual of hydropower.
  - The other issue is the increase in consumptive water use due to the advancement on agriculture, road construction and other development activities. This issue has led the small hydropower to suffer from inadequate water availability in the catchment area. Does the research cover this issue as well?

- **Climate Change Adaptation in the Hydroelectricity Sector: Benefits to Private Sector:** *Dr. Divas Basnyat, Team Leader, Study Team, NDRI*
  - Dr. Basnyat illustrates two scenarios using CMIP5 climate projections for Nepal – 2050. The two models provide contradictory conclusion. One model shows 10% decrease in precipitation and the other shows 30% increase in annual precipitation. He concludes that if we are to rely only on climate projection, our results/findings/recommendation will be contradictory. He confers about the " bottom up" approach taken from the book named " Beyond Downscaling", which promotes the concept of determining vulnerability domain, seeing critical climate parameter that affect our system performance and defining system performance system indicators

through stakeholders' consultation, which differs from the "traditional approach" that counts on downscaling a few climate projection, generating a few water supply series and determining whether system performance is acceptable for these series.

- Dr. Basnyat reflects on their approach of study, where the process is designed to be informed but not driven by GCM model projections. Therefore, the study will be based on this bottom up approach only. There will be identification of iterative adaptation pathways considering risks and the high uncertainty involved. It would encompass strong participatory engagement of stakeholders for mainstreaming climate compatible development (CCD) in the sector as well as raising awareness and capacity building. This mini-workshop is a part of the stakeholder engagement.
- He talks about the study trying to come up with structural and non-structural options for handling "higher" floods, "sediment load" and GLOF risks, estimation of "adaptation costs" , guidelines on "design flows/capacity" considering climate risks and policy recommendations on the "optimal power mix" and coordinated operation of storage, ROR and thermal plants to mitigate climate risks.

❖ **Planning a Way forward for Engagement of Private Sector in Adaptation to climate change in the Hydroelectricity Sector in Nepal-** *Moderated by Mr. Vishwa B Amatya, Head of Programme, Energy, Practical Action*

- Some of the issues raised during the session are as follows:

a) There is a gap between policy framework and implementation. It isn't possible for a policy to incorporate all elements of hydropower. Hence, a universal policy will not work for all size of hydropower projects (below and above 500MW) rather it should be categorized or segregated according to sector, capacity etc. The adaptation options should also frame according the type of scheme such as ROR and storage. The same adaptation option will not work for ROR and storage based hydropower plant.

b) It is not clear that what would be end result of the study. Will the research come up with vague policy recommendations or the specific list of activities? It would be better if the research could come up with some specific recommendation so that we can put some flexibility in power production agreement because of climate change uncertainties.

Response: To identify the adaptation option, it is essential to identify the entry points. It isn't possible to come up with a manual particularly, but can come up with specific recommendations for PPP, EIA, design, input for master plan criteria, early warning system etc.

c) The climate models will take care of changing climatic condition, but the study should also look on the existing hydropower and their performance under changing climatic conditions. In other words, details on how much energy has been generated by such firms and how much could have been produced but they couldn't due to climate change. Similarly, mitigation policies can be developed to combat climate change impacts accordingly.

d) The hydrological database doesn't comprise of relevant and valid information, which indeed effects the study that is being conducted on different facets. Hence, policy needs to support and enhance the quality of current database. The hydropower company themselves can setup a small meteorological station within their power plant, which will produce quality data and can be used to analysis how climatic factors will impact the power generation.

e) Load demand forecast is a critical issue that hydropower producers have been facing. The only buyer (NEA) itself forecast the load, which has several biases in forecast.
f) The life of the hydropower is usually 100 years but private sector gets to reap the benefit for 20-25 years only. The concerned parties must understand that hydropower is an asset of our nation. Therefore, national policy should be made considering the fact that it produces electricity for not just 20-25 years but 100 years. Hence, policy should be developed from the perspective of hydropower's lifetime i.e. it being 100 years and not just 25 years. It would be better if the study could see the impact of climate change throughout the project period.
g) National policy should also incorporate the fact that electricity is not just used for consumption at national level instead it can be used for trading as well.
h) The current policy is highly regulatory and not facilitative. The current policy shows risk/ penalty to be paid by only private sector. Hence, risk sharing mechanism must be developed. In other words, the policy must be facilitative rather than regulatory.

❖ **Closing Remarks-** *Ram Chandra Khanal, Country Representative, CDKN*

- Explicates on "CDKN's" role in climate and development knowledge network. The previous study funded by CDKN on "Economic Impact of Climate Change in Key Sectors of Nepal" led to a recommendation that further studies need to be conducted to take the suggestions to the policy level. Hence, currently, three studies are being conducted i.e. in hydropower, agriculture and irrigation relating to climate change.
- He believes there is need for energy security (by government) and profit making (for private firm) for sustainability of hydropower projects in the longer run. Private sector's involvement is required for longer term sustainability. Hence, this study is trying to contribute to materialize this concept.

References

[1] B. Pvt, "Bhote Koshi power company pvt. Ltd," 2010. [Online]. Available: http://www.bhotekoshi.com.np/faqs.php.

[2] "String of disasters curtail upper Bhotekoshi's capacity," Nepal Energy Forum, 2016. [Online]. Available: http://www.nepalenergyforum.com/string-of-disasters-curtail-upper-bhotekoshis-capacity/.