District Development Committee

Makwanpur

DISTRICT CLIMATE AND ENERGY PLAN

Makwanpur District

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Acronyms and Abbreviations

AEPC	Alternative Energy Promotion Centre
BAU	Business as Usual
BPL	Below Poverty Line
BSP	Biogas Support Program
BSP-N	Biogas Sector Partnership Nepal
BIRP	Bio-fuel Research and Production
CBOs	Community Based Organizations
CBS	Central Bureau of Statistics
CDR	Central Development Region
CRS	Climate Resilient Scenario
CRT/N	Centre for Rural Technology Nepal
DCEP	District Climate and Energy Plan
DDC	District Development Committee
DEECC	District Energy and Environment Coordination Committee
DEEU	District Energy and Environment Unit
DEPP	District Energy Perspective Plan
DFO	District Forest Office
DFP	District Focal Point
DIO	District Irrigation Office
DSP	Dhaulagiri Solar Pvt. Ltd.
EPS	Energy Poverty Study
ESAP	Energy Sector Assistance Programme
FECOFUN	Federation of Community Forest Users, Nepal
FGD	Focus Group Discussion
FN	Future Nepal
GHG	Green House Gas
GJ	Giga Joule
GoN	Government of Nepal
GSI	Gender and Social Inclusion
Ha.	Hectare
HDI	Human Development Index
HH	Household
ICS	Improved Cooking Stove

IGA	Income generating activities
INGO	International Non Governmental Organization
IPCC	Intergovernmental Panel on Climate Change
IWM	Improved Watermill
Kg	Kilogram
KII	Key Informant Interview
Km	Kilometre
kW	Kilo Watt
kWh	Kilo Watt hour
LDO	Local Development Officer
LPG	Liquefied Petroleum Gas
m	Meter
MAS	Medium Adaptation Scenario
MHP	Micro Hydro Project
MH/PH	Micro Hydro/ Pico Hydro
MT	Metric Ton
NAPA	National Adaptation Programme of Action
NEA	Nepal Electricity Authority
NGO	Non Governmental Organization
NPC	National Planning Commission
NRs.	Nepalese Rupees
PDD	Program Development Document
RE	Renewable Energy
REDP	Rural Energy Development Program
RET	Renewable Energy Technology
RTPA	Rural Technology Promoter's Association
SHS	Solar Home System
sq. km	Square Kilometre
TUEC	Technology Upliftment & Engineering Centre
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat
Wp	Watt Peak

Executive Summary

0.1 General Background

The main goal of the District Climate and Energy Plan (DCEP) is to create a planning process for accelerating the dissemination of renewable energy technologies at district level, contributing to development goals at national and local level. In addition to energy development, DCEP addresses climate change impacts on energy planning and ensures that women and social excluded and marginalised groups are addressed throughout the planning and implementation processes..

The overall objective of the DCEP of Makwanpur is to:

Prepare a climate change adaptive, decentralized renewable energy plan that can contribute to climate change mitigation and ensure Gender and Social Inclusion (GSI) issues are addressed, through assessment of the institutional set up of the district in relation to requirements of accelerated dissemination of Renewable Energy (RE) and recommendations on organisational arrangements needed to implement the DCEP.

This document has treated climate change and GSI issues in a systematic way at all stages of the planning process rather than treating it separately as an appendix. The focus of DCEPs is to both expand energy service provision through and coordination of implementation. .

Primary data was collected from certain village development committees (VDCs) to validate and update secondary sources.The estimates of energy consumptions are based on secondary information from Water and Energy Commission Secretariat (WECS) and projections were supported by Practical Action's Study on Energy Poverty (2010) which could not be fully linked to macro-economic parameters other than population.

The study is more focussed on residential sector energy consumption compared to industrial or commercial energy needs as this is the major demand in the district.

Limitations to the study include a general lack of recent disaggregated data of Makwanpur on GSI especially those relating to renewable energy, which reflects in the study as weakness and needed to be strengthened in coming days. There is also very limited reliable climate data for Makwanpur.

Makwanpur:

Makwanpur encompasses diverse topography with altitude from 166m above sea level to 2584m above sea level and has an area of 2,426 sq km.There are altogether 43 VDCs and 1 municipality in the district. There are number of rivers running through the district, the main ones being the Rapti, Bagmati, Bakaiya, Manahari and Lothar.

The total population of Makwanpur was 392,604 with an annual population growth rate of 2.2% in 2001. The projected population for 2010 is around 478,385. Makwanpur has 78 different ethnic groups living in the district including *Brahmin, Newar, Magar*, and marginalized groups such as *Chepang*, and endangered groups such as *Bankariya*.

Major energy sources come from two major power stations within Makwanpur, Kulekhani-1 and 2 with installed capacities of 60 and 32 MW. Out of 32,182 HHs electrified, 29,402 HHs receive electricity from the grid, 1,100 through micro hydro power (MHP) and 1,680 from solar home system (SHS) (DEPP, 2009).

0.2 DCEP Preparation Process

The DCEP has followed a nine stages of the DCEP preparation process as highlighted in the DCEP guidelines. Extensive district and national level stakeholder consultations were conducted. An initial desk study was followed by secondary data collection, compilation and validation at the field. The DCEP task force at the district, facilitated by AEPC/SNV was responsible for coordination at district level to ensure local input into the process. A local NGO assisted the planning team in the process.

A planning workshop was held in Hetauda on the 15 and 16th of February 2011 to share the outcomes from the data analysis and the scenario development. The feedback has been incorporated into this planning document.

0.3 The DCEP Situation Report

Climate Change assessment

Temperature and Rainfall Spectrum of Makwanpur

The lowest recorded monthly average of minimum temperature from 1975 to 2005 is -2.7°C in Daman (2314m), while the highest recorded monthly average of maximum temperature in the district is 37°C in Hetauda (474m). Daman observed an average of 1751.5 mm of rainfall from 1975 to 2005, while Hetauda observed 2439 mm of rainfall.

Most of flood plains and adjoining Siwalik and Bhawar regions in Makwanpur experience sub-tropical climates. Remaining areas 1,200 meters above mean sea level (msl), which is about 40% of the district, fall on temperate climate zone. Annual mean maximum temperature lies between 28°C and 30.5°C excluding some exceptions (such as in 1993). The past trend shows high variability in temperature and annual rainfall has ranged from 1864 mm to 3111 mm with very high variability between years.

A climate assessment of Makwanpur revealed that high variability in precipitation combined with unsustainable land use practices have resulted in adverse environmental situations in terms of floods, landslides and droughts as reflected by the discharge in the Rapti River. It has also affected cropping pattern and crop growth. The common community observation across the district is that *too much rain falls in short time and there are longer gaps between successive rainfalls.* The changing pattern also means decreasing ground water recharge as well. Long dry-periods results in unfavourable river hydrology for hydropower generation and biomass based energy yields. These variabilities also have implications on energy demand in terms of heating and cooling requirements.

Energy resources that are dependent on water or are impacted through climate induced disasters are the most vulnerable to stresses of climate change. Decreasing water availability has direct impact on hydropower production, decrease in forest cover, decrease in agriculture production and livestock rearing. Increased spell of droughts result in forest fires which can impact on forest resources, while climate induced disasters either eradicate the source or limit access to such resources. Weather induced hazards such as landslides can disrupt the supply of fuel and electricity to some extent when infrastructure like roads and transmission lines get damaged.

Forest fires resulting from long spell of drought in the winter can result in further scarcity of wood fuel, however, technologies like improved cook stoves (ICS) are not directly vulnerable to such effects of climate change. Though renewable energy technologies like SHS are the least vulnerable to climate changes they are not free from it. Efficiency of solar technologies can also be affected by an increase in the number of cloudy days and are at high risk from extreme weather events like hailstorm.

Gender and social Inclusion assessment

Women are primarily responsible for managing household level energy supplies. Replacing firewood with other RETs or managing firewood supply differently will have greater implication on women. The cost of technologies will be crucial for women and poor groups that do not have access to or control over financial resources even though the technology may be preferred by these groups of people.

The majority of the poor, Dalit and ethnic groups such as Chepang reside far from district headquarters with limited access to and limited capacity to afford other energy sources. For these groups, firewood is one of the cheapest sources of cooking. Efficient use of firewood through introducing ICS is thus an important strategy both for contributing to and responding to climate change through reducing the amount of firewood use without compromising energy needs of the households. This also contributes in reducing drudgery and workload of the people, particularly of women.

Energy Demand Assessment

The minimum energy required in the residential sector for cooking has been recorded as 5.5 GJ/HH/year and for lighting 1,431,000 lumen-hours per year for energy scenario development and assessment purpose. The minimum primary energy requirements were then projected assuming a given set of energy efficiencies of various energy devices.

The residential sector is the largest consumer of energy (84% of the total energy consumption) in the district with a demand of 4,876,000 GJ in 2010. Energy consumption in the commercial and the industrial sector in 2010 were estimated to be 116,000 GJ and 813,800 GJ, respectively. Cooking makes up 55% of the energy consumption in the residential sector which is met by wood fuel in rural areas (83%). Industrial sector uses wood fuel, electricity and coal to meet its energy requirement. In 2009, 1,004,010 kg of wood fuel was used in the industrial sector, while the total consumption of electricity was 42,065 MWh (DEPP, 2009)

Energy Resource Assessment

Wood fuel remains the major energy resource for residential and commercial use in Makwanpur sourced from 167,453 Ha of forest of various categories capable of providing for 1.43 million GJ of cooking energy needs. Agricultural residue and animal dung are additionally important biomass energy sources supplying 246.63 GJ and 1080.27 GJ, respectively.

Among commercial energy needs, 37.9% lighting energy is met by fossil fuel, kerosene, in the household sector. Fossil fuels consumed in the district are imported from India. In cooking kerosene makes up for 25.8 % and LPG 15.6 % of fuel used for cooking. Hydro power is the main source of electricity in Makwanpur district. Hetauda and Palung are two distribution centres of Nepal Electricity Authority. 21% of supplied electricity is consumed in the residential sector, 1.3% by non commercial sector and 71% by the industrial sector (DEPP, 2009).

Two large hydro power stations Kulekhani 1 and 2, has combined installed capacity of 92 MW. A third project is currently in development to produce a further 14 MW of energy. A total of 9 hydro schemes with a generation capacity of up to more than 30 MW have been issued with survey licences. As of March 2011, applications for survey license for generation of 35 hydro schemes (up to 25 MW), with total capacity of 70 MW have been received.

Among the renewable energy supplies, there are currently 38 Micro and Pico hydro systems in operation whose total installed capacity is 112.5 kW and supplies power to over 600 HHs. Additional 77.74 kW are under construction. Similarly, 1,022 short and long shaft Improved Water Mills (IWM) are also in operation in the district.

The study conducted by WECS in 1994 identified 2,500 hours of yearly sunshine with average 2,458 W/m^2 solar radiations. Wind energy data is still very scant and unconvincing for the district. Though an experimental installation of very small wind power plant is functional currently at Phakhel, wind resource assessment needs to be carried out to determine the potential.

Biogas is another potential and popular renewable energy source in the district. The total energy potentiality for biogas is estimated at 1,080.27 GJ annually. With the total number of households that have biogas potential at 16,969 with 15,736 already installed.

Technology Assessment

In addition to conventional technology assessment parameters such as status/trends of different technologies, end-uses as practiced, comparative costs and benefits and after sales service and technology costs, a number of new parameters have been considered including climate vulnerability of technologies, adaptation and mitigation potential and trends including emissions factors and gender and social aspects with respect to choice, need and affordability and capacity building needs.

Ownership data that was available for biogas, improved water mills and improved cooking stoves has shown that female ownership in aggregate for ICS, IWM and biogas installations are 21%, 4% and 34%, respectively.

Energy technologies are important player in climate change, mitigation and adaptation measures. Energy and adaptation is not a well addressed concept and it has been shown during this study that adaptation depends on adjustments and changes in production and consumption. The capacity to adapt varies significantly from community to community and the range of practices that can be used to adapt to climate change is diverse. Specific adaptation measures and recommendations are therefore presented in the bulk of the report.

An exercise held during a planning workshop ranked solar energy to be least vulnerable and IWM most vulnerable to climate change and has highlighted the need for climate proofing of technologies.

The study has shown that the RET mitigation potential for a small SHS is about 0.076 tonne of CO_2 equivalent and 6 m^3 biogas plant can abate 4.88 tonne of CO_2 equivalent.

The following table shows the technology ranking based on a variety of issues affecting energy systems. It should be noted that due to the lack of statistical and disaggregated data available on climate change impacts, contribution to adaptation and GSI it was not possible to quantify climate change and GSI issues at district level in order to show their influence on the scenario development process. For this reason a subjective scoring system has been used based on expert judgement and stakeholder perception.

Ranking of technology against assessment parameters

Technology	Less Vulnerable to climate	Help in Adaptation	Help in Mitigati on	User Frien dly	Promote Social Inclusion	Contribute to poverty reduction	Cost
Traditional Stove	5	6	4	6	3	4	4
ICS	4	5	3	5	2	3	1
Biogas	3	2	2	3	4	2	2
Kerosene	2	4	6	4	6	6	5
LPG	1	3	5	2	5	5	3
Electricity[1]	6	1	1	1	1	1	6

Institutional Assessment

Institutional assessment of relevant stakeholders in the district was carried out in the district using tools such as coverage matrix, actor constellation mapping and SWOT analysis. Coverage matrix provided the information on degree of involvement of actors in providing various services related to renewable energy. Actor constellation was used to identify the relationships between these actors in terms of participation, funding and coordination with each other.

0.4 The Scenario Development Energy Demand Projection

Data collected during the study was used to create three energy planning scenarios (Business as usual, Medium adaptation and Climate resilient). For the preparation of the scenarios the Long-Range Energy Alternative Planning Model (LEAP)[2] software was used, which is a computer-based energy accounting, simulation and scenario analysis software designed to support policy makers in assessing energy policies and to develop

[1] Electricity generated through grid, solar and micro and pico hydro. Electricity generation technology should be only disaggregated in “vulnerability” criteria, where hydro systems are most vulnerable to climate change whereas solar is the least vulnerable.

[2] LEAP is a widely-used software tool for energy policy analysis and climate change mitigation assessment developed at the Stockholm Environment Institute (SEI)

alternative energy scenarios. A 10 year planning period was established, with the year 2010 as base year.

Energy demand and driving parameters like population were disaggregated into urban and rural populations, a yearly population growth rate of 2.2% with following breakdown:

Year	Rural HH %	Urban HH%
2010	73.24	26.76
2015	68.89	31.11
2020	64.1	35.9

All three scenarios (BAU, MAS, and CRS) use the same demographic. The GDP growth is also taken to be the same across all the scenarios. The energy efficiencies of technologies are also kept fixed throughout the projection period and in all scenarios.

Business as Usual Scenario (BAU)

BAU scenario was based on current trends of interventions and demand growth. This scenario is gender neutral and does not consider GSI issues beyond existing interventions.

Under this scenario, residential energy consumption will decrease to 4.6 million GJ from 4.9 million GJ per year in 2020 compared to base year. The decrease is mainly due to the increase in urbanisation and subsequently the shift towards efficient technologies. The energy requirement for cooking will be 1.5 million GJ in 2020 compared to 2.4 million GJ in the base year. Similarly, lighting energy requirement will increase to 12,692,248 kWh in 2020 of which electricity provides for 4,834,296 kWh.

Wood fuel will remain as the major source of fuel for cooking in rural areas in 2020. It will provide for 1.1 million GJ of the 1.5 millon GJ of cooking energy demand in 20

Medium Adaptation Scenario (MAS)

The Medium Adaptation Scenario (MAS) has taken into account the development of livelihoods by providing inclusive access to energy sources. Although it does not embrace a full-climate resilient strategy it will provide some adaptive measures and consider potential vulnerabilities of resources and technologies. This scenario also integrates GSI consideration.

The energy demand is be met by an energy mix of renewable and clean energy as well as fossil fuels and biomass. Biomass shall fulfil more cooking energy demand compared to BAU.

Overall energy demand will reduce significantly compared to BAU due to increase in efficient technologies. Total residential energy consumption will decrease from 4.9 million GJ per year in the base year to 3.8 million GJ in 2020. Rural energy will decrease from 4.3 million GJ to 3 million GJ between 2010 and 2020, urban demand will increase from 0.6 million GJ to 0.7 million GJ. The MAS also sees penetration of LPG more in rural areas compared to BAU. It is to provide for 23,134 GJ of cooking energy in 2020 amounting to 5% of HH reach.

Climate Resilient Scenarios (CRS)

The final scenario Climate Resilient Scenario (CRS) will support the development of livelihoods through provision of inclusive access to energy. However in this case the assumption has been made that there will be elevated substitution towards improved and climate proofing technologies. There will be minimal usage of fossil fuel for cooking and lighting purposes. This will be enforced through necessary subsidy policy changes in the implementation guide.

Whilst the CRS does not directly consider GSI in the scenario development it is assumed that increased resilience and adaptation measures will have indirect GSI impacts.

Total residential energy consumption will decrease from 4.9 million GJ per year in the base year to 3 million GJ in 2020. The industrial sector and commercial sector outlook is also expected to be optimistic in CRS, with major industries making a switch to clean energy. Rural energy demand will decrease from 4.3 million GJ to 2.7 million GJ between 2010 and 2020, urban demand will also decrease from 0.5 million GJ to 0.23 million GJ.

Wood fuel will still remain as the major source of fuel for cooking in rural areas in 2020. It will provide for 0.6 million GJ of the 0.75 million GJ of cooking energy demand in 2020. However the consumption of wood fuel is expected to be around the production capacity. LPG share in cooking in 2020 is accounted to be minimal, due to it being a dirty fuel as well as it being a source that is not available within the country thus raising its vulnerability to supply disruption

Electricity is calculated to provide for 80% of all lighting demand in CRS in 2020.

The Comparison of Three Scenarios

The three scenarios diverge in terms of the technology selection and consumption growth. Though the total energy demand is expected to rise as per the population growth, use of efficient technologies may result in reduced demand. Table below shows technology mix for cooking and lighting in three scenarios.

	Cooking					Lighting				
	RET	**2010**	**BAU**	**MAS**	**CRS**	**RET**	**2010**	**BAU**	**MAS**	**CRS**
Rural	Traditional Stoves	70.8	58	40	0	Non elec. Based	79	63	60	20
	ICS	5.2	7	40	70	Solar	7.7	18	20	30
	Biogas	18	25	10	10	MH	1.8	3	4	7
	Electricity	0	0	5	20	Grid based	11.5	16	16	43
	LPG	0	0	5	0					
	Kerosene	6	10	0	0					
	Fuel Mix	**Mixed**	**Mixed**	**Mixed**	**100% RE**	**Fuel Mix**	**Mixed**	**Mixed**	**Mixed**	**Mixed**
	RET	**2010**	**BAU**	**MAS**	**CRS**	**RET**	**2010**	**BAU**	**MAS**	**CRS**
Urban	Traditional Stoves	18.3	2	0	0	Non elec. Based	10	0	0	0

ICS	5.2	7	5	10	Solar	4.5	5	5	5
Biogas	18	25	0	0	MH	0	0	0	0
Electricity	15	5	35	90	Grid based	85.5	95	95	95
LPG	24.5	51	55	0					
Kerosene	19	10	5	0					
Fuel Mix	**Mixed**	**Mixed**	**Mixed**	**100% RE**	**Fuel Mix**	**Mixed**	**100% RE**	**100% RE**	**100% RE**

0.5 DCEP Implementation Plan

The implementation plan provides detail activities for 3 years, from 2011/12 to 2013/14, of the MAS and CRS scenarios. However, it also provides longer term targets for 10 years.

The technology based activities are supported by activities that will contribute to gender and social inclusion issues, increase climate change capacity and awareness and promote inclusive growth and reduce regional and social disparity on energy access and governance.

DDC Makwanpur has already adopted the District Energy Perspective Plan (DEPP) that outlined renewable energy targets for the district. DCEP is the logical extension of DEPP and the DDC has adopted a series of policies and identified activities which will again be of help to adopt and implement DCEP. Additionally central government is also implementing RE programme at national level which the district can support DCEP implementation. Renewable Energy Subsidy Arrangement provides subsidies to various technologies which will ease financing at the district level.

Detail Implementation Plan

The detail implementation plan outlines in-depth plan both MAS and CRS, for three years starting from 2011/12 to 2013/14. The differences between the two scenarios are mainly related to the scale of intervention, while most of the other capacity building and support activities remain the same. Interventions under two scenarios are as follows:

Description	**Target (■: MAS ■: CRS)**		
	2011/ 12	**2012/ 13**	**2013/ 14**
Improved Cook Stove (units)	**4,012**	**3,911**	**6,143**
	6,109	**6,062**	**10,387**
Biogas (units)	**97**	**97**	**97**
	97	**97**	**97**
Solar Home System (units)	**735**	**782**	**828**
	1,458	**1,485**	**1,512**
Micro/ Pico Hydro (kW)	**14.3**	**15**	**15.7**
	33.1	**33.7**	**34.3**
Improved Water Mill (units)	**30**	**30**	**30**
	30	**30**	**30**

Besides the central government (AEPC) and DDC, other line agencies as well as NGOs, CBOs and the private sector will need to play role in delivering the targeted output. All these institutions can be mobilised and utilised within their capacity to fulfil the responsibility requirement to attain the desired target.

Financing Requirements

Financing requirements for two scenarios are summarised below:

MAS Scenario

Description	Budget in NPR		
	2011/12	2012/13	2013/14
Improved Cook Stove	2,186,240	2,133,720	3,294,360
Biogas	6,192,480	6,192,480	6,192,480
Solar Home System	21,226,800	22,584,160	23,912,640
Micro/Pico/IWM Electrification	6,680,290	6,992,408	7,309,186
Improved Water Mill	882,000	882,000	882,000
Capacity building/Trainings	983,750	411,834	416,836
Other Supports	1,460,000	660,000	160,000
Total	**39,611,560**	**39,856,602**	**42,167,502**

CRS Scenario

Description	Budget in NPR		
	2011/12	2012/13	2013/14
Improved Cook Stove	3,376,680	3,552,240	6,201,240
Biogas	6,192,480	6,192,480	6,192,480
Solar Home System	42,107,040	22,584,160	23,912,640
Micro/Pico/IWM Electrification	15,405,660	15,689,828	15,969,338
Improved Water Mill	882,000	882,000	882,000
Capacity building/Trainings	1,421,306	497,430	500,589
Other Supports	1,460,000	660,000	160,000
Total	**70,845,166**	**50,058,138**	**53,818,287**

Monitoring

District Energy and Environment Unit (DEEU) together with District Energy and Environment Coordination Committee (DEECC) Makwanpur shall be the main coordinating and facilitating agency for monitoring and evaluation. Monitored should be carried out annually with adequate support from AEPC, implementing partners, RET companies, NGOs and CBOs.

0.6 Recommendation

In addition to the implementation plan recommendations have been made for improvement of the institutional structure and data storage for further information gathering.

Gender and Social Inclusion focus is lacking currently at all stages of planning and implementation and hence needed to be strengthened by conducting gender and social assessments in the RE sector. RE opportunities can be utilised to foster equitable development from GSI perspective.

- Renewable energy awareness activities should be given priority as it is the first-step towards RE development. Women and excluded groups need to be especially targeted for awareness raising and capacity building on RE development.
- Efforts and policy to make use of clean development mechanism (CDM) mechanisms should be stressed at the national level, especially for investments to be made from the private sector.
- Though Makwanpur has shown some interest in bio-fuel plantation and production, no significant progress has been made on it so far. It should be further explored for its feasibility.
- More resources need to be allocated for forest fire prevention and relief as well ensure more people's participation in forest resource management should be fostered.
- Promotion of multi use water systems to counteract the seasonal variability of too much water too little water.
- The district needs effective mechanisms and institutional capacity for structural (check dams, embankment improvement etc) and non structural measures (disaster preparedness, mainstreaming disaster risk reduction into development planning, awareness etc) for hazard mitigation for climate induced hazards such as flood and landslides.
- Develop strategies for empowering women and excluded groups in planning for DCEP.
- A more appropriate weighting system needs to be designed that more effectively qualifies the influence of climate change and GSI on energy planning in terms of access, reduced drudgery, Increased livelihoods and improved decision making

Table of Contents

1 Introduction, Background and Rationale 1

1.1 Background and Rationale 1

1.1.1 Rationale 1

1.1.2 Objectives of DCEP 3

1.1.3 Scope of DCEP 3

1.2 Limitations of DCEP 4

1.3 Overview of Makwanpur District 6

1.3.1 Geographic profile 6

1.3.2 Demographic structure 7

1.3.3 Land distribution and natural resources 11

1.3.4 Roads and infrastructure 11

1.3.5 Institutions 12

2 DCEP Preparation Process 13

2.1 Process 13

2.1.1 Preparatory phase 13

2.1.2 Mobilisation - Interaction at district level 13

2.1.3 Findings report presentation and plan design workshop 14

2.1.4 DCEP finalisation 14

2.1.5 Discussion Approval District level consultation 14

2.2 Methodology 14

2.2.1 Overview 14

2.2.2 Data collection 15

2.2.3 Data Analysis 17

3 District Climate Change and Energy Situation Report of Makwanpur24

3.1 Climate Change Assessment 24

3.1.1 Climate 24

3.1.2 Hazards 25

3.1.3 Past and perceived future trend on climate change, impacts and vulnerability 28

3.2 Gender and Social Inclusion Assessment 30

3.3 Energy Consumption/ Demand Assessment 32

3.3.1 Implication on energy consumption due to climate change 34

3.4 Energy Resource/ Supply Assessment 34

3.4.1 Traditional (Biomass) 34

3.4.2 Commercial 35

3.4.3 Renewable 36

3.4.4 Vulnerability and stresses to energy resources in the context of climate change 38

3.5 Technology assessment 39

3.5.1 Overview 39

3.5.2 RET status/trends 41

3.5.3 Ownership of systems by gender and different Caste/ethnicity 44

3.5.4 Technology costs 45

3.5.5 Adaptation potential 47
3.5.6 Energy technology vulnerability due to climate change 51
3.5.7 Climate proofing technologies 52
3.5.8 Mitigation potential and trends – general emissions factors 53
3.5.9 Technology assessment parameters 55
3.6 Institutional assessment 55
3.6.1 Overview 55
3.6.2 Stakeholder identification and roles 56
3.6.3 Stakeholder relationship 57
3.6.4 Capacity and potential assessment 58
4 District Energy Scenario Development/ Demand Projection 63
4.1 Introduction 63
4.2 Business as Usual Scenario (BAU) 68
4.2.1 Overview 68
4.2.2 Energy demand 68
4.2.3 Energy supply 71
4.3 Medium Adaptation Scenario (MAS) 72
4.3.1 Overview 72
4.3.2 Energy demand 73
4.3.3 Energy supply 74
4.4 Climate Resilient Scenarios (CRS) 76
4.4.1 Overview 76
4.4.2 Energy demand 77
4.4.3 Energy supply 78
4.5 Comparison 80
5 DCEP Implementation Plan 83
5.1 Introduction 83
5.2 Existing policies to implement proposed plan 83
5.3 Detail Implementation Plan 84
5.4 Financing Plan 90
5.4.1 Medium Adaptation Scenario 91
5.4.2 Climate Resilient Scenario 95
5.5 Monitoring and Evaluation Plan 98
5.6 Analysis of 10 year intervention required in different scenarios 104
5.6.1 Improved Cook Stoves 104
5.6.2 Biogas 105
5.6.3 Solar Home System 105
5.6.4 Micro Hydro/ Pico Hydro 106
6 Recommendations 108

List of Figures

Figure 1: Map of Makwanpur district 7
Figure 2: Ethnicity composition of Makwanpur 8
Figure 3: Number of health facilities 10
Figure 4: Land use map of Makwanpur 11
Figure 5: DCEP preparation process 13
Figure 6: Data Collection Components of DCEP 15
Figure 7: Average yearly temperature in Daman for 30 years 28
Figure 8: Average yearly temperature in Hetauda for 30 years 28
Figure 9: Trend of monthly and annual rainfall in Daman (altitude 2314 m) 29
Figure 10: Trend of monthly and annual rainfall in Hetauda (altitude 474 m) 29
Figure 11: Average Annual Discharge of East Rapti at Rajaiya Hydrological station 30
Figure 12:Caste wise ownership of IWM 32
Figure 13: Caste wise and gender disaggregated biogas ownership in Makwanpur 32
Figure 14: Energy consumption by sector in Makwanpur 32
Figure 15: Residential sector energy consumption 32
Figure 16: End use consumption of residential sector in rural areas 33
Figure 17: Consumption by fuel type in rural residential 33
Figure 18: Types of fuel consumption in the industries 33
Figure 19: Annual Average Global Horizontal Irradiance of Makwanpur in kWh/m^2/day 37
Figure 20: Wind Potential of Makwanpur district 38
Figure 21: Year by year SHS installation 42
Figure 22: Year by Year Biogas Installations 43
Figure 23: Year by Year ICS Installations 44
Figure 24 : Costs of cooking technologies 46
Figure 25 : Costs of lighting technologies 47
Figure 26: Energy demand by areas in BAU 70
Figure 27 & 28: Rural and urban energy demand share by end-uses in BAU 70
Figure 29 : Energy resource mix in BAU 71
Figure 30: Rural resource mix in BAU 72
Figure 31:Urban resource mix BAU 72
Figure 32: Energy demand by areas in MAS 74
Figure 33 & 34: Rural and Urban Energy Demand by Activity in MAS 74

Figure 35: Resource Mix 2020 MAS 75
Figure 36: Rural Resource mix in MAS 76
Figure 37: Urban Resource mix MAS 76
Figure 38: Energy demand by areas in CRS 78
Figure 39 & 40: Rural and Urban Energy Demand by Activity in CRS 78
Figure 41: Energy resource mix of CRS 79
Figure 42: Rural Resource mix in CRS 80
Figure 43: Urban Resource mix CRS 80
Figure 44: Overall GHG emissions for three scenarios 80
Figure 45: Overall energy consumption for three scenarios 81
Figure 46: Improved cook stove Installation by year for scenarios 104
Figure 47: Biogas Installation by year for scenarios 105
Figure 48: SHS Installation by year for scenarios 106
Figure 49: MH/PH capacity installation by year for scenarios 107

List of Tables

Table 1: Population of Makwanpur 8
Table 2: School and Enrolment in Makwanpur 9
Table 3: Economic status of Makwanpur 9
Table 4: RETs installed by VDC's Poverty Index 10
Table 5: Water and sanitation coverage in Makwanpur 12
Table 6: Device efficiencies of technologies 17
Table 7: Summary of the minimum energy requirements per end-device 17
Table 8: Device share of various technologies in 2010 18
Table 9: Comparative emission rates of each of the technologies 20
Table 10: Ranking of Hazards (Key hazards in the district) 26
Table 11: Temporal distribution of hazards in Hattiya VDC, Makwanpur 27
Table 12: Temporal distribution of hazards in Gogane VDC, Makwanpur 27
Table 13: Disaster events of flood in Bhimphedi, Makwanpur District 27
Table 14: Firewood resource 34
Table 15: Agricultural Residue Resource Supply 35
Table 16: Animal Waster Resource Supply 35

Table 17 : Electricity Supply from NEA Grid (2008/2009)....36
Table 18: Biogas installed versus potential for selected VDCs/Municipality....38
Table 19: Micro-hydro projects currently in development....41
Table 20: Caste wise gender disaggregated biogas ownership in Makwanpur....44
Table 21: IWM ownership by ethnic groups....45
Table 22: Ownership of selected technologies by gender (summary)....45
Table 23 : Cost Benefit of technologies....45
Table 24: Adaptation potentials within the sample VDCs with respect to specific technologies....49
Table 25: Ranking of technologies based on vulnerability....52
Table 26 : Mitigation Potential of various technologies....53
Table 27: Costs and Emission factors of selected technologies....54
Table 28: Ranking of technology against assessment parameters....55
Table 29: Technology linkages with climate change and GSI....64
Table 30: Makwanpur Scenario Household Shares (2020)....66
Table 31: Energy demand of sector in BAU....69
Table 32: Rural – Urban energy demand in BAU....70
Table 33: Energy demand of sector in MAS....73
Table 34: Rural – Urban energy demand in MAS....74
Table 35: Energy demand by various sectors in CRS....77
Table 36: Rural – Urban energy demand in CRS....78
Table 37: Comparison of final energy consumption per HH in cooking....81
Table 38: Comparison of final energy consumption per HH in lighting....81
Table 39: Comparison of final energy consumption % cooking....82
Table 40: Comparison of final energy consumption % lighting....82
Table 41: Detail Implementation Plan for MAS and CRS....85
Table 42: Subsidy policy for various RETs....90
Table 43: Budget set aside FY 2010/11 by DDC....91
Table 44: Financing requirement for MAS....93
Table 45: Financing requirement for CRS....96
Table 46: Monitoring and evaluation plan for MAS....99

List of Annexes

Annex 1 : Summary of Findings from VDCs 114

Annex 2: Intervention scale of RETs from 2010 to 2020 in three scenarios 125

Annex 3: Hazard information of Makwanpur 129

Annex 4: Institutional assessment tools 132

Annex 5: Checklist for FGD 145

Annex 6: Checklist for Key Informants for DCEP in District 148

Annex 7 : Survey license for hydropower 149

Annex 8: Energy demand and supply balance 152

Annex 9: List of participants in focus group sessions 153

Annex 10: DCEP Preparation process 157

Annex 11:List of PQ companies in RET 158

Annex 12: LEAP fact sheet by Stockholm Environment Institute's 166

1 Introduction, Background and Rationale

1.1 Background and Rationale

The main goal of the District Climate and Energy Plan (DCEP) is to create a planning process to increase the dissemination of renewable energy technologies at district level, contributing to Nepal's national and local development plans. In the DCEP preparation guideline the overall goal of DCEP is

"To create an implementation plan that increases Renewable Energy Technology (RET) dissemination and development in each district of Nepal and contributes to Nepal's national and local climate change mitigation and adaptation plans. DCEPs will act as a systematic roadmap, which serves as a periodic rolling plan of the district in the sector of renewable energy development and climate change preparation. Strategies for development and dissemination of the RETs in the district will be mapped out and climate adaptation and mitigation and gender and social inclusion linkages identified."

1.1.1 Rationale

DCEP is a key document that shows how the District Development Committees (DDCs) will address energy development at district level whilst acknowledging climate impacts and incorporating gender[3] and social inclusion[4] issues. They will provide an inventory of district energy resources to identify the most appropriate actions and opportunities and interventions for increasing access to RETs and therefore promoting low carbon development as well as how RET will contribute to climate change adaptation measures. Addressing climate change requires a rapid development of renewable technologies in Nepal, careful planning is vital to achieve this at any level, particularly at the district level.

Effectively implemented sound energy plan can improve adaptive capacity of the communities and contributes to carbon abatement. In addition, potential resilience capacity created through energy measures can also address gender and social inclusion (GSI) issues to build on the resilience capacity of women, children, persons with disability and communities with specific livelihood strategies who are differently vulnerable to different adversities and stresses including the impacts of climate change. On the other hand, if ignored, it can lead to inappropriate policy measures (PAC, 2010) and malpractices generating adverse feedback inputs. GSI is therefore a key component of DCEPs.

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[3] Gender refers to the socially constructed roles and responsibilities of women and men which include the expectations held about the characteristics, aptitude, and likely behaviour of both women and men (femininity and masculinity). These roles and expectations are learned, changeable over time, and variable within and between cultures.

[4] Social inclusion is removal the institutional obstacles that prevent socially excluded and marginalised groups as well as the enhancement of incentives to exercise their rights and increase access and benefit from economic, social and political resources. It is also a process of creating an environment that gives every individual equal opportunities to access the resources, whatever social group she or he belongs to.

In Nepal, exclusion[5] is seen in line with gender, class, caste, ethnicities and geographical locations causing inequalities in various dimensions: social, cultural economic, technological, political, etc. Because of such exclusionary practices, women, poor, Dalit, ethnic groups and people living in remote areas are constrained from voicing their concerns, access to and control over resources and services, and making policies and institutions favourable to them[6].

Because of gender-based divisions of labour found in Nepal, managing household level energy supply, especially, for cooking and grinding grains comes under women's responsibility. Hence, the lack of access to clean, modern energy services has a more pervasive and severe impact on the lives of women and girls. Likewise, lack of access to clean energy services may have severe negative impacts to the lives of the poor, ethnic groups, so called low caste groups and people living in remote geographic locations as these categories of people have very limited capacity to afford alternative energy resources.

Hence, the issues of gender and socially excluded peoples' needs, concerns and their rights have to be fully taken into consideration not only as beneficiaries and users but also as powerful change agents throughout planning, implementation and evaluation processes. Ignoring the meaningful participation and the capacities of women and socially excluded people into planning processes including the choice of energy technologies may lead to the wrong selection of the technologies and capacity building needs. Hence, mainstreaming GSI issues is the only way to reduce the gap and attain gender and social equalities.

There are already several international and national level policies and strategies in place to include the demand and inspiration of excluded groups by lifting the obstacles that present socially excluded people from accessing and benefitting from economic, social and political resources and creating an environment that gives every individual the same opportunity to access the resources, whatever social group she or he belongs to.

Similarly, the DCEP process has looked at addressing these imbalances in the institutional set up of Makwanpur in relation to GSI in dissemination of RE and made recommendations about what systems, processes and organisational arrangements will be needed to improve RET dissemination and provide strong links to climate change activities.

Without adequate consideration in policy and planning women and traditionally excluded and marginalised groups can become particularly vulnerable to climate change issues (PAC, 2010), therefore, GSI issues will be addressed throughout the DCEP. These issues are evaluated throughout the planning process. In this context GSI refers to the

[5] Social exclusion is a process and a state that prevents individuals or groups from full participation in social, economic and political life and from asserting their rights. It derives from exclusionary relationships based on power (DFID 2005)

[6] DFID and World Bank, 2005. Unequal Citizens, Gender Caste and Ethnic Exclusion in Nepal.

interactions between society with resources and technology in relation to gender and social discrimination and other aspects of inclusion.

1.1.2 Objectives of DCEP

The overall objective of a DCEP is to prepare a climate change adaptive, decentralized renewable energy plan that presents a detailed implementation plan that can contribute to climate change mitigation and also ensures GSI issues are mainstreamed within the plan.

Some of the specific objectives of the DCEP are:

1. To outline energy needs for Makwanpur district,
2. To carry out resource, technology and institutional assessments
3. To outline interventions of renewable energy technologies by identifying climate change and GSI issues
4. To identify the capacity development needs to implement the climate change adaptive renewable energy plan
5. To assess the institutional arrangements of the district and identify adjustments and recommend improvements
6. To outline implementation of the plan with identification of roles and responsibilities of different stakeholders

1.1.3 Scope of DCEP

This DCEP report maps district energy resources, providing a suitable basis for making decisions on the most appropriate actions and interventions necessary for accessing RETs, promoting low carbon development and aiding climate change mitigation and adaptation measures.

Climate change, particularly its impacts on energy sector, has been considered at each stage of the planning process such as assessment of energy resources, demand and supply. Although assessment of climate change and its impacts in different sectors warrants a separate in depth studies that accrues longer time and resources, the DCEP has focused on the existing and potential impacts of climate change on energy and potential of energy through the DCEP to climate change adaptation and mitigation. Climate change issues have been integrated in the planning process in identifying and prioritising societal, resource and technology related vulnerabilities to climate change.

The focus of DCEPs is to both expand coordination and service provision of renewable energy at district level identifying opportunities where the GSI responsive energy plan can contribute to climate change mitigation and adaptation in all energy related planning processes. The GSI responsive energy planning process provides the opportunity to work with the poorest of the poor, as women, Dalit, and indigenous people are among the poorest groups.

Some of the specific scopes of the DCEP are;

1. Assess and analyse energy supply and consumption patterns in the district supported by data disaggregated by gender and caste/ethnicity
2. Identify potential of renewable/rural energy sources and associated technologies based on climatic, geographical and socio-economic variations.
3. Prepare a broad climate change assessment of the district – (based on existing data)
4. Prepare integrated rural/renewable energy development and management plan including divisions of responsibility and specific activities of stakeholders.
5. Identify current and potential stakeholders in the renewable/rural energy (and interlinking) sectors, analyse capacity in terms of ability to implement RE strategy developed taking into consideration climate change and GSI issues including capacities for outreach, awareness of rights and access to information in languages they understand.
6. Prepare an integrated inclusive climate change adaptive district energy plans supporting potential mitigation actions
7. Provide tentative financial requirements for identified/proposed plan and suggest ways of finance (grant/ credit), funding mechanisms
8. Ensure that GSI planning and processes are mainstreamed into all DCEP plans and recommendations provided for GSI strategies during implementation of the DCEP.
9. Provide a monitoring and evaluation plan for the implementation of DCEP fully taking into account GSI indicators

1.2 Limitations of DCEP

Given the vastness of the subjects (i.e. renewable energy, climate change and GSI) it is not feasible to encapsulate all aspects of these topics within a DCEP and the DCEP document. In this regard the DCEP will only focus on alternative and renewable energy. Also the preparation of a DCEP requires primary data to be collated, however due to resource limitations this document has been prepared mostly from secondary sources. Primary data has been collected to validate and update the secondary sources and has been limited to certain village development committees (VDCs).

Due to lack of primary data, it is difficult to estimate actual energy consumption in residential sector in Makwanpur. Secondary data from Practical Action's Study to Determine Outline Plans for Eliminating Energy Poverty in Nepal (Energy Poverty Study) published in 2010 is adapted to serve this purpose which gives an estimation of the minimum energy required to perform daily common activities of residential sectors like cooking, water boiling, lighting and space heating. This is principally restricted to incorporate macro-economic parameters like Gross Domestic Product (GDP) in development of energy intensity of energy users in Makwanpur as the minimum energy required to perform certain activities to be same in every level of economic development. Also during analysis of scenarios since minimum energy has been utilised the fact that people might be adopting new technology for various needs or cross switching to other technologies, etc. has not been considered. The use of the minimum energy requirement also means that the scenarios that are presented will not be analysed from an energy balance (demand vs. supply) perspective but from providing for the minimum energy requirement that is analysed. Some of the other limitations of the study are highlighted below:

- The study is more focused on the residential sector especially energy consumption in rural residential than industrial or commercial.
- The scenario building utilises the fact that the major end uses in residential sector is cooking and lighting .The subsequent planning is also focussed on providing for these end uses. However planning for improved water mill (IWM) dissemination for agro processing has also been carried out based on its potential. Planning for water boiling needs has been not investigated due to the unavailability of secondary data to draw tangible conclusions on current situation and future growth with respect to scenario development and technology usage.
- As this study was not a user focused assessment it has not been possible to explicitly assess the particular needs of women and social groups.
- Given the context of transport and the amount of energy/fuel consumed within a district it is very difficult to pinpoint empirical data on how much fuel could have been consumed within the district, therefore no analysis has been done on energy consumed in transport in Makwanpur.
- There is a general lack of recent disaggregated data of Makwanpur on GSI especially those relating to renewable energy, which translates to the study. The data presented in terms of total technology installed doesn't correlate with the current numbers. However for the purpose of analysis older data has been utilised.
- The data collection methodology did not always capture the gender situation in households. For instance where financing mechanisms were not available for technologies for example with ICS, the technology owner was normally recorded as the household owner as the data was not disaggregated. For this reason it seems that there is little female ownership of ICS, however this may be a misrepresentation
- There is no district-specific climate change projection or study on district-specific impacts of climate change. These have to be adapted from national reports and interposed for Makwanpur. The climate analysis therefore is based on national reports, perceived impacts and vulnerability, and climate trends.
- The planning will remain to abstain from planning for hydro projects that are not pico or micro hydro projects.
- The resource assessment lacks proper assessment due to the unavailability and accuracy of available secondary information.
- Due to the lack of statistical and disaggregated data available on climate change impacts, contribution to adaptation and GSI it was not possible to quantify climate

change and GSI issues at district level in order to show their influence on the scenario development process. For this reason a subjective scoring system has been used based on expert judgement and stakeholder perception.

- The information available, from implementing partners, of RET interventions in the district are based on the total number of installations carried. There is no such information on whether a particular household (HH) has installed the same technology twice and no such information on the number of functioning technologies. Therefore the study makes some assumption on the lifespan of the technology and subsequently the operation number of technologies.

1.3 Overview of Makwanpur District

1.3.1 Geographic profile

Makwanpur district lies in Narayani Zone of the Central Development Region of Nepal. Spatially it is located from 27°10’ to 27°40’ North latitude and 84°41’ to 85°31’ East longitude. The district rises from 166m above sea level to 2,584m above sea level and has an area of 2,426 sq. km, making up 1.65 percent of the total land area of Nepal. Towards the north a 66km wide Mahabharata range makes up 41% of the district area whereas the southern part of the district has 92 km wide Chure (Silwalik) hills that makes up for 59% of the district area.

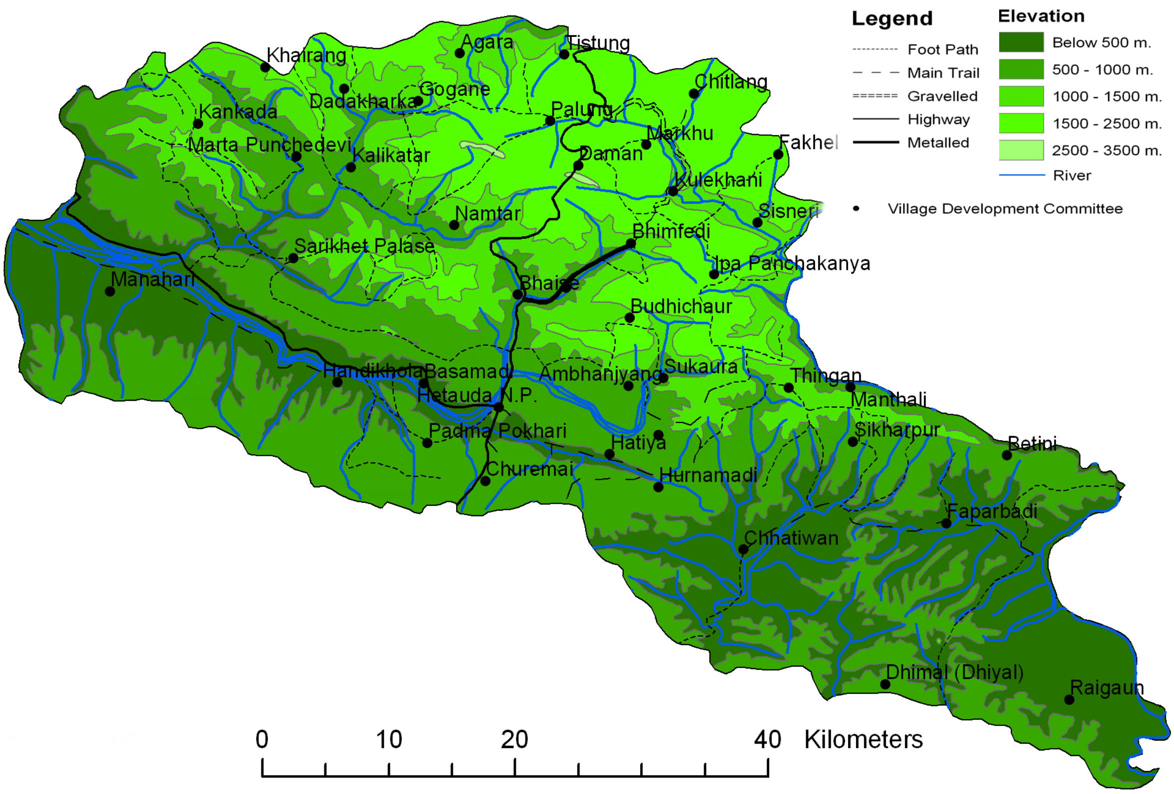


Figure 1: Map of Makwanpur district **Source: Digital Himalaya**

The land gradient make up of Silwalik region is 8.48% of medium to high slopes and 63.59% of high slopes to extremely high slopes. Similarly the mid hills have 33.25% of mid to high slopes and 60.45% high slopes to very high slopes. Less than one fourth of the total area of Makwanpur district has up to 5° inclination, slopes with 20° inclination are mostly on southern part and some northern belts. Slopes having 30° or more inclination occupy more than half of the district and most northern areas.

There are altogether 43 VDCs and 1 municipality in Makwanpur. Hetauda is the district headquarters of Makwanpur. The district is bordered by Lalitpur, Kavrepalanchowk, and Sindhuli in the East, Kathmandu and Dhading in the North, Chitwan in the West and Bara, Parsa and Rautahat in the South.

1.3.2 Demographic structure

a) Population

The national census conducted by Central Bureau of Statistics (CBS) in 2001 has the total population of Makwanpur as 392,604 with an annual population growth rate of 2.2%. This made up for 1.7% of the total Nepal population. The 2010 projected population, utilising the growth rate, is around 478,385.

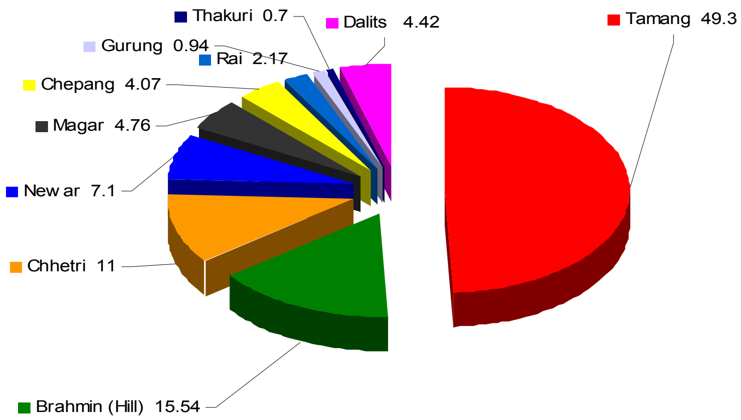
Table 1: Population of Makwanpur

Population	2001 Census	2010 Projection
Total Population	392,604	478,385
Male	199,144	242,655
Female	193,460	235,730
Total Households	71,112	86,649
Average Household Size	5.52	7
Population Density/sq.km	162	197
Population Growth Rate	2.2	

Source: CBS, 2001

b) Caste/Ethnic composition

Makwanpur district has a predominant Tamang population, one of the ethnic groups in Nepal which occupy 5.5 % of the total population of Nepal. In fact, Makwanpur has the highest number of Tamangs among all districts of Nepal. Tamang alone occupy 49 percent of the total population of the district (CBS, 2001). The Tamang population is well spread throughout the district and has the most dominance in the north western and central VDCs of the district. Altogether there are 78 different ethnic groups living in the district. Other groups like Brahmin, Newar, Magar, marginalized groups such as Chepang, and endangered groups such as Bankariya also reside in the district. The Chepangs mostly reside in the Western part of the district in VDCs like Kankada, Khairang and Raksirant. There are Newars in the northern VDCs like Chitlang and Bajrabarahi, which are also in close proximity to the Kathmandu valley. Brahmin and Chettris are mostly residing in south central VDCs of the district like Hattiya and Aambhanjhyang which also bear close proximity to Hetauda municipality.



Source: CBS, 2062

Figure 2: Ethnicity composition of Makwanpur

c) Educational status

The 2001 CBS census listed the literacy rate of population of Makwanpur from 6 years and above at 63.18 percent. The 2010 projection shows that the literacy rate of the same is 77 percent. The literacy rate of the adult population (15-24 years) is 79.6 percent while the net enrolment ratio of children is 87.8 percent.

Table 2: School and Enrolment in Makwanpur

School Level	Number	Teacher		Total Students	GER	NER[7]
		Female	Male			
Pre Primary	616			18510	74.3	
Primary	586	1128	2802	92944	155.8	94.5
Lower Secondary	200	150	630	32723	105	90.4
Secondary	107	70	405	13159	61.7	38.9
Higher Secondary	23	15	271	3035	14.4	3.7
Campus(constituent)	1	41	144	185		

Source: ISRC, 2010

d) Economic activity

There are a high percentage of women that are economically active in Makwanpur. A large number of the economically active population are involved in farming, fishing and forest products.

Table 3: Economic status of Makwanpur

Economic Activity (10 years and above)	2001 Census	2010 Projection
Economically Active Population Male	97,744	119,100
Economically Active Population Female	60,989	74315
Economically Active Population Total	158,733	193415
Economically Inactive Population Male	48,347	58,910
Economically Inactive Population Female	48,347	98,234
Economically Inactive Population Total	128,966	157,144
Group: Legislator/Senior Official/Managers	1,828	2,227
Group: Prof./Semi Prof./Tech Workers	11,624	14,164
Group: Adm & Clerical Workers	4,626	5,637
Group: Services workers & shop, market sales	16,861	20,545
Group: Farm /Fishing / Forestry Worker	76,125	92,758
Group: Craft & Trade Workers	14,193	17,294
Group: Prod. Labour Workers	8,139	9,917
Group: Other & Not stated	17,954	21,877

Source: ISRC, 2010

e) Health

According to the 2004 Human Development Index of Nepal, Makwanpur's child mortality rate per thousand children is 95.8, where Nepal's average is 68.5. The average life expectancy at birth is 55.7 years, much less than Nepal's average which is 61 years. The poor number of hospital and clinics also accounts for Makwanpur's poor health record.

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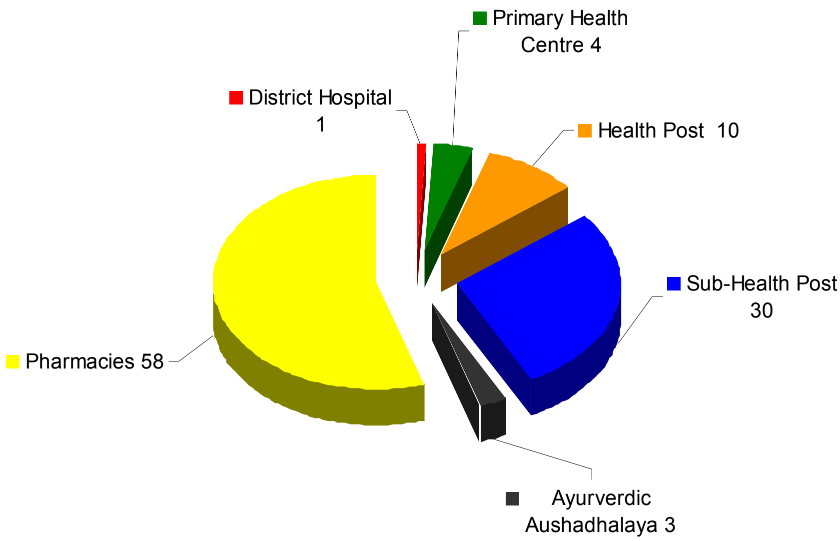
[7] NER = Enrolled children in the official school age group / Total number of children in the official school age group
GER = Enrolled children of all ages / Total number of children in the official school age group



Source: ISRC, 2010

Figure 3: Number of health facilities

f) Energy access and affordability

Of the total HHs in Makwanpur the main lighting source for 60% of the HHs is electricity, followed by 38% kerosene and 2% from other sources. In terms of cooking 51.6% of HH use firewood for cooking, 25.8% use kerosene and around 15.6% use Liquefied Petroleum Gas (LPG) (CBS, 2062 BS).

In line with table below it can be observed that bio-gas installations are generally more prevalent in non-poor VDCs. This is related to affordability as well as material availability. Also there is a high incidence of solar home system (SHS) installation in poor VDCs compared to ultra poor and vulnerable VDCs.

Table 4: RETs installed by VDC's Poverty Index

Poverty Status Index	VDCs	Available RETs installed		
		Micro/Pico Hydro	SHS	Biogas
Ultra Poor (77.4 – 70.2)	Tistung, Betini, Kankada, Dhandakharka, Dhiyal, Bharda, Raigaun, Sukaura,	16	4	296
Poor (69.6 – 65.0)	Chhattiwan, Aagra, Gogane, Thingan, Raksirant, Phaparwari, Basamadi, Sikharpur, Budhichaur	4	600	1666
Vulnerable (64.5 – 60.2)	Kalikatar, Manthali, Namtar, Bibuwatar, Sarikhet, Harnamadi, Bhainse, Handikhola, Manahari, Aambhanjyang, Churiyamai, Kogate, Markhu, Kulekhani, Makawanpurgadhi, Daman		443	4177
Non poor/ General (69.5 – 55.6)	Phakhel, Padampokhari, Sisneri, Bajrabarahi, Hattiya, Bhimphedi, Palung, Hetauda Municipality, Ipa, Chitlang			5719
VDC Unknown/		18	1	2

Source: DEPP, 2009

1.3.3 Land distribution and natural resources

40,842 Ha of the district is considered cultivated land and 18,815 Ha non-cultivated; pasture land comprises 3,136 Ha and forest land 167,453 Ha. Of the total forest cover in Makwanpur the largest proportion is sub-tropical Sal forest. There are approximately 121,414 plots in total, 1,899 tenants and 33,884 land owners in the district. The main cereal crops produced in Makwanpur are Paddy, Maize Millet Wheat and Barley; there are additional cash crops including pulses, oilseed, potato, tobacco and sugar cane (CBS, 2062 BS).

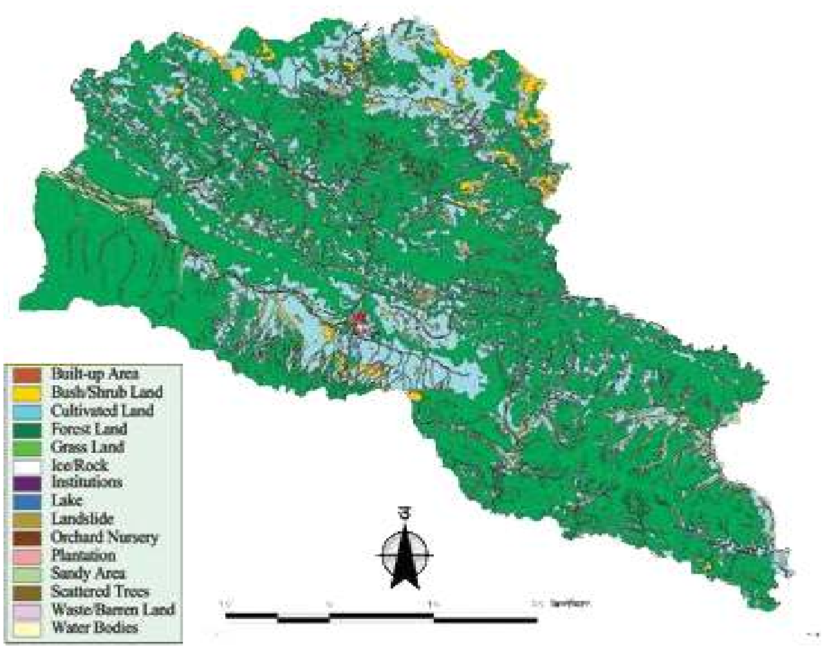


Figure 4: Land use map of Makwanpur

There are a number of rivers running through the district, the main ones being the Rapti, Bagmati, Bakaiya, Manahari and Lothar; in addition there are many smaller stream and side rivers. The major hill ranges in the district are the Chandragiri Range (Phakhel VDC to Tistung VDC), Mahabharata Range (Betini VDC to Khaireni VDC) and Chure Range (Rai Guan VDC to Manahari VDC) (CBS, 2062 BS).

1.3.4 Roads and infrastructure

a) Roads

The total road coverage in the district is 436 km; 172.5 km black topped; 81.6 km gravel; 92 km earthen. Most of the VDCs are connected by road to one of the two major highways of Nepal, the Tribhuwan Highway and Mahendra Highway (DEPP, 2009).

b) Irrigation, drinking water and sanitation

Up to 2008/2009 Department of Irrigation had managed to provide irrigation to 3,231 Ha, while Asian Development Bank (ADB) supported initiative had irrigated 510.60 Ha of land in Makwanpur. The drinking water supply coverage in the district is 72.12 percent, with the rural population having 67.35 percent coverage (ISRC, 2010).

Table 5: Water and sanitation coverage in Makwanpur

Drinking Water and Sanitation	Percentage
Water Supply coverage	72.12
Rural Population Water Supply coverage	67.35
Urban Population Water Supply coverage	92.02
Population with sanitation coverage	48.05
Rural population with sanitation coverage	38.95
Urban population with sanitation coverage	86.03

Source: ISRC, 2010

c) Electricity

There are currently two main power stations within Makwanpur providing a large proportion of the electricity to the district as well as the country as a whole. Kulekhani-1 and 2 provide 60 and 32 MW of power output respectively. In addition Kulekhani project is currently under construction providing an additional 14 MW of power. Of the total, 34 VDCs and Hetauda Municipality amounting to 37%, or 32,182 HHs, of which 29,402 HHs receive directly from the Nepal Electricity Authority (NEA), 1,100 through Micro Hydro Projects (MHP) and 1,680 from SHS (DEPP, 2009).

1.3.5 Institutions

a) Banks and NGOs

There are altogether 326 Non Governmental Organisation (NGOs) working in the district. Of these 15 works in environment protection, where as 196 NGOs are working in community development. As of July 2009, there are altogether 20 commercial banks and their branches in operation in Makwanpur. Most of them operate from Hetauda. There are more than 300 co-operatives of various interests in the district.

b) Industry

There are a total of 1,596 small and cottage industries out of which 717 are in the productive and 777 are in the service sector. Altogether there are 64 industries registered and 46 approved for foreign investment in the district. These industries provide employment for around 11,052 people. In Hetauda Industrial Zone there are around 55 industries in operation.

2 DCEP Preparation Process

The consultancy services for preparing the Makwanpur DCEP has followed the nine stages of the DCEP preparation process as mentioned in the DCEP guidelines. The preparation has been done in line with the proposed district and national level stakeholder consultations. The final DCEP document has incorporated the relevant and appropriate feedback from these stakeholders and been approved by the DCEP task force (including DDC) and national level stakeholders. The DCEP preparation process is highlighted below a more detailed process is shown in Annex 10.

Figure 5: DCEP preparation process

2.1 Process

2.1.1 Preparatory phase

Initially a desk study was carried out to identify list of potential data source. The representative from the district partner NGOs, the district focal points (DFPs), were oriented on the DCEP preparation during this phase. They were provided with the DCEP preparation guidelines and adequately informed to sensitise the relevant stakeholders in the district. In this regard, data that need to updated, validated and collated from the district were also identified.

2.1.2 Mobilisation - Interaction at district level

The district had a pre-selected DCEP task force facilitated by AEPC/SNV. The DCEP task force includes the Local Development Officer, DDC Planning Officer/programme officer, District Energy and Environment Unit (DEEU), District Chief of Women Development Office, NGOs representative and private sector/ service providers representative etc. The DFPs was responsible for coordinating and liaised with the DCEP task force to ensure their input into the process.

A one day consultative meeting with DCEP Task Force was held in the district on December 13, 2010. The overall objective of the meeting was to garner support to start the DCEP process and carry out necessary steps at the district level. The work plan was shared and agreed upon along with responsibilities of DDC, District Energy and Environment Coordination Committee (DEECC) and task force team defined for DCEP process. The meeting also decided on the three VDCs for which the data was to be collected. Field visits were carried out these three VDC's in which necessary primary data on climate change and GSI implication on energy was collected through participatory rural appraisal tools.

2.1.3 Findings report presentation and plan design workshop

A planning workshop was held in Hetauda on the 15 and 16th of February 2011 to share the outcomes from the data analysis and the scenario development. The feedback has been incorporated into this planning document.

2.1.4 DCEP finalisation

The DCEP report, including activity plans, financial sections, actor identification and monitoring and evaluation plan was finalised in this step. Conclusions and recommendations were developed. The major planning steps and recommendations for implementation or for further research, studies and steps necessary to fully address all of the required issues were also included as part of the final DCEP document.

2.1.5 Discussion Approval District level consultation

The first draft of the DCEP report was submitted to AEPC's Carbon and Climate Unit (CCU) and SNV for review and approval. After required revisions were made the final report was circulated to wider stakeholders in the district and at the national level. A district level workshop was held to share the DCEP draft. With their feedback and comments a final draft was prepared which was shared in a national workshop. The final report was prepared based on the feedback and review from the district and national workshops.

2.2 Methodology

2.2.1 Overview

The DCEP preparation methodology is based upon the DCEP preparation guidelines (available from AEPC's CCU). The guidelines provide the tools and framework necessary to prepare a DCEP, however the overall methodology that was used to prepare DCEP Makwanpur is as follows:

Data is mostly compiled from secondary sources particularly from the district. The District Profile of Makwanpur and the District and VDC Profile of Nepal published by the Intensive Study and Research Centre provided much of the information for the district overview including socio-economic data. Energy consumption patterns were adopted from the Energy Poverty Report by Practical Action. Necessary primary data was collected to update and validate existing data. Relevant participatory rural appraisal (PRA) tools like focus group discussions (FGDs), key informant interview (KII) and stakeholder/experts consultation also formed the basis for collection of information on energy and climate vulnerabilities and impact and GSI issues. The FGDs were carried out in selected VDCs that were chosen during the DCEP Task Force meeting based on the VDC selection criteria mentioned in the guidelines. To ensure a representative sample VDCs were chosen to represent the varied topographical and climatic areas in the district. Particular attention was made to ensure a selection of VDCs with varying level of access to RETs compared to the district as a whole. The VDCs chosen for primary data collection were Hattiya, Gogane and Khairang.

The collected data was utilised to present an overview of the district, the district socio-economic condition, and energy situation in terms consumption and supply. The collated data was further used to undertake a climate, GSI, technology and institutional assessment. This information is presented in the Chapter 3 of this document. Energy consumption data was used to develop the *business as usual scenario* (BAU), where current trends of energy use and technology intervention were assumed to continue. Up to date RET intervention levels were incorporated into the data in order to provide the most up to date information. Following this two further scenarios were developed representing a medium adaptation scenario and a climate resilient scenario. These scenarios were developed on the basis of a desirable future based on the interpretation of the scenario as well as after assessment of climate, GSI, technology and energy. The intervention level required for various technologies was then calculated for both medium adaptation scenario (MAS) and climate resilient scenario (CRS), which has been translated into the detailed implementation plan for three years for Makwanpur.

2.2.2 Data collection

As depicted in the Figure 6 below the data collection looked to collate the data required for the four key assessments required to address the DCEP (energy, resource, institutional and technology assessment). Other cross cutting issues of gender, social inclusion, climate change and institutional capacity were assessed in terms of how they will impact on the energy planning framework. Required data was collected from both secondary and primary sources.

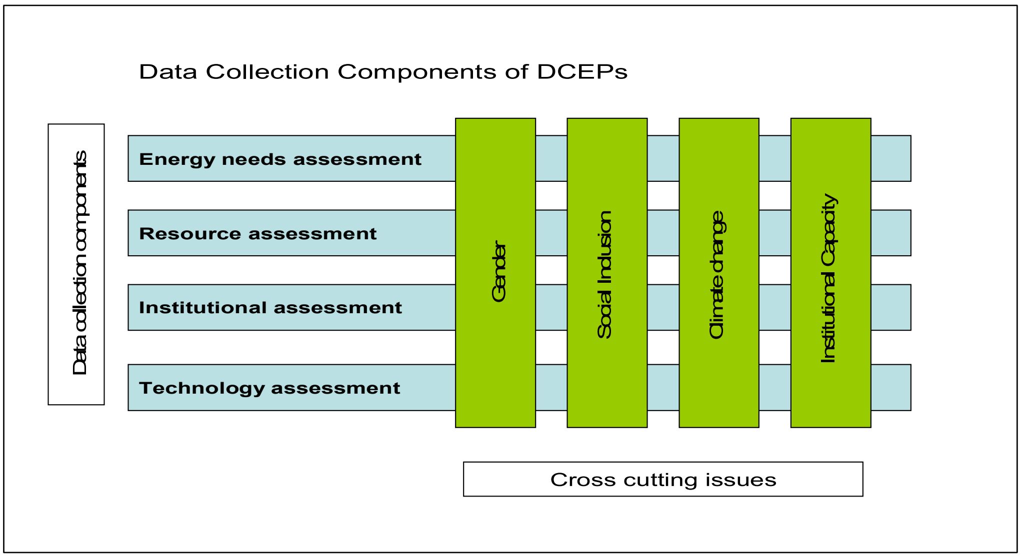


Figure 6: Data Collection Components of DCEP

a) Secondary data collection

Information on the socio-economic overview of the district, energy data, policy inter-linkages, etc was collected from secondary sources. The data collection was based mostly on secondary sources of information as presented in Annex A.3 of the DCEP guidelines. Where secondary data was not available centrally, it was collected from the district itself. This involved information collection from the district based offices DDC, DEEU, service providers and market actors in RET. Secondary data was particularly sourced from the District Profile of Makwanpur and the District and VDC Profile of Nepal published by the Intensive Study and Research Centre in 2010. These documents provided much of the information for the district overview including socio-economic data. Energy consumption patterns were adopted from the Energy Poverty Study (EPS) by Practical Action and validated against the data presented in the District Energy Perspective Plan for Makwanpur. Current RET status and trends were sourced from the relevant implementing bodies, such as Centre for Rural Technology (CRT/N), Energy Sector Assistance Program (ESAP), Biogas Sector Partnership (BSP) Nepal. The climate data, especially the trends, have been adapted from Department of Hydrology and Meteorology's (DHM) 30 years temperature and precipitation data. The district hazard information was also sourced from Makwanpur's District Disaster Management Plan. The detail list of secondary sources is listed in the reference section of this document.

b) Primary data collection

Primary data collection was carried out to update and validate data collected from secondary sources, as necessary. VDC selection criteria outlined in the DCEP guideline was utilised for selecting three VDCs for primary data collection. The three VDCs selected were Hattiya, Gogane and Khairang VDC. This was decided upon during the DCEP task force meeting in Hetauda. The selection was based on accessibility or the lack of transportation and roads, energy access, topography, exposure to hazards etc of the VDCs.

FGDs and KIIs etc were utilised along with tools (institutional capacity assessment) outlined in the guideline to collate primary data. FGDs with diverse group were held in the three selected VDCs. The focus group consisted of a mix of the most vulnerable, marginalised, teachers, local politicians, RET users and non-users etc. Out of the total participants in FGDs carried out, almost half of the respondents were women. The main objective of carrying out the FGDs was to validate secondary data. Information on energy consumption patterns, technology choices, and resource utilisation was extracted. This information albeit qualitative was extrapolated to create the district scenario. Personal discussion sessions were also held with some members of the community to extract household level energy consumption data. The wider group session also provided information on local climate change trends and impacts including on energy resources. KIIs were held with key persons in the VDC and at the district headquarter, Hetauda, with officials from various government line agencies including DEEU, Department of Irrigation, etc. Checklist and questionnaires that were prepared for FGD, KII and personal discussion has been included as annexure in this document. The summary of overall field findings from the three VDCs is also presented in Annex 1 of this document.

2.2.3 Data Analysis

Energy Assessment

The minimum energy required for residential activities has been based on report produced by Water and Energy Commission Secretariat (WECS) and has been estimated considering the minimum level of each of these basic services and the corresponding energy that needs to be provided. According to the WECS, the minimum energy required for cooking is 5.5 GJ/HH/year and 1,431,000 lumen-hours per year for lighting.

The minimum energy required is then multiplied by average efficiencies for each device to obtain total energy requirements for each end-use. Device efficiencies are summarized below.

Table 6: Device efficiencies of technologies

TCS	*Iron Tripod/ 3-Stone*	*ICS*	*Gasifier*	*Charcoal Stove*	*Biogas Stove*	*LPG Stove*	*Pressure Stove*	*Wick Stove*	*Clay Heater*	*Electric Kettle*
10%	*5%*	*20%*	*30%*	*20%*	*60%*	*65%*	*50%*	*45%*	*55%*	*90%*

Source: EPS, 2010

Table 7: Summary of the minimum energy requirements per end-device

Minimum Energy Required for cooking (GJ/HH/year)										
Wood fuel				*Charcoal*	*Biogas*	*LPG*	*Kerosene*		*Electricity*	
TCS	*Iron Tripod/ 3-Stone*	*ICS*	*Gasifier*	*Charcoal Stove*	*Biogas Stove*	*LPG Stove*	*Pressure Stove*	*Wick Stove*	*Clay Heater*	*Rice Cooker*
55.0	110.0	27.5	18.3	27.5	9.2	8.5	11.0	12.2	10.0	6.1

Minimum Primary Energy Required (kWh/HH/year) for Electric Devices					*Kerosene Devices*		
CFL (7 W)	*Fluorescent Lamps (40 W)*	*Incandescent Lamps (40W)*	*SHS (7 W)*	*SSHS (0.03 W)*	*Kerosene Tuki (5 lm)*	*Lantern (50 lm)*	*Gas Lamp (1000 lm)*
35.8	44.2	143.1	35.8	38.2	2.6	8.6	26.1

Source: EPS, 2010

To calculate energy demand, two factors are necessary: the level of activity and the energy intensity of the device. Level of activity is the household shares. Values for these factors have been adapted from secondary sources (WECS and EPS) however where possible current data such as RET status and electrification rates have been used to update the results.

Table 8: Device share of various technologies in 2010

	Cooking		Lighting	
	Technology	**%**	**Technology**	**%**
Rural	Traditional Stoves	70.8	Non elec. Based	79
	ICS	5.2	Solar	7.7
	Biogas	18	MH	1.8
	Electricity	0	Grid based	11.5
	LPG	0		
	Kerosene	6		
Urban	Traditional Stoves	18.3	Non elec. Based	10
	ICS	5.2	Solar	4.5
	Biogas	18	MH	0
	Electricity	15	Grid based	85.5
	LPG	24.5		
	Kerosene	19		

Source: Adopted from EPS 2010 and other sources

Specific energy consumption for devices has been calculated from the average annual household energy consumption (GJ/household) and their corresponding device shares, which have been derived from the EPS. The share of biogas stoves was updated from the Biogas resources in Nepal data from BSP, whereas ICS data was sourced from CRT. For LPG and kerosene stoves, the device share was calculated based on the ratio of average LPG energy consumption (GJ/HH/year) to energy intensity (GJ/HH) of the respective stove. Electricity device shares are based on the electrification coverage in the district. However in some cases where information on RETs installed in rural and urban is not available, the district percentage shares have been applied for rural and urban areas. For example in the case of ICS, the number of HHs that have ICS installed in the district is 5.2%. This has been applied to both rural and urban areas (Table 8) as there is no information on where the ICS was installed.

The specific annual household energy consumption (GJ/HH) was multiplied by the device efficiencies. The result was then multiplied by the corresponding share of households using that device to obtain the final energy consumption (GJ/year).

Resource Assessment

Data on energy resource potential is adopted from DEPP as well as the EPS. The Department of Electricity Development's website, which provides information on application for licenses and issues licenses on survey for generation, is taken as a viable source to identify potential of hydro power generation in Makwanpur. The Solar and Wind Energy Resources Assessment (SWERA) reports were referred to for wind and solar potential of Makwanpur. The biogas potential was adopted from BSP's study on Technical and Market Potential of Biogas in Nepal. In terms of resource vulnerability the National Adaptation Programme of Action (NAPA) report along with other supporting reports of climate change impacts and local perception of climate change impacts collected through focus group sessions was utilised to identify resources vulnerable to the impacts of climate change in Makwanpur.

Technology Assessment

The technology assessment is based on both primary as well as secondary data. The status and trend of specific technologies have been analysed with respect to data collected from principal implementing organisations[8]: Biomass, solar home systems, watermills and bio fuel: AEPC; Biogas: BSP-Nepal; Micro Hydro: REDP; Improved water mills: CRT/N.

These have further been verified during focus group discussions. This section further assesses issues related with energy costs which are based on market prices regarding costs of fuel as well the installation costs from REDP as well as triangulation with the implementing organisations in the districts and the principal organisations. Comparative analyses have been computed to prioritise the energy technologies on the basis of financial estimates as well as from the environment perspectives.

For financial assessment, comparisons are based on:

- Cost benefit analysis
- Energy cost

From the environment perspective, comparisons are carried out based on:

- Comparative emission rates of each of the technologies
- Carbon emission abatement cost
- Potential contribution to climate change adaptation
- Vulnerability of the technology due to climatic variation and extreme events (through FGD)

These analyses have been done in order to prioritize different renewable energy technologies taking prevailing values in the district to assess required costs to abate GHG emissions for different incremental investment for each technology.

Financial assessment

Cost Benefit Analysis

A cost-benefit analysis has been used, providing a systematic evaluation of the economic advantages (benefits) and disadvantages (costs) of a set of investment alternatives. Typically, a "Base Case" is compared to one or more Alternatives (which have some significant improvement compared to the Base Case). The analysis evaluates incremental differences between the Base Case and the Alternative(s). In other words, a benefit-cost analysis tries to answer the question: What additional benefits will result if this Alternative is undertaken, and what additional costs are needed

[8] Principal Organisation – organisations that have been recognised by AEPC for management/implementation of the technology at national/regional and district level.

to bring it about? It translates the effects of an investment into monetary terms and to account for the fact that benefits generally accrue over a long period of time while capital costs are incurred primarily in the initial years. The primary energy-related elements that can be monetized are investment costs, technology operating costs, ongoing maintenance costs, and remaining capital value (a combination of capital expenditure and salvage value). The computation is based on the discounted values of all costs and benefits.[9]

Energy Cost

Here other costs, besides the cost of energy used per hour or per season, are taken into account. This is because:

- Energy source selected dictates the type of power unit that must be purchased
- Different types of power units have greatly different purchase prices and estimated useful service lives
- Some require significantly more labour for maintenance and repairs as well.

These differences must be factored into the overall cost before a true cost comparison can be conducted. In this method the present value of all costs of an energy system is divided by the annuity factor for the life of the project to give the annualised cost. The total energy cost is the sum of this annualised cost and the payment made for running the system.

From the environment perspective comparisons are carried out based on comparative emission rates of each of the technologies.

Table 9: Comparative emission rates of each of the technologies

Technology	Emission Factor (ton CO_2 equivalent/6 m^3 plant/year)
Biogas 6m^3	4.88 per 6 m^3 system
Micro Hydro per kW	1.94 per kW
Solar 40 Wp SHS	0.076 pW

Source: IPCC, 1996

Carbon emission abatement cost

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[9] *Discount rate is the rate used to generally appropriate weighted average cost of capital, which reflects the risk of the cash flows. The discount rate reflects two things: 1 – The time vale of money (risk-free rate) - according to the theory of time preference, investors would rather have cash immediately than having to wait and must therefore be compensated by paying for the delay. Mathematically Discount rate (d) can be*

Depicted by this way:

$d = i / (1 + i)$.

Where i = interest rate.

This formula is used to calculate "principal future value" and, how much future value is will be taken as interest.

Economic cost calculation is the ideal cost concept for use in GHG abatement assessment. Given the limitations in data and time for this country study review report, it will not be possible to employ full economic costs in the analysis. Life cycle cost (LCC) analysis has been carried out for all three potential renewable energy technologies in order to find out the abatement cost which has been used as the basis for prioritization. LCC is the total discounted cash flow for an investment during its economic life. In other words, it is the present value of all the costs associated with an investment which generally includes the initial cost, the sum of discounted annual maintenance and operating cost, and a credit for any residual value for the investment at the end of the project period.

The formula for LCC is:

Lifecycle cost (LCC) = $C_c + \frac{C_n}{CRF} - \frac{RV}{(1+r)^t}$

Where:

Cc = Initial capital cost (capital, labor, administration cost)

Cn = Operating cost (operation, and maintenance cost, fuel, tax and interest) in year n

n = time period (year)

r = discount rate

t = total life of project

RV = Residual Value

If the annual operating costs are constant, the simplified formula will be:

$$LCC = C_C + \frac{C_n}{CRF} - \frac{RV}{(1+r)^t}$$

Where: CRF (capital recovery factor) = $\frac{r}{1-(1+r)^{-t}}$

(Source: Spalding-Fecher, Clark, James, 1999, P. 23, 24)

The incremental cost thus obtained through the LCC analysis assuming constant O&M costs for REGA technologies and the conventional system is divided by the CO_2 abatement potential to get the incremental cost per ton of CO_2 abatement. An initial attempt has been made to calculate the incremental cost based on various assumptions. There is ample room to make the calculations more explicit once all the required empirical data are available.

Gender and Social Inclusion Assessment

The available disaggregate data formed the basis for GSI assessment. Data available from AEPC in terms of ownership of technologies as per ethnicity and gender was analysed to present a general scenario. The disaggregated data was not current but it did provide for the percentage proportion of ownership. This data was then validated against field findings from FGDs. The FGDs also provided for a brief overview of the utilisation of various technologies, ownership, acceptance of various RET technologies and the livelihood benefit it has been providing to various groups.

Climate Assessment

Climate, climate variability and change of Makwanpur district has been analysed using bio-physical, hydro-meteorological data and community as well as stakeholders' experience and perceptions. Bio-physical properties include the information on landscape such as topography, altitude, aspect and, thus exposure that build on the local climate. Secondly, available hydro-meteorological data from the stations in the district has provided trends of climate variability and change. Available meteorological information from Daman and Hetauda has been referred to establish past trends of climate variability and change in the district. Similarly, available hydrological information from Rajaiya on water discharge trend of East Rapti River has been useful on evaluating climate and resource management interface. These data were triangulated with the community experiences in focus group meetings and stakeholder consultations in the district. Thirdly, community and stakeholders consultations provided information on sensitivity of different energy resources and livelihood strategies to climate variability and change in the district.

Institutional Assessment

Institutional assessment of relevant stakeholders in the district was carried out in the district using tools such as coverage matrix, actor constellation mapping and SWOT analysis. Coverage matrix provided the information on degree of involvement of actors in providing various services related to renewable energy. Actor constellation was used to identify the relationships between these actors in terms of participation, funding and coordination with each other. SWOT analysis helped to identify the gaps and potential of these stakeholders and provided an assessment of the capacity development needs.

Scenario development

Collated data was analysed and processed to create the energy, climate and GSI situation of Makwanpur. Information from the current situation was then used to create three scenarios (BAU, MAS, and CRS). For the preparation of the scenarios the Long-Range Energy Alternative Planning Model (LEAP) software was used. The Long-range Energy Alternatives Planning System (LEAP), developed by the Stockholm Environment Institute, is a widely-used software tool for energy policy analysis and climate change mitigation assessment. Hundreds of organisations in more than 150 countries worldwide have adopted LEAP. Its users include government agencies, academics, non-governmental organisations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications, especially in the developing world. The United Nations recently announced that more than 85 countries have chosen to use LEAP as part of their commitment to report to the U.N. Framework Convention on Climate Change (UNFCCC). The detailed fact sheet of LEAP is presented in Annex 12 of this document.

The total primary energy consumption in the district is based on the demand tree concept of the LEAP Model, and is configured as follows.

Makwanpur District (Demand Sector)

- |→ Residential (Demand Area)
  - |→ Urban/Rural Settlements (Demand sub-areas)
    - |→ End-uses
      - |→ End-use Devices

|→ Commercial (Demand Area)

|→ End-use fuel

|→ Industrial (Demand Area)

|→ End-use fuel

The energy consumption in the district was disaggregated by residential commercial and industrial sectors, with further residential consumption further divided into urban and rural sub-areas, which in turn are disaggregated into end-use and finally end use device. Commercial and industrial sector energy consumption was disaggregated by end-use fuel.

Starting from 2010 base year, the BAU scenario was established assuming current trends of energy use and technology interventions continue throughout the planning period. In BAU scenario, end-use device shares are assumed not to change along with their corresponding energy intensities. However, where possible penetration levels of RETs were updated with data collected from relevant implementing bodies (AEPC, CRT/N, BSP etc), in order to accurately reflect the current situation. Since, in a household, multiple energy devices and fuels are often used for a specific end-use, the total share of devices exceeds 100 per cent. The device shares have been adjusted assuming that each household uses a single device-type for a particular end-use. Intervention of convenient energy technologies and increasing access to electricity and modern fuel at a current rate is assumed to continue. Values were also validated against the District Energy Perspective Plan to ensure they were in line. The study team presumed, based on the results from the EPS and the DEPP, that the household cooking sector is the major consumer of energy for Makwanpur. Hence extra efforts were made to validate the data with field finding and other related report produced by different institutions. The industrial and commercial energy demand of the district was adapted from data given in the DEPP of Makwanpur.

The MAS and CRS scenarios were developed using the BAU case as a starting point. The scenario were developed based on the interpretation of the scenarios provided in the DCEP guidelines applied to the district context in regards to resource vulnerability, mitigation potential, adaptation potential etc. Energy shares for end uses for the year 2020 were established from which energy demand was back cast. Back casting allows for defining a desirable future scenario and working backwards to identify the interventions that will connect present with the future. However staying true to the planning requirement of the DCEP which is also to describe the scale of necessary interventions, it has also been assumed that a particular HH will be using one technology for an end use. This allows for the generation of targets for interventions.

The detailed description of the scenarios is provided in Chapter 4 of the document.

3 District Climate Change and Energy Situation Report of Makwanpur

This chapter of the report will present overall situation of climate change, energy and social inclusion of Makwanpur based on the data collected for this report.

3.1 Climate Change Assessment

3.1.1 Climate

a) Rainfall and temperature

Climate of Makwanpur district is the function of topography built in altitude, aspect and terrain. The district has sub-tropical, lower temperate and upper temperate climate variations generally extending from South to North respectively following increasing altitude. Some exceptions are in the inner valleys such as Hetauda and downstream flood terraces of rivers such as Bagmati, Lothar, Manahari and East Rapti where sub tropical climate exists to further north particularly due to their low altitude. The climate of the district has been analysed based on the available information and significance to the energy strategy in the context of climate change in the district.

Most of Siwalik region and Bhawar like flood plains of the region fall in the sub-tropical climate zone up to altitude of about 1,200 meters and covers about 59% area of the district. This region, as shown by the HM data from Hetauda station 1975-2005 period, experiences average minimum temperature between 15^0 C and 17^0 C. Annual mean maximum temperature lies between 28 and 30.5 excluding some exceptions (such as in 1993). High variability in temperature has been observed and the past trend shows increasing temperature. Areas around Hetauda in the district are among highest rainfall receiving per annum and in highest increasing trend along with Kaski district in Nepal. However, annual rainfall has ranged from 1,864 mm to 3,111 mm with very high variability between years indicating an increasing trend.

Temperature and Rainfall Spectrum of Makwanpur

The lowest recorded monthly average of minimum temperature from 1975 to 2005 is -2.7°C in Daman (2314m), while the maximum recorded monthly average of maximum temperature in the district is 37°C in Hetauda (474m). Daman observed an average of 1751.5 mm of rainfall from 1975 to 2005, while Hetauda observed 2439 mm of rainfall. From DHM's 1975 to 2005 climate data the yearly rainfall total of Makwanpur was found to be in an increasing trend. However September, which is also the exit month of Monsoon season, throughout the years has observed decrease in the amount of rainfall. Whereas, the month of June has seen an increase in the total rainfall received. Information reveals higher rainfall intensity during summer monsoon period in the district. Figures in section 3.1.2 depict the past trend of temperature, rainfall and its impact on hydrology.

Mahabharata Mountains harbour lower and upper temperate climate up to the altitude of 3,500 meter above sea level and covers about 41% of the district. Although available information from a weather station in Daman which falls in temperate climate region poorly represents the whole range in the district, available data shows increasing temperature (both max and min) and decreasing rainfall with very high variability making it difficult to draw statistical inference.

This information on temperature and precipitation from both climatic regions were triangulated with the information available from community experiences in the respective region that verified the variation and impacts on agricultural livelihoods and hazards to which energy resources, technologies and infrastructure are sensitive. This information was collated with hydrological information from Rajaiya hydrology station. The combined picture demonstrates the complexity of climate change and future predictions for the district (figures at the end of this section) in terms of energy planning.

Although annual precipitation in the district has shown to be increasing in the low altitudes, it has a decreasing trend in the upper altitude regions. There is very high variability in precipitation within and across the regions. Combined with unsustainable land use practices such as deforestation, inappropriate land use, these have resulted adverse environmental impacts including flood, landslides and droughts as reflected by the discharge in the Rapti River. Community consultations revealed this more clearly with their impacts on agricultural crops, increase in weather induced hazards and erratic pattern of rainfall which is in terms of more intense less frequent but more confined rainfall pattern

Community consultations in Hattiya and Gogane VDCs and stakeholder consultation in the district headquarters at Hetauda revealed that changed and varying rainfall pattern has adverse impact on agricultural production particularly on crop calendar, cropping pattern and crop growth. Communities experienced that '*when rainfall comes, it comes too much within few hours and it does not rain for long*'.

Additional experiences of communities in different VDCs showed growing uncertainties in rice planting and maize sowing in different communities, revealing changing variability of climate in the district. This is likely to reduce the energy resources such as agriculture residue in future. Similarly, information from both Meteorological stations and community consultations show the similar likelihood of pressure on water resources.

Intense but short lasting rainfall (figure 9 and 10) combined with mal practices on land use has increased overland flow limiting watershed recharge. Torrential water flow combined with decreasing ground water recharge capacity of the ground is occurring due to unsustainable agricultural practices, deforestation and improper land use. Other experiences highlighted by the consulted communities included reduced water available for both hydro-energy, renewable biomass based energy resources and livelihood activities as shown by the figures and tables in this chapter (see also Annex 1 for the community based information on vulnerability to climate change) often tailoring to increased drought leading to increased risk of forest fire.

3.1.2 Hazards

Fragile steep landscape, high variability in rainfall and unsustainable land uses make Makwanpur vulnerable to hazards including impacts of climate change. Siwalik regions are more sensitive to climate induced hazards due to their fragile geology. Only 6.49%

area in the district is considered less sensitive to hazards (CBS, 2062 BS). Over the last 40 years there have been many natural hazards (see Annex 3) including flooding, landslides, soil erosion, lightening, fire and epidemics of diseases including crop diseases (UNDP, 2004). Makwanpur landscape covers both the hills and flood plains. In the hills, the problem of landslides is more prevalent, whereas in the plain areas, there is an ever increasing threat of floods. Windstorm, hailstorm, forest fire and debris flow are also equally occurring.

Table 10: Ranking of Hazards (Key hazards in the district)

S. No.	Hazards	Rank
1	Debris flow	III
2	Deforestation	V
3	Earthquake	VI
4	Epidemic	IV
5	Flood	I
6	Forest fire	VIII
7	Hailstorm	IV
8	Landslide	II
9	Thunderbolt	IX
10	Windstorm	VII

Source: UNDP, 2004

Table 9 shows that climate related hazards have stood in the higher priority based on their severity, frequency and losses and damages to properties caused by different hazards in the past. The district has recognized environmental degradation such as deforestation to be hazard which is in line with international understandings (UNEP, 2007). It is recognised that hazards listed in table 9 have impacts on energy resources, technologies and advancement of these hazards is likely to adversely affect energy demand and supply in the district.

The 1993 cloudburst

Constant rainfall from 19th to 21st July, 1993 triggered an unprecedented number of landslides and floods in South-Central Nepal including Makwanpur. The event was caused by a "break monsoon phenomenon". A station in Tistung recorded 540 mm of rainfall in 24 hours on July 19th. This is the maximum 24 hour rainfall ever recorded in Nepal. The catchments of Manahari, Lothar and Rapti rivers and tributaries of Bagmati River were swollen causing major flooding and landslides. The Kulekhani catchment was affected as well. The cloudburst severely damaged the Kulekhani hydropower system. Altogether 84,196 people in Makwanpur were affected by the cloudburst and there were 247 reported deaths. A total of 4,112 Ha of land was washed away and considerable damages were observed in roads and infrastructure, including schools.

- NCVST, 2009

The historical overview of the hazards as listed in table 12 reveals that there has been an increase in recent years in flooding, landslides, deforestation and land degradation. Participants of FGD in Gogane stressed that there has been an increase in occurrence of flash flood in Gogane. The flash flood of 1993 and 2009 flood resulted in the loss of lives and extensive damage to property (roads and water mills) and agriculture lands. In Hattiya severe hail storms some five years ago caused considerable damage to property and crops. People were forced to change their roofs from mud tile to GI tin. However after 1993 there has been no such major water induced hazard in Hattiya but river cutting is a regular phenomenon that is observed.

Seasonal hazard mapping exercises were also carried out in two VDCs of the district to document the observed calendar of various hazards (Table 10 and 11). The mapping exercise showed that the incidence of floods were more prevalent during the months of *Shrawan* to *Ashoj*, where as thunderstorm, windstorm and forest fires were observed during the months *Chaitra* and *Baishakh*, the drier months of the year. This shows that energy resources (agriculture, forests, water, and sunshine) are differently exposed to different hazard in different time in the year. Since fog and clouds are lasting longer during the months of *Mangsir* and *Poush*, less sunshine hours is observed which affects plant growth, solar energy tapping and community mobility for different livelihood activities putting stress in the line of hazard on energy resources and livelihoods.

Table 11: Temporal distribution of hazards in Hattiya VDC, Makwanpur

SN	Major hazards	Months in Nepali calendar											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Flood												
2	Less sunshine												
3	Forest fire												
4	Too hot												
5	Diseases												
6	Thunder												
7	Cold wave												
8	Wind storm												

Table 12: Temporal distribution of hazards in Gogane VDC, Makwanpur

SN	Major hazards	Months in Nepali calendar											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Flood												
2	Less sunshine												
3	Forest fire												
4	Too hot												
5	Diseases												
6	Thunder												
7	Cold wave												
8	Wind storm												

Table 12 below provides frequency of damaging flood events in the district in the past. Variability of frequency is inconsistent: it reveals the increased frequency indicating uncertainty in future.

Table 13: Disaster events of flood in Bhimphedi, Makwanpur District

Year of event (BS)	Return period (Years)	Loss from flood
2002 (Shrawan)		Maize and paddy fields washed away by landslides and death of a person
2011 (Shrawan 11 and	9	Washed away lands, livestock and markets of the

Bhadra 9)		village
2018	7	Though floods occurred, it did not cause a huge loss except to 20 loads of maize
2031	13	Washed away a village completely (Ranikhola basti) causing death of 30 persons
2039 (Shrawan)	8	Flood and landslide occurred but did not cause much disaster
2046	7	Cultivated land washed away
2050 Shrawan 4	4	Lands, houses and livestock were washed away causing a huge loss
2059 Shrawan 3	9	Land, cattle and houses of Bhimphedi - 6 (dammar) were destroyed

Source: Practical Action 2010

3.1.3 Past and perceived future trend on climate change, impacts and vulnerability

Figures in this section reveal the past trend of climate variability in the district. This information was triangulated with nearby community experiences and perceptions. Temperature rise is occurring at a higher rate in higher altitudes as reflected by the data from Hetauda and Daman stations. However, community perception on temperature rise is not uniform across different communities. Studies including consultations during DCEP process reveal that community perceptions are less consistent on temperature variability. The perceptions were factored by sensitivity of livelihood strategies and socio-economic factors of respective communities.

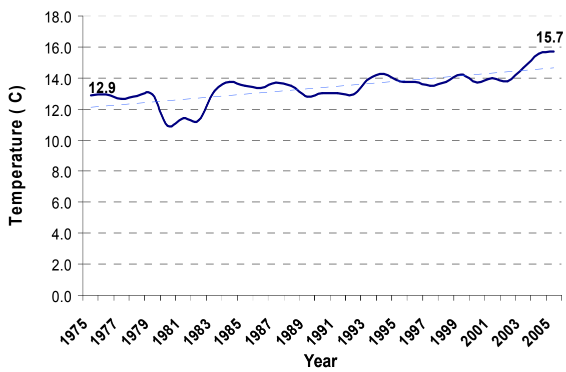


Figure 7: Average yearly temperature in Daman for 30 years

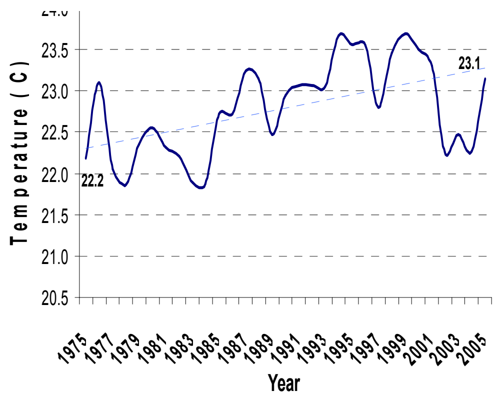


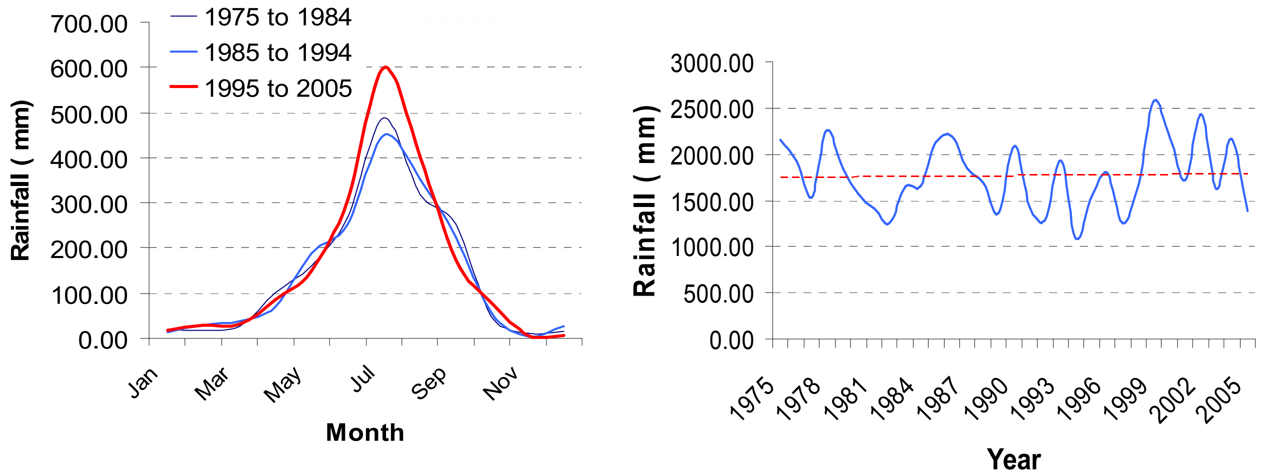
Figure 8: Average yearly temperature in Hetauda for 30 years

Source: Adapted from DHM data

The variability of temperature is also higher in higher altitudes such as revealed by figure 7 above. This variability has implications on energy, such as in the cases of extreme low temperature or high temperature, creating increased energy demand for heating and cooling respectively, in addition to effects on resources. Community and stakeholder consultation revealed there has been higher variability in temperature. Participants in the group discussions complained that summer feels hotter. There has been mixed perceptions on winter temperature; some respondents complained that winter was becoming colder while others observed that it is becoming less cold. However, winter fog, rainfall and other weather phenomena combined with sensitivity of the community generate such perceptions that differ between individuals.

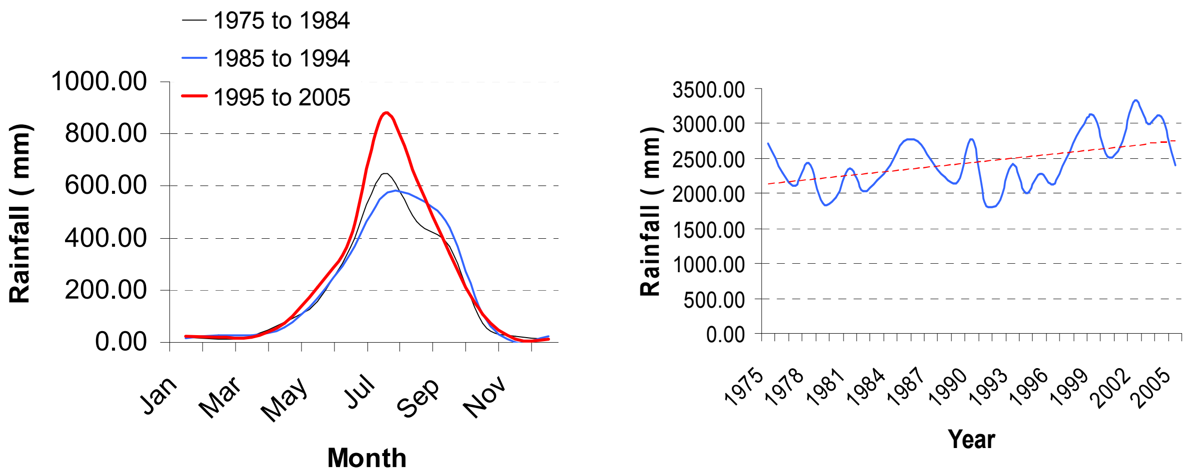
Figure 9 and 10 below provide trends of rainfall in lower and higher altitudes in the district. Annual rainfall has increased in higher rate in lower altitude. However, variation is so high that it has greater implications on energy resources and access of communities to the energy resources.

Figure 9: Trend of monthly and annual rainfall in Daman (altitude 2314 m)



Source: Adapted from DHM data

Figure 10: Trend of monthly and annual rainfall in Hetauda (altitude 474 m)

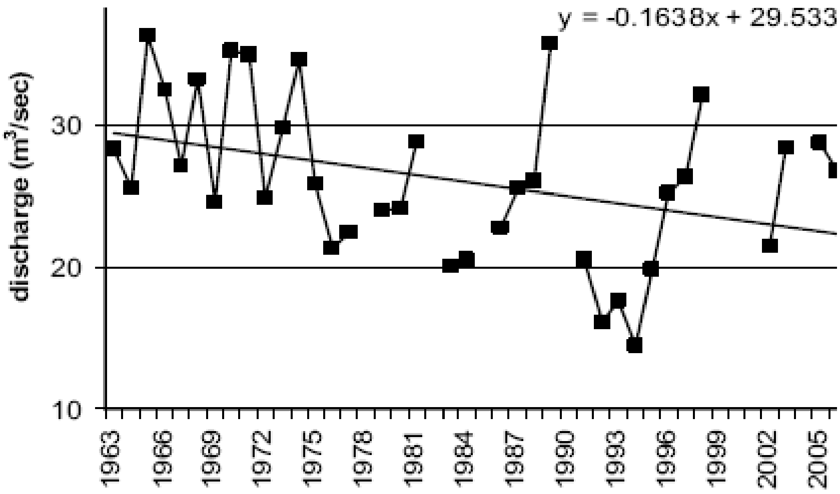


Source: Adapted from DHM data

Community experiences revealed that the rainfall has become less predictable. It is occurring with more intensity and there are bigger gaps between two successive rainfalls. Inference from Figure 9 above also supports the community experiences. Combined with socio-economic factors on resource use and management, extreme rainfall events have aggravated flood and other weather induced hazards as shown in the table 9. Despite increases in annual rainfall, stress of drought is experienced as increasing as the amount of useful rainfall reduces, ground water recharge systems are disturbed for various reasons and increasing gaps are emerging between two successive rainfalls.

Extreme weather events have the potential to reduce the capacity of energy resources. Hazards damage resources, increase energy demand and limit access to resources for particular groups in the community. As informed by the communities, there has been a decrease in the number and quality of water sources in the district. Higher levels of sedimentation have altered watercourses causing difficulties in accessing water. Due to changes in rainfall patterns, there have also been changes in cropping patterns. A paddy that was before planted during *Ashar* is now being planted in *Shrawan*.

As the frequency and intensity of droughts are increasing, the risk of forest fire is also increasing. Despite improved management after the start of community forestry, there is still an increase in events of forest fires due to increased frequency and intensity of droughts. Production and productivity of agriculture and energy potential of water resources have been adversely affected by prolonged drought, erratic rainfall, associated climate-induced disasters, pests and diseases. Figure 11 below shows decreasing discharge of rivers over the period in the district providing contrasting implication of erratic rainfall despite increase in gross annual rainfall.



Source: Practical Action (2010)

Figure 11: Average Annual Discharge of East Rapti at Rajaiya Hydrological station

Future climate pattern are likely to be more uncertain as shown by HM data and community perception. Variability was very high in the past leading to inconsistent impacts and implications on the ground. While socio-economic practices are sensitive to a number of unpredictable factors, combined results may become further uncertain in the district.

Therefore, preparedness of uncertainty and implementation of ‘no regret’ resource management strategies would be appropriate for the district. This scenario suggests a preference for a diversity of energy resources.

3.2 Gender and Social Inclusion Assessment

In the district, out of the total energy demand more than 50% of the energy is for cooking and more than 80% of it comes from wood (firewood). Since women are primarily responsible for managing household level energy supplies replacing firewood by other RETs or managing firewood supply differently will have greater implication on women. Likewise the cost of technology will be crucial for women and poor groups that do not have access to or control over financial resources even though the technology may be preferred by these groups of people.

The majority of the poor, Dalit and ethnic groups such as Chepang reside far from district headquarters with limited access and capacity to afford other energy sources. For these groups, firewood is one of the cheapest sources of cooking. Efficient use of firewood through introducing improved cooking stoves (ICS) might be an important strategy both for contributing to responding to climate change and to reduce the amount of firewood use without compromising energy needs of the households. This also contributes to reduced drudgery and workload of the people, particularly of women. From the analysis of the ICS installed throughout the district, altogether there are 14,412 ICS installed which approximately cover 15 % of the total households of the district. Improved cooking stoves have no alternative in remote areas where the transportation cost of raw material for other alternatives is very high. During field visit in one of the sites in Makwanpur, households using biogas were found to be nominal because of the sites location in the high hill where transporting sand and other raw material for constructing bio gas is very costly.

Despite the high cost of installation, biogas has several positive impacts on women and poor households as it contributes to reducing women's workload and drudgery through reducing time to collect wood fuel from distant forests, improving health through avoiding smoky kitchens while using wood fuel, saved time can be utilized for some income generating work, children will get better care, reduced use of animal dung allow the farmers to use dung as a fertilizers. Due to the high degree of feminization of agriculture throughout Nepal, availability of fertilizers at home through shifting energy use from cow dung to bio gas has positive implications for women farmers in increasing farm production which might be an unintended but positive impact of renewable energy technology promotion. However, farmers who have large animals with access to fodder and grain supply can run bio gas.

IWMs play an important role in reducing people's workload and drudgery to a large extent in the remote villages of the district where other options are not available for grinding the grains except using tedious traditional technologies. On one hand, the currently available numbers are not enough to meet the demand even if they come to full operation and on the other all the available mills are not in operation (personal communication with the villagers in Gogane, Dec 2010) due to drying out of the water sources.

Ownership patterns of RETs have greater implication on the effectiveness and sustainability of the technologies. Out of three technologies analyzed (see Chapter 3.4.2 for detail), women's ownership level is very low in ICS and IWM as compared to bio gas. This may not be fully accurate as many ICS may have been recorded to be owned by males as the household is, male headed. This may not always be the case and requires revisions to the surveying methods to ensure that the data is always disaggregated. Caste wise ethnic groups have the majority of the IWM.

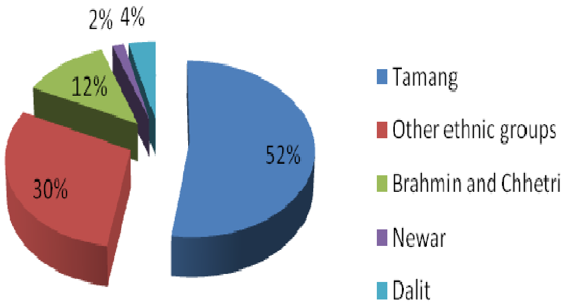


Figure 12:Caste wise ownership of IWM

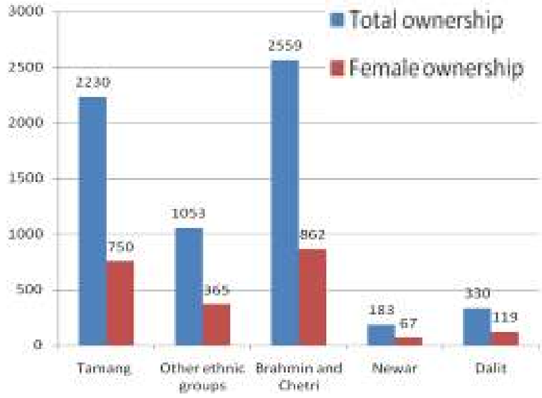
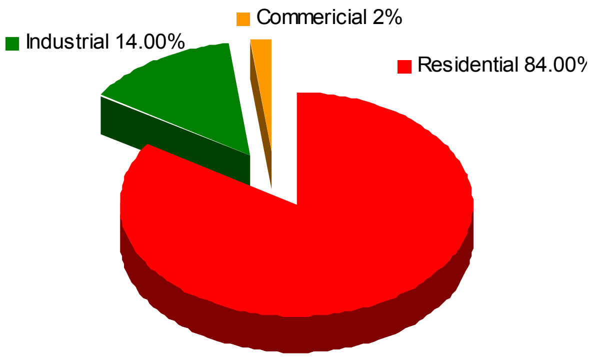


Figure 13: Caste wise and gender disaggregated biogas ownership in Makwanpur

3.3 Energy Consumption/ Demand Assessment



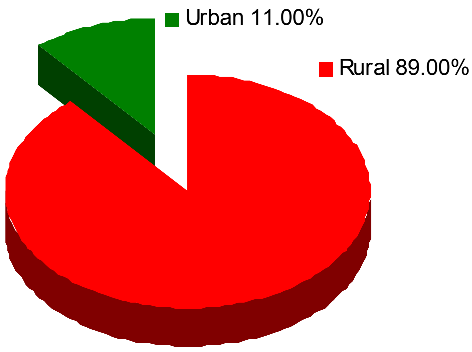


Figure 14: Energy consumption by sector in Makwanpur

Figure 15: Residential sector energy consumption

The residential sector is the largest consumer of energy in the district with a demand of 4,876,000 GJ in 2010. It amounts for around 84% of the total energy consumption of the district. Total energy consumption in the commercial sector in 2010 is 116,000 GJ. Major commercial consumers include restaurants, hotels, schools, hospitals cinema halls etc. The industrial sector energy demand in Makwanpur is 813,800 GJ. Makwanpur is one of the main industrial districts in Nepal, with a large industrial estate located in Hetauda, as well as a many medium sized industries located throughout the district.

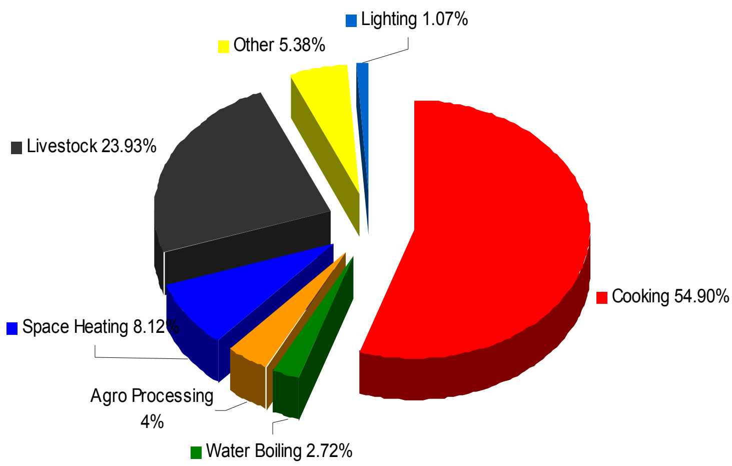


Figure 16: End use consumption of residential sector in rural areas

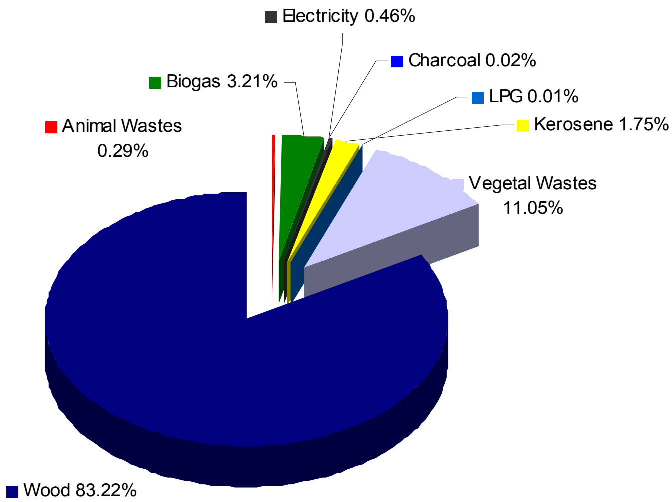


Figure 17: Consumption by fuel type in rural residential

Cooking makes up the biggest share of energy consumption in the residential sector, totalling 2,450,000 GJ, which is also around 55% of the total energy consumption in terms of end use in the residential sector. In terms of fuel consumption in the residential sector in rural areas wood fuel has the largest share, making up over 83% of fuel use. In urban areas, easier access to alternative fuel means that the share of wood fuel is lower at 19%, replaced by kerosene, LPG and electric appliances. In terms of lighting, the main sources of energy are electricity, if the HH has access to the NEA and off-grid electricity connection and kerosene, mainly in rural areas. During load shedding HHs mostly resort to lighting through kerosene wicks, battery powered LED lights and petromax.

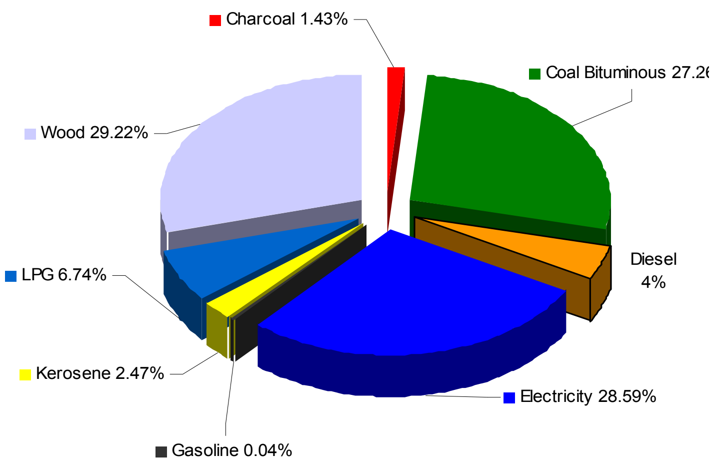


Figure 18: Types of fuel consumption in the industries

In the industrial sector wood fuel, electricity and coal are the most used fuel types in Makwanpur and in total account for 85% of the fuel type used in industries. In 2009, 1,004,010 kg of wood fuel was used in the industrial sector, while the total consumption of electricity was 42,065 MWh (DEPP, 2009)

3.3.1 Implication on energy consumption due to climate change

Regardless of its climatic variability Makwanpur is observing a general rise in temperature. Participants in FGDs described the declining culture of using wood fuel for space heating and the need for space heating in general. This, according to the respondents, was because of the introduction of newer technologies, warmer winters, as well as increased affordability to buy warm clothes. Therefore energy consumption in this front is most likely to decrease in coming years. On the other hand increased temperature will result in demand of energy (electricity) for cooling and refrigeration purposes mostly in urban areas as well as for commercial purposes. Likewise, people in many places in Makwanpur have already been compelled to use motor pumps to extract ground water due to the increasing unavailability of water for irrigation. With projections of an aggravated situation if current trends are allowed to continue, the energy demand for irrigation purposes is most likely to grow. The energy-poverty-vulnerability nexus will also necessitate the increase in energy demand to improve livelihoods and adaptive capacity of vulnerable groups.

3.4 Energy Resource/ Supply Assessment

3.4.1 Traditional (Biomass)

a) Firewood

Wood fuel remains the major energy resource for residential and commercial use in the district. In total the district has 167,453 Ha of forest land, which is categorised into community forests, private forests leasehold forests and government forests, with some market sourced. The available wood fuel supply was 121,881.4 m^3 in 2008 from all available forest sources (DEPP, 2009). The total energy potentiality of firewood is 1.43 million GJ.

Table 14: Firewood resource

Type of forest	Area in Ha.	%	Population using firewood	Supply
Community Forest	38,338.0	22.89	N/A	N/A
Leasehold/Private Forest	105.2	0.06	N/A	N/A
Government/Other Forest	129,009.8	77.05	N/A	N/A
Total	**167,453.0**	**100.00**	**233.659**	**121,881.4 m^3**

Source: DEPP, 2009; ISRC, 2010

b) Agricultural residue

Another traditional source of energy in the district is agricultural residue and animal dung. The main sources of agri-residue in Makwanpur are paddy, maize, millet, wheat, barley, oilseed and sugar cane. The total energy potentiality of agricultural residue in Makwanpur is 246.63 GJ.

Table 15: Agricultural Residue Resource Supply

Crop Type	Area (Ha)	Production (Mt)	Energy Potentiality[10] (GJ)
Paddy	12,700	37,500	169.66
Maize	18,050	44,520	29.22
Millet	2,900	3,300	7.44
Wheat	4,203	8,826	33.73
Barley	21	29	0.07
Oilseed	1,458	1,180	4.57
Sugar Cane	90	2,600	1.94
Total	**39,422**	**97,955**	**246.63**

Source: EPS, 2010; CBS, 2062

c) Animal dung

With many rural households owning cattle, animal dung is often used as a fuel source. Within the district there are an estimated 42659 households owning cattle, with cattle and buffalo populations of 101,215 and 95,350 respectively, producing a combined 240,059 Mt of waste. The total energy potentiality is 1080.27 GJ. (EPS, 2010; CBS, 2062)

Table 16: Animal Waster Resource Supply

Type	Number	Waste Production(Mt)	Energy Potentiality
Cattle	101,215	111337	501.01
Buffalo	95,350	128723	579.25
Total	**196,565**	**240060**	**1080.27**

3.4.2 Commercial

a) Fossil fuel

According to the DEPP of Makwanpur, 37.9% lighting energy need is met by fossil fuel, kerosene, in the household sector. Fossil fuels consumed in the district are imported from India. In cooking kerosene makes up for 25.8 % and LPG 15.6 % of fuel used for cooking.

b) Grid – electricity

Hydro power is the main source of electricity in Makwanpur district. There are two distribution centres providing electricity to the district, Hetauda and Palung. From NEA data 21% of supplied electricity is consumed by the residential sector, 1.3% by non commercial sector and 71% by the industrial sector (DEPP, 2009).

[10] The energy potentiality has been derived by calculating the total waste production of a crop through its yield per Mt of production and then multiplying it by its lower calorific value (LCV).

Table 17 : Electricity Supply from NEA Grid (2008/2009)

Distribution Centre	Consumer	Consumption in MWh						Total
		Domestic	Non-commercial	Commercial	Industrial	Water Supply	Others	
Hetauda	22,333	11,088	671	818	41,907	1,014	959	56,457
Palung	5,774	1,407	138	221	158	0	0	1924
Total	28,107	12,495	809	1,039	42,065	1,014	959	58,381
Percentage		**21.4**	**1.39**	**1.78**	**72.05**	**1.74**	**1.64**	**100.00**

Source: DEPP, 2009.

Two large hydro power stations Kulekhani 1 and 2, produce 60 and 32 MW respectively. A third project is currently in development, and expected to produce a further 14 MW of energy. The Department of Electricity Development has also received application for survey license for generation and issued survey license for generation for a number of schemes. A total of 9 hydro schemes, with an installation capacity of more than 25 MW have been issued with survey licences. As of March 2011 it has also received application for survey license for hydropower of 35 hydro schemes (up to 25 MW), with total capacity of 70 MW. The detail list is provided in the Annex 7.

3.4.3 Renewable

a) Hydro energy potential

Micro and Pico hydro

There are currently 38 Micro and Pico hydro systems in operation, providing a total of 112.5 kW of power for 606 HHs (DEPP, 2009). In addition to this, there are a number of projects nearing completion, providing an additional 77.74 KW to 790 HHs. AEPC's 2009 Renewable Energy Data Book further mentions pico hydro schemes under construction in Gundruk Khola, Ghatte Khola, and Kitini Khola etc. which will be generating more than 25 kW of electricity. All in all there are five major rivers flowing in Makwanpur district: Rapti, Bagmati, Bakaiya, Manahari and Lothar, all with numerous sub-rivers and streams that provide ample opportunity for development of micro and pico-hydro schemes.

Improved Water Mill

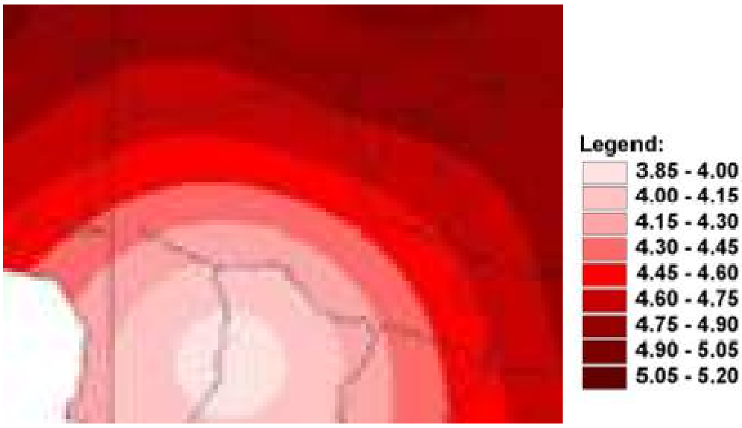
The total number of IWM, both short shaft (SS) and long shaft (LS), installed is 1022. There are countless rivulets and streams that provide for opportunity for IWM installation as well as there are still many traditional water mills that can be improved for electricity generation as well as mechanical power. In all of Makwanpur there are still 313 traditional water mills that can be improved to provide improved efficiency in agro-processing.

b) Solar energy potential

According to World Meteorological Organisation, the average value of solar insolation[11] is about 4.5 kWh/m^2/day (DEPP 2009). From the figure adapted from Solar and Wind

[11] Insolation is a measure of solar radiation energy received on a given surface area in a given time. It is expressed as average irradiance in watts per square meter (W/m2) or kilowatt-hours

Energy Resource Assessment (SWERA) on annual average GHI of Nepal it can be observed that the annual average global irradiance of Makwanpur ranges from 4.00 to 4.75 kWh/m^2/day. The exact value of solar radiation is not yet available for different parts of Makwanpur however Makwanpur has a very good potential of solar energy for thermal and photovoltaic (electricity generation) related activities, which is also showcased by the number of solar PV installations in areas where the grid has not been extended yet.

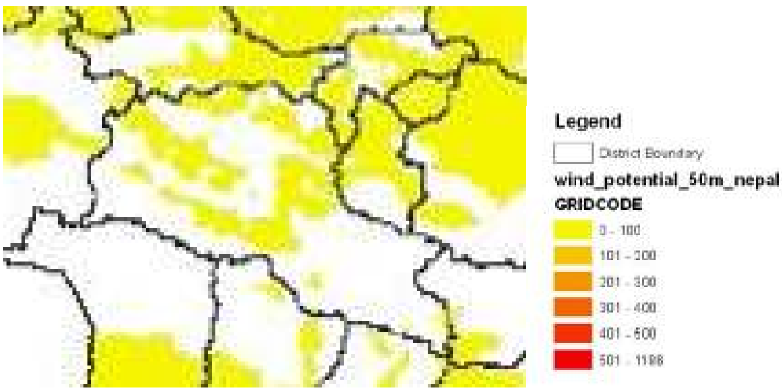


Source: SWERA, 2006

Figure 19: Annual Average Global Horizontal Irradiance of Makwanpur in kWh/m^2/day

c) Wind energy potential

With hilly terrain spanning much of the district there is the potential for wind turbines in Makwanpur, however there is only one wind power plant installed in Phakhel of Makwanpur district. The SWERA report produced by AEPC also does not suggest any convincing source of wind energy in Makwanpur. Further feasibility studies in regards to wind should be carried out in the high hills of Makwanpur district to get accurate information on wind energy potential.



per square meter per day (kW·h/ (m2·day)) (or hours/day). In the case of photovoltaic it is commonly measured as kWh/ (kWp·y) (kilowatt hours per year per kilowatt peak rating).

Source: SWERA, 2006

Figure 20: Wind Potential of Makwanpur district

d) Biogas potential

Within the district there are an estimated 42,659 households owning cattle, with cattle and buffalo populations of 101,215 and 953,550 respectively, producing a combined 240,059 Mt of waste. The total energy potentiality is 1,080.27 GJ (EPS, 2010; CBS, 2062 BS). However the total estimated household with land and livestock is 16969, while the technical potential of biogas is 12,733 HHs and market based potential household is 7,977 (BSP 2008). However there seem to be some discrepancy in potentiality versus numbers installed (see Table below)

Table 18: Biogas installed versus potential for selected VDCs/Municipality

VDC/ Municipality (selected)	Plant	Total HH with Land and Livestock
Basamadi	732	697
Churiyamai	1475	1055
Handikhola	1175	1198
Harnamadi	832	505
Hattiya	1581	1089
Hetauda N.P.	2690	2676
Manahari	980	908
Padampokhari	2077	1166

Source: Adopted from BSP 2008/2010

In some VDCs information from BSP shows that the number of biogas plants that have been installed have exceeded not just the technical potential but the number of HHs owning land and livestock as well. This calls for further study of biogas potentiality in the district. However this study will stay with the conclusion that the number of households that have biogas potential is 16,969 with 15,736 already installed.

3.4.4 Vulnerability and stresses to energy resources in the context of climate change

Energy resources that are dependent on water or are impacted through climate induced disasters are the most vulnerable to stresses of climate change. Decreasing levels of water availability has a direct impact on hydropower production. It also results in decrease in forest cover, decrease in agriculture production and livestock rearing which impact availability of energy resources like firewood, agriculture waste and animal dung respectively. Increase spell of droughts result in forest fires which adversely impact forest resources and availability of firewood, while climate induced disasters either eradicate the source or limit access to such resources. Weather induced hazards such as landslides can disrupt the supply of fuel and electricity to some scale when infrastructure like roads and transmission lines get damaged. The specific impact of climate change on forest and waterways is described below.

Forests

Erratic pattern of rainfall in Makwanpur and increased temperature are both likely to have adverse impacts on forest growth as sharper and shorter spells of Monsoon has lessened the proportion of ground water recharged. On the other hand increased evaporation and transpiration due to increased temperature has lessened the moisture content leading to longer dry periods and subsequently drought situations. Such drought situations have increased the chances of fire hazards. Forests fires are frequent in Makwanpur, demonstrating the forest's high vulnerability to fire hazards. Landslides are another threat to the forests in Makwanpur. However increased community participation in forest management in recent years has provided impetus to adaptive management that is necessary to reduce the vulnerability of forest resources to the undergoing impact of climate change and socio-economic factors.

Waterways

Rivers in Makwanpur originate from Mahabharata and Silwalik range and thus are not snow fed or glacier based. However, the effects of climate change are felt on flow variation (increase in intensity of flooding as well) due to changing rainfall patterns and increasing temperature trends. With the increase in population in the district, the consumptive uses of water in the rivers seem to have also increased. Due to this, there will likely be less water to use for non consumptive activities like generation of electricity, agro processing through water mills, biogas generation etc. Therefore, efficient use of water resources, watershed conservation and promotion of rainwater harvesting and protection of drinking water sources and their catchments are necessities for Makwanpur in the context of climate change. So the investment and support on water for regular supply is the key for the regular operation of some of RE technologies like biogas as water is one of the essential inputs for biogas generation. Increased availability of water also supports to reduce drudgery and save time for managing water needed for renewable energy technologies and as well as for consumptive and other purposes.

However based on available past information on climate, prediction of future scenario of climate in the district is difficult and potentially unreliable. Therefore, future vulnerability of energy in the context of climate change lies within great uncertainty. Issues around resource management and utilization exist. Improved management would enable communities and their resources to absorb future stresses.

3.5 Technology assessment

3.5.1 Overview

Energy technologies have conventionally been assessed in terms of available resources and its application at the point of use. In all this the financial element has been the prime determining factor together with the tangible and intangible benefits. The tangible benefits in energy projects are measured in term of actual financial saving from energy replacement, efficiency and health improvements. Intangible benefits are measured in terms of time saved, reduced drudgery and better lifestyle. Moreover as per the prevalent gender roles, women will be benefit more from technological innovations in energy in small scale at household level (mostly cooking and lighting) and the men and youth will be benefitted more from the innovation in large scale energy technologies (mainly processing) which they can utilize for employment and enterprise generation. However, with climate change and its implication on the energy resources and vice versa, the need to move on to the use of cleaner energy forms and the assessment of energy technologies with respect to its implication on the environment and natural resources is of utmost importance.

As with any technology, unless it is able to meet the needs of the users, it serves no purpose. For our analysis, the end uses considered are consumptive and productive uses within the domestic, agriculture and industrial sectors. The specific uses considered are cooking, lighting and processing within these sectors. Furthermore technology assessment needs to consider gender, social and economic differences. These parameters influence the differences in energy needs, affordability, and access to resources and capacity to sustain the system.

In determinants the present chapter assesses the technologies under conventional parameters such as distribution trends of the different technologies used in the domestic, agriculture and enterprise level as well as the thematic parameters associated with social and climate change.

a) Conventional parameters considered are

- Status/trends of different technologies
- End uses as practiced
- Comparative costs and benefits
- After sales service and technology costs

b) New parameters introduced are

- Climate proofing technologies
- Mitigation potential and trends – general emissions factors
- Potential contribution to climate change adaptation
- Vulnerability of the technology due to climatic variation and extreme events (through FGD)
- Gender and social aspects with respect to choice and need and affordability [12]

c) Sustainability parameters

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[12] Choice and need in one hand demand cleaner energy technologies but on the other hand affordability may constraint the actual choice. The access to finance can play an important role in affordability which varies by different income groups across different caste and ethnic groups, gender, availability of social networks and geographical isolation (basically the banking infrastructures). Often women, poor, ethnic minority and people living in remote locations may have limited access to and control over the financial. Until and unless energy technologies are pro-poor and women friendly, they will be out of the reach of the poor, women and marginalized because of the capacity of these people to afford the available technologies.

- Gendered and social aspects of technology sustenance and capacity building needs. Sustainability requires users to be trained and capacitated, affirmative actions to have balanced participation of women to enhance women's capacity

3.5.2 RET status/trends

a) Hydro energy

Micro and pico hydro

There are currently 38 Micro and Pico hydro systems in operation, providing a total of 112.5 kW of power for 606 HHs (DEPP, 2009). Micro hydros are hydroelectric power installations that typically produce up to 100 kW of power. These installations are usually used to provide power for small communities. Pico hydro systems are smaller hydroelectric installations that provide power from few hundred watts to 5 kW. These are mostly used in cases of small isolated communities or a single household. In addition to the already existing systems, there are a number of projects nearing currently being implemented, providing an additional 77.74 KW to 790 HHs. AEPC's 2009 Renewable Energy Data Book further mentions pico hydro schemes under construction in Gundruk Khola, Ghatte Khola, and Kitini Khola etc which will be generating more than 25 kW of electricity.

Table 19: Micro-hydro projects currently in development

Project Name	Status	kW	HH
Nag Daha Khola	One year crossed	19.2	165
Agra Khola Klaganesh Khola	Conditional approved	9.26	103
Agra Janamukhil	Conditional approved	18	195
Chhahare Khola I	Conditional approved	9.81	81
Reuti Khola	Conditional approved	15	150
Khani Khola	Verified Project	4.12	65
Yadu Khola	Verified Project	2.347	31
	TOTAL	**77.74**	**790**

Source: ESAP

Improved Water Mill

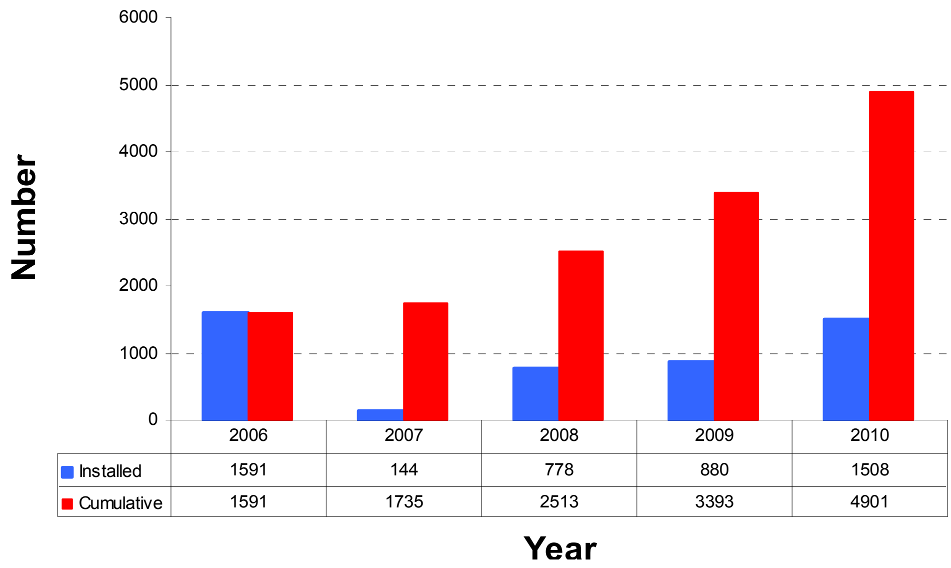
There are also a large number of traditional and improved water mills in operation within the district. Currently there are 1,022 IWM schemes, of which 975 are short shaft, and 47 are long shaft. Short shaft mills are used solely for grinding purposes, whilst long shaft mills can provide diversified services such as paddy hulling, oil expelling, rice beating, saw milling, electricity generation etc. (CRT/N, 2010a).

Climate trends and weather patterns (Chapter 3.1) have shown that climate variability and change is very likely to affect water resources such as stream flow and therefore the functionality of IWMs. Strong hazard resistant infrastructure, climate smart disaster risk reduction strategy and effective watershed conservation initiatives are necessary along with less climate sensitive and energy efficient technologies for the energy sector. This warrants strong mechanism for coordination between different sectors and stakeholders.

DDC through its DEEU has to strongly facilitate the process among agencies working in water, land use, agriculture and watershed conservation. There should also be additional components added to the feasibility studies for IWMs that looks at potential impacts of changing water resources for IWMs.

b) Solar energy

Solar energy is an important source of lighting in the district, as many HHs are situated in hilly terrain there is good sunshine and the potential for solar energy is large. In total there are 4,901 SHS with a total capacity of 93,976 Wp. Besides individual SHSs there are also a small number of institutional Solar PV systems in the district. There are two solar PV systems providing a total of 60 Wp installed at the Department of Mines and Geology; there is a solar water pumping system installed in the Kankada VDC with a output of 400 Wp; and one institutional Solar PV system installed at a health post office in Thingan VDC (DEPP, 2009).



Source: ESAP

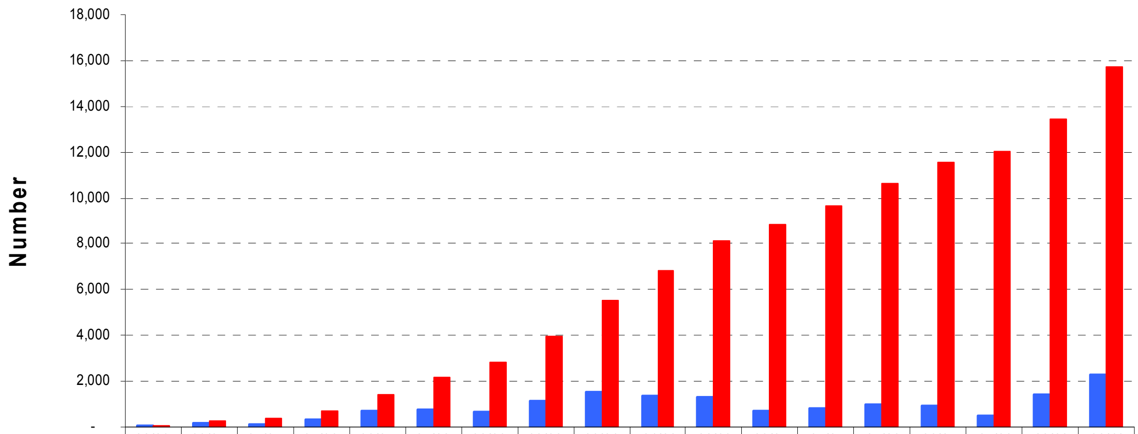
Figure 21: Year by year SHS installation

c) Wind energy

In Makwanpur currently there is only one system installed providing energy for 7 bulbs for a school, for community meetings in the evening, and video for literacy classes. The turbine is located at Phakhel and provides 200 W of power.

d) Biogas

Biogas can be used for lighting and cooking purposes. There have been a total of 15,736 biogas plants installed in Makwanpur, (BSP, 2010).



	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10
Installed	74	175	126	342	691	755	662	1,155	1,527	1,329	1,306	720	790	962	934	490	1418	2280
Cumulative	74	249	375	717	1,408	2,163	2,825	3,980	5,507	6,836	8,142	8,862	9,652	10,614	11,548	12,038	13,456	15,736

Year

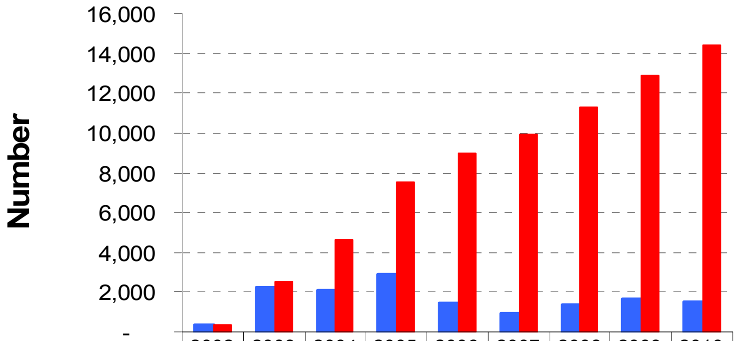
Source: BSP, 2010

Figure 22: Year by Year Biogas Installations

The social benefits from the installation of the biogas has saved time of women which helps in avoiding smoky kitchen, thus having good impact on women's health. Installing bio gas has positive impact to the environment and to the participating households, local community forest management systems should incorporate fodder promotion agenda to support livestock farming enabling sustained amount of biogas feed supply with no added drudgery to women and men. Production of fodder in community forest will also encourage poor people to raise livestock and go for biogas. There could also be efforts made to increase female participation in the sector.

e) Improved cook stoves

ICS represent a simple and cost-effective solution to improve the efficiency of cooking stoves. In Nepal there has been a long standing implementation program for this technology which is currently being implemented by CRT/N. The total number of ICS installed in the district is 14,412. As the adoption of technologies depends upon the local context, ICS is a useful technology for poor farmers who cannot afford high cost for bio gas despite the high subsidy (though not the case now). ICS can be effective where the local forests are managed sustainably with emphasis on wood fuel production. In the case of low land areas fast growing firewood species can be planted in marginal land. Another benefit from ICS to women is they can also sell their skills for making ICS once they are gone through the skill development training for themselves.



	2002	2003	2004	2005	2006	2007	2008	2009	2010
Installed	348	2,218	2,070	2,873	1,458	963	1350	1639	1493
Cumulative	348	2,566	4,636	7,509	8,967	9,930	11,28	12,91	14,41

Source: CRT/N, 2010b

Figure 23: Year by Year ICS Installations

3.5.3 Ownership of systems by gender and different Caste/ethnicity

Out of six RETs discussed here, due to unavailability of gender and caste disaggregated data only three technologies assessed for ownership namely biogas, improved water mills and improved cooking stoves. The analysis also relies on disaggregated data from previous years due to the lack of current data. However the percentage share should be indicative of the current situation as well.

Table 20: Caste wise gender disaggregated biogas ownership in Makwanpur[13]

Caste group	%of population	Total biogas ownership	%of female ownership
Tamang	49	2230 (35%)	33% (750)
Other ethnic groups (Chepang Magar Gurung, Lama)	12	1053 (17 %)	35% (365)
Brahmin and Chhetri	28	2559 (40%)	34% (862)
Newar	7	183 (3%)	37% (67)
Dalit	4	330 (5%)	36% (119)
Total	**478, 385 (49% are female)**	**6386**	

Source: AEPC

As depicted in Table 14 and Figure 12 Brahmin - Chhetri group, who occupy only 28 % of the total population, alone has installed 40% of the total biogas installed in the district. Tamang and other ethnic groups all together constitute more than 60 % of the population of the district and their share in biogas is slightly more than 50% followed by Dalit and Newar. As the population of Newar is bigger than Dalit, lower number of biogas installation might be because Newars use LPG as most of the Newar population reside in the district headquarter where as the Dalits reside in remote locations.

[13] This information is from the year 2001/2002.

The ownership of women in various caste groups ranges from 33 to 37 percent. The highest percent comes from Newar at 37% followed by Dalit, Brahmin Chhetri and ethnic groups. It is interesting to note that women from ethnic groups and Brahmin Chhetri group have same ownership status which in other cases women from ethnic groups used to have higher status as compared to Brahmin Chhetri group.

Table 21: IWM ownership by ethnic groups

Ethnic groups	% of Population	IWM ownership
Tamang	49	530 (52%)
Other ethnic groups	12	301 (30%)
Brahmin and Chhetri	28	124 (12%)
Newar	7	17 (2%)
Dalit	4	38 (4%)
Total Population	**478,385 (49% are female)**	**Total = 1,020**

Source: AEPC

As shown in Table 15 and ethnic group (Tamang and other ethnic group) own more than 80% of the IWMs folowed by Brahmin Chhetri, dalit and Newar. Gender disaggregated data however is not available.

In case of ICS, out of the total stoves installed (2590), 10 are institutional and out of the remaining 2,580 women own only 21 % of them. Overall, women own less ICS and IWM as compared to biogas, though a more expensive technology. The ownership of female is more than 30 percent of the total installation in ethnic and caste groups.

Table 22: Ownership of selected technologies by gender[14] (summary)

Technology	Total	Male	Female	Community/ Institutional
ICS	2,590	2,036	544 (21%)	10
IWM	1,018	970	40 (4%)	
Biogas	6,383	4,217	2,166 (34%)	

Source: AEPC

3.5.4 Technology costs

The benefit to cost ratio of various significant technologies is presented below. The cost benefit is computed based on discounted values.

Table 23 : Cost Benefit of technologies

Technologies	Capacity	Unit	Cost per Unit	Benefits (NPR/year)	Benefit Cost Ratio	IRR
Biogas	6	m^3	48,634	11,603	1.81	12%

[14] Data from 2003

Micro Hydro Project	1	kW	265,000	41260	1.10	2.09%
Small Solar Home System	20	watt peak	20,000	3203	2.11	NA

Source: BSP, 2009a; ESAP, 2003.

It is also necessary to compare the energy cost of the using devices based on these energy forms. Below is a comparison of the energy cost of using different devices for cooking and lighting.

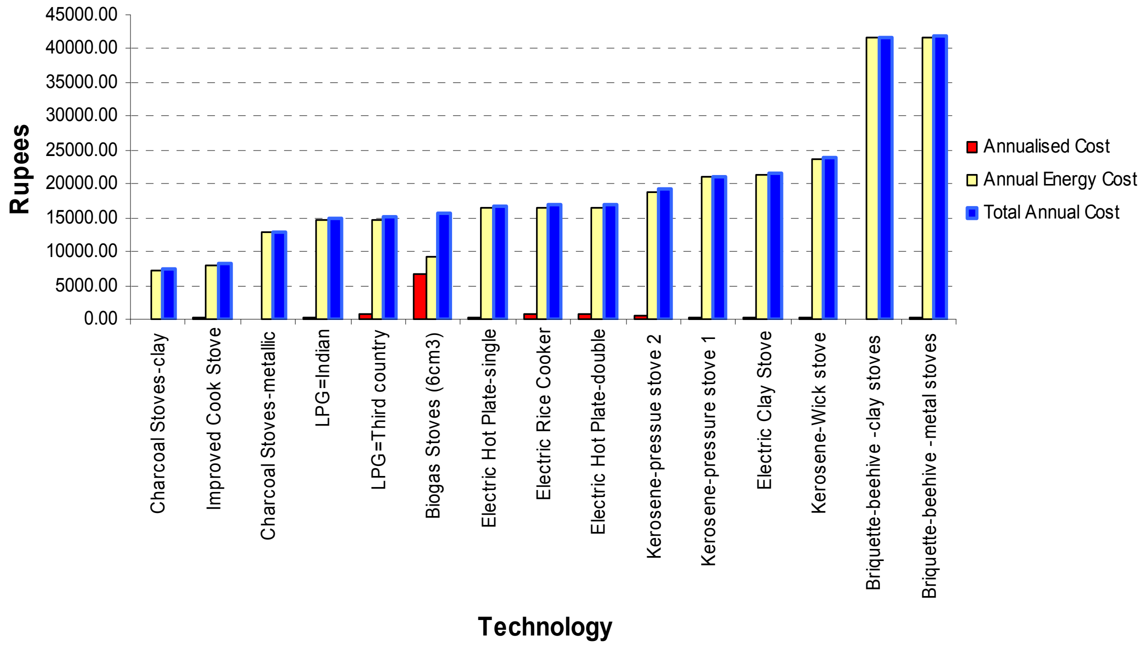


Figure 24 : Costs of cooking technologies

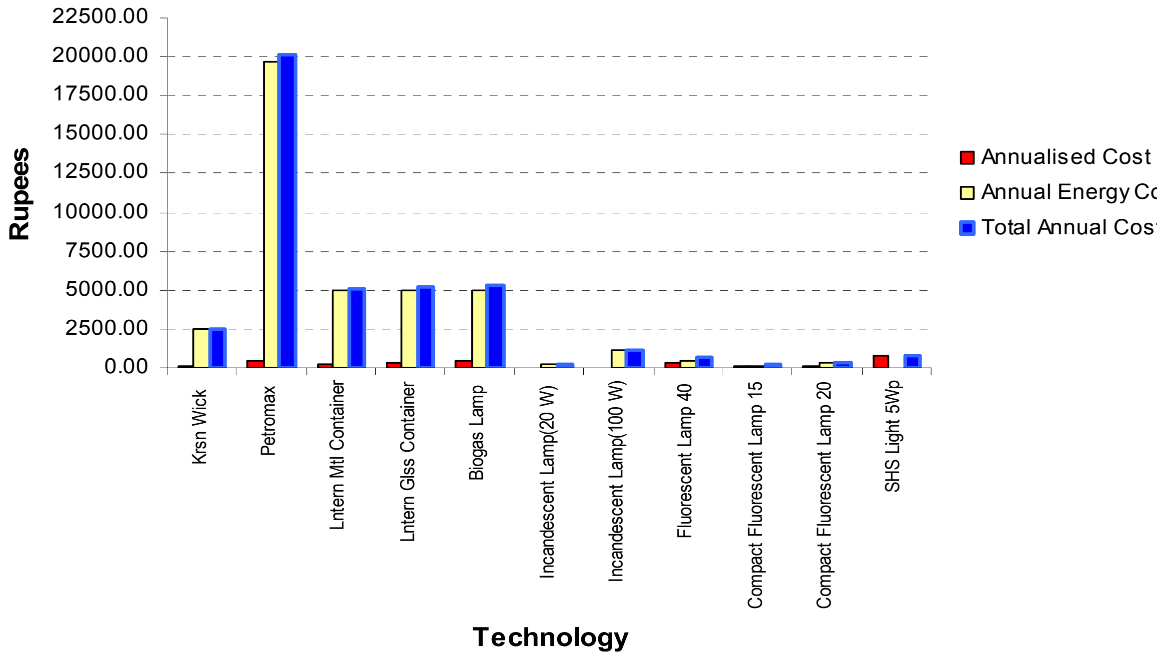


Figure 25 : Costs of lighting technologies

3.5.5 Adaptation potential

Energy is important player in climate change, mitigation and adaptation measures.

Adaptation to climate change is defined as:

'*Adjustments to actual or expected climatic stimuli to moderate harm or exploit benefits*' (IPCC, 2001).

Ability to adapt at country, community or household level is characterized as adaptive capacity and is related to the assets that one has access to (financial, natural resource, human and social capital) and how well these are used (Denton, O'Neill et al., 2008).

This section explores the adaptation potentials of Makwanpur district in the context of the different technologies asses in this study. The adaptation in this study is being analysed for both in terms of be spontaneous or planned[15] . In doing so, it also realises that:

- Adapting to climate change depends on adjustments and changes at every level - from community-based to national and international.
- The capacity to adapt will vary significantly from community to community and in particular to the level of development.
- The range of practices that can be used to adapt to climate change is diverse, and includes changes in behaviour, structural changes, policy based responses, technological responses or managerial responses.

Within the above elements, the adaptation capacity of Makwanpur has been assessed to determine the status within a mixed culture as found existing in the pilot area. Table 18 presents the assessment. In general terms, the adoption of MHP, IWM, biogas, SHS and ICS can be seen as measures of reducing the use of resources including wood fuel and kerosene, which have adverse implications on the environment which would otherwise promulgate climate change. The major adaptation measures that RETs contribute to are through provision of livelihood enhancement and diversification. Adaptation opportunities exist in of the form of reduced drudgery and income generation which help people in climbing up the energy poverty ladder. Diversification of livelihoods further acts as a

[15] Adaptability refers to the degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions (IPCC, 1996).

buffer against potential climate change in case one form of livelihood is particularly vulnerable to changes in climate another form of income is still available.

From the gender perspective, time saved and its use for social networking and involvement in community activities help in exchanging information and gaining knowledge regarding risks, disasters and the successes and failures of encountering them can also lead to adaptation. In terms of different ethnic and marginalised groups, their settlement away from the rest of the community impairs their access to information. Due to lack of data it is not possible to define properly their adaptive potentials.

In light of the future uncertainty of climate change impacts and persisting high variability, specific adaptation potential of the energy resources cannot be generalised. Agencies are required to consider the more site specific interventions and their adaptation potential. However, specific activities exist such as improvement on agricultural practices to conservation friendly technologies such as Sloping Agriculture Land use Technology, promotion of drought tolerant crops and varieties, effective forest management with focus to fire prevention, multi use of water resources, promotion of efficient energy devices and hazard mitigation measures as well as livelihood development and diversified economic opportunities. A range of support activities are necessary such as awareness and capacity building of communities and institutions to enable coping and adaptive capacities of resources, implementing institutions and energy users.

Table 24: Adaptation potentials within the sample VDCs with respect to specific technologies

Technology	General	Gendered	Caste/ Ethnicity	National Response
Micro Hydro	Used only when water is available, reduced electricity supply during low flow; use of alternatives for lighting and mechanical energy for agro processing; improved livelihood provides opportunity for moving up the energy ladder to more efficient lighting systems and diversification of livelihood.	Planned agro-processing works during high flow when the plant is in full operation and storing of the produce;	Dalits and the marginalized group living at a distance from the plant need to wait for longer hours before work is done. no immediate adaptation measures	MH promoted to replace/reduce the use of kerosene for lighting thereby reducing CO_2 emissions; promotes local service providers to ensure sustainability of the systems Promote end uses and livelihoods potential of MHP
IWM	Same as MHP	Same as MHP	Same as MHP	Promoted for eliminating the use of mature trees required in the construction of traditional[16] “ghattas”, thus reducing deforestation; promotes local service providers to ensure sustainability of the systems
Biogas	The systems can operate using any organic waste that disintegrates easily; attaching it to toilets makes it possible to generate energy (reduced); income generation also through use of slurry enables users to climb up the energy ladder for adopting more efficient cooking	Use of mixed energy – using biogas for specific purpose is the common adaptive practice; Improved health enables uptake of income generating activities, involvement in social activities thus being	Use of mixed energy – using biogas for specific purpose is the common adaptive practice; Improved health enables uptake of income generating activities, involvement in social activities thus being informed about climate change issues	Promoted for replacing wood fuel and kerosene; enabling access through subsidy and micro financing Special subsidy for women, low economy group and Dalits and remote areas; promotes local service providers to ensure sustainability of the systems

[16] The traditional Ghatta or water mill has a wooden wheel and shaft is replaced every two years. Replacing wooden wheel requires at least two mature trees; discussion with Ghatta Owners’ Association and centre fro Rural Technology. Replacing the wooden wheel with metallic shaft not only increase the life span of the system but has an important impact on forest conservation.

	energy or also to generate energy using poultry and smaller livestock that require less water and fodder	informed about climate change issues and adapting to it	and adapting to it	
Solar	Solar SHS used for lighting as well as for operating TV; provides opportunity to access information and can provide channels for enhancing knowledge about dealing with disaster and risks	Potential skill development through employment (both construction and livelihood creation) and increased access to knowledge and resources (money, social networks, etc.) that are valuable for adaptation	Improved health and knowledge as well as income generation provides opportunity for reacting during risks and disaster, adopting more efficient energy sources;	Technology promoted for replacing use of kerosene and burning of resinous plants; subsidy to enhance access of the poor; local service providers,
Improved stoves	Uses less quantity of wood fuel; shift to alternative source for cooking	Less exposure to indoor smoke and improved health; improved livelihood and thus opportunity for moving up the energy ladder	Less exposure to indoor smoke and improved health;	Technology promoted for reduced use of wood fuel; continuous improvement in the technology

3.5.6 Energy technology vulnerability due to climate change

According to Nepal's National Adaptation Programme of Action (NAPA) to Climate Change report, Makwanpur district falls under moderately vulnerable group of districts on the overall climate change vulnerability index of Nepal. Its drought vulnerability is low while vulnerability to flood is low and to landslide is high.

Of these, indices on drought and flood contrast with the inferences from meteorological and community based analyses in the district. Analysis of local information shows greater likelihood of exposure of the district to flood and drought in the context of climate change. However, the level of vulnerability to climate change impacts is different for different technologies depending on the resource type. Water resources, forests and agriculture are more sensitive and exposed to climate variability such as erratic rainfall and consequences such as flood, drought, fire and extreme weather events.

Water mills in Makwanpur were found to be given less priority compared to other consumptive purpose of water like drinking and irrigation. As a result many water mills have been forced to close or relocate due to unavailability of adequate water to run them. Scarcity of ample water as well as a decrease in livestock rearing has also resulted in far less adoption of biogas plants. Livestock rearing is generally decreasing as people are finding harder to find grazing land for livestock and at the same time are moving away to a more lucrative livelihood option.

Likewise, micro-hydro systems are vulnerable to decreasing level of water flows particularly in the dry season, as well as hazards like landslides and floods. At a given site, hydropower production is defined by the river flow, so changes in flow due to climate change will alter the energy potential. More importantly, as most hydropower schemes are designed for a particular river flow distribution, plant operation will become non-optimal under altered flow conditions (Harrison and Whittington, 2002). Therefore risk of closure of hydro system that is increasing.

The technologies based on water resources are further vulnerable to climate change (erratic rainfalls) and subsequent to climate change induced water related hazards. Considerable damages to energy systems infrastructure have been observed in the past, as observed in Kulekhani storage plant in the 1993 cloudburst, due to landslides, floods and sedimentation. Also the infrastructure and technology that is used for generation is vulnerable to rise in temperatures, as most of the technology is designed under a certain temperature constant.

Forest fires resulting from long spell of drought in the winter result in further scarcity of wood fuel, however no such vulnerability is felt for improved cook stoves. Though renewable energy technologies like SHS are the least vulnerable to climate changes they are not free from it. Efficiency of solar technologies is also affected by increase in the number of cloudy days and they are at high risk to extreme weather events like hailstorm.

Through the planning workshop exercise, in Hetauda, the technologies and their vulnerability were further verified. The findings is summarised in the table below. Though the end use application of these technologies are different to each other, it does give provide for a local perception to the analysis above.

Table 25: Ranking of technologies based on vulnerability

Rank	Least Vulnerability
1	Solar
2	ICS
3	Biogas
4	Bio fuel
5	LPG
6	Kerosene
7	Diesel
8	Hydro
9	Micro hydro
10	IWM

3.5.7 Climate proofing technologies

Renewable and decentralized energy services contribute to mitigating GHGs. Additionally, they are comparatively accessible compared to other technologies and provide opportunities to increase resiliency to the impacts of climate change. So this study has given priority to decentralized energy services in the context of climate change.

There is high scope for the solar technology promotion. Likewise, well designed hydro systems could be another option. There is need for national plans of hydro optimisation. Additionally, well managed forest plans can also help to secure firewood supply. Biogas could be good option for meeting cooking energy needs, but requires promoting livestock as a lucrative livelihood option.

There is a need to assess and monitor energy systems to ensure systems can adapt to anticipated climate change impacts. Importantly, there is need to develop medium- to long-term strategies for decentralised low carbon energy supply systems. Similarly, there is need to implement energy demand management as adaptation measure.

National RET programmes such as MGSP or the IWM programme could look at the vulnerability of RE systems and revise feasibility studies to include analysis of climate vulnerabilities.

3.5.8 Mitigation potential and trends – general emissions factors

Climate change, mitigation refers to a human intervention to reduce the "sources" of greenhouse gases or enhance the "sinks" to remove carbon dioxide from the atmosphere. Climate change mitigation in the energy sector includes measures that prevent greenhouse gas emissions such as sustainable energy management and using biomass energy and other alternative energy sources.

Whilst the contribution to carbon emissions at national and district level in Nepal is limited, attempts to estimate potential mitigation potential at district level can help toM development process and prepare Nepal for a low carbon development strategy.

The analysis for this study has solely focused on reducing carbon emissions. Analysis has been carried out for selected RETs in carbon emission without the RETs and the costs of carbon abatement for each of the technologies. The result is presented below.

Table 26 : Mitigation Potential of various technologies

Technology	Mitigation potential explanation
Mini and Micro Hydro	Significant reduction in emission; Replaces kerosene lamp, diesel mill
Improved Water Mill	Significant reduction in emission; Replaces diesel mill; Replaces kerosene lamp if electricity generation unit added
Household Improved Cooking Stove	Reduction in GHG emission; protection of the forest resources and environment
Household Biogas Plant	Reduction in GHG emission; saving of fuel-wood, kerosene use
Briquette/ Charcoal	Replaces fuel-wood and diesel; utilizes biomass residues
Solar Home System	Significant reduction in emission; replaces diesel or gas motor
Small Scale Wind Power System	Significant reduction in emission; consumes no fuel
Bio-diesel	Replaces petro-diesel; reduction in GHG emission

The comparison is also carried out based on the cost of abating CO_2 through selected technologies. Economic cost calculation is the basis here for GHG abatement assessment. Given the limitations in data it will not be possible to employ full economic costs in the analysis. Life cycle cost (LCC) analysis has been carried out for four potential technologies in order to find out the abatement cost which has been used as the basis for prioritization. LCC is the total discounted cash flow for an investment during its economic life.

The following simple analysis has been done in order to prioritize different renewable energy technologies taking prevailing values in the district to assess required costs to abate GHG emissions for different incremental investment for each technology.

The GHG for selected technologies have been adapted from the project development document at the country level. The GHG values used and the basis of calculation are presented in table below.

Table 27: Costs and Emission factors of selected technologies[17]

Technology	Investment cost In NPR	Repair Maintenance as percentage of initial cost	Wood fuel Reduction in kg/year	Kerosene reduction in litres/year	Reduction in dry cell batteries consumption: pairs/year	reduction in diesel consumption for milling in litres/year	Residual value (RV) of micro-hydro at the end of project lifetime by initial investment,	Emission Factor (tonCO^{2}equivalent/6 m^3 plant/year)
Biogas 6m^3	48,600	2.50%	4,045	38				4.88 per 6 m3 system
Micro Hydro per kW	265,000	7.5%		38	24	34	15%	1.94 per kW
Solar 40 Wp	850.00	7.50%		38	30		10%	0.076 Wp

Source: PDD of the various projects and IPCC

Based on these data the life cycle cost and the respective CO_2 analysis have been carried out below. These have been worked out based on the emission values as per IPCCC and the work done in the country; some technologies are already in the CDM market while others are various stages of validation and verification.

	CO_2 reduction per year	CO_2 reduction in a lifetime	Cost Before	Cost After	Increased Cost	Incremental Abatement Cost
Biogas 6 m^3	4.88	98	22,161	58,985	36,824	377
Micro Hydro 1 kW	1.94	39	46,075	339,423	293,348	7,561
Solar 5 Wp	0.076	2	11,749	41,151	29,402	19,344

Prioritization of REGA Technologies

[17] Note: Emission factor for kerosene kgCO2/liter 2.54 (IPCC, 1996); Emission factor for diesel kgCO2/kWh 0.9 (CDM guideline for small scale projects)

The prevailing energy problem in Nepal arises from an excessive reliance on non-renewable energy sources and wood fuel consumption at an unsustainable rate while the vast potential of other forms of renewable energy (hydropower, solar, etc.) remain virtually underdeveloped. In taking a broader look at the issue of sustainability during identification and prioritization of energy technologies, the focus is on capacity – including technological development, decision-making capacity, and financial flexibility.

3.5.9 Technology assessment parameters

Based on these parameters the technologies have been judged against each other and is presented in a ranking format in the table below. The scoring for the technologies against the different parameters have been judged based on expert judgement by the DCEP preparation team and based on data collected during the study, presented in chapter 3)

Table 28: Ranking of technology against assessment parameters

Technology	Less Vulnerability to climate	Help in Adaptation	Help in Mitigation	User Friendly	Promote Social Inclusion	Contribute to poverty reduction	Cost
Traditional Stove	5	6	4	6	3	4	4
ICS	4	5	3	5	2	3	1
Biogas	3	2	2	3	4	2	2
Kerosene	2	4	6	4	6	6	5
LPG	1	3	5	2	5	5	3
Electricity[18]	6	1	1	1	1	1	6

3.6 Institutional assessment

3.6.1 Overview

This section involves mapping of stakeholders and identifying capacity needs in order to implement the DCEP in Makwanpur. Identifying the major stakeholders in the district is one of the most important tools to create a detailed implementation plan. This section will identify all potential actors that will be involved in implementing an energy plan.

Overall the institutional assessment has covered three main components:

- Stakeholder identification and roles in renewable energy sector
- Capacity assessment of various organisations

[18] Electricity generated through grid, solar and micro and pico hydro. Electricity generation technology should be only disaggregated in “vulnerability” criteria, where hydro systems are most vulnerable to climate change whereas solar is the least vulnerable.

- Relationships amongst various organisations working in renewable energy sector

The institutional assessment was carried out using coverage matrix, SWOT analysis and actor constellation mapping.

A full list of RET stakeholders can be found in Annex 11.

3.6.2 Stakeholder identification and roles

The coverage matrix tool was used to identify the involvement of various stakeholders including government, private sectors, financing institutions, NGO etc in providing various services including subsidy support, RET promotion, dissemination, technology installation, monitoring and evaluation etc in renewable energy sector. The coverage matrix was carried out for each of various significant RETs. The detailed matrix is provided in Annex 4. Overall it is observed that subsidy support was provided by AEPC and DDC where as local organisations were focussed on dissemination, awareness and technology installation, usage training. No major involvement was seen of district based financing institutions in providing lending support. Also there is limited involvement of organisations in sustainable management of resources, hazard mitigation and research and development.

a) Biomass

In the case of biomass related RETs in Makwanpur, there seems to be strong subsidy support from the central government matched by Makwanpur DDC. AEPC also has major involvement in RET promotion, dissemination, technology training, monitoring and evaluation etc. There is also no significant involvement of private sectors and financing institutions in providing any service in this sector.

A couple of NGOs namely Rural Technology Promoter's Association (RTPA) and Future Nepal and FECOFUN are actively involved in providing services in the sector in Makwanpur. Besides channelling central subsidy these organisations are also providing after sales, institutional development, training of trainers, and monitoring and evaluation in the sector.

b) Solar

AEPC's involvement in the solar sector in Makwanpur is as strong as in the biomass sector. Makwanpur DDC is also providing support such as subsidy, institutional development, monitoring and evaluation etc in the sector. The participation of private sector in solar related renewable energy technologies is very high. Both Dhaulagiri Solar Pvt. Ltd and Technology Upliftment and Engineering Centre (TUEC) provide services like RET promotion, training on technology usage and installation, after sales services, institutional development and training of trainers. Future Nepal also in involved in providing services in the sector.

c) Hydro

Though there are number of organisations including DEEU, AEPC, DDC and private sector involved in providing various services in the hydro sector, there doesn't seem to be a particular organisation solely dedicated to providing services in the sector. As a result, no major involvement is seen of organisations in providing services in the hydro sector in Makwanpur. The DDC and AEPC provide support through some subsidy and RET promotion and dissemination where as TUEC and Water Mills Association is involved in dissemination of technology, training, after sales support and some research and development. The lack of major participation of district based organisations in the hydro based renewable energy sector may be well amounted to the need of technical expertise and capital resources in the sector. Decrease in subsidy in IWM and lack of financing also has meant decreased involvement in the sector.

d) Bio-fuel

Makwanpur is seeing a rise in Jatropha plantation in recent times. Several organisations including GEF and Bihani Nepal, BIRP Industry and FECOFUN are involved in promotion of bio fuel through technology training, RET dissemination, institutional development etc. The sector itself is in its infancy, therefore there is also quite substantial involvement of the organisations in research and development. The details of the services and the involvement are presented in Annex 4.

3.6.3 Stakeholder relationship

The actor constellation mapping tool was used to identify horizontal and vertical relationship amongst various donors, government line agencies, NGOs, INGOs, private sector, finance institutions and local organisations in terms of providing capacity development support, coordination and participation, funding support and subcontracting. The details of the map are provided in Annex 4.

Various donors like NORAD, DGIS, and DANIDA are found to be involved in the district. The provide funds to AEPC which in turn runs its program through DEEU housed in the DDC office. The DEEU in turn acts as the central organisation in the district for all activities related to renewable and alternative energy. GEF and SARI are other international institutions which however coordinate with local NGOs in the district. AEPC and national NGOs like BSP and CRT/N are involved in the district in providing capacity development services to other local NGO, private sector and RET companies.

There seems to be lack of more thorough coordination and joint participation amongst district line agencies like District Agriculture Development Office, District Irrigation Office and District Forest Office as well as other organisation involved in the renewable energy sector. The coordination amongst organisation seems to be limited to within particular sector and cross sectoral coordination doesn't stand out.

3.6.4 Capacity and potential assessment

Capacity assessment of some key organisations was carried out using SWOT analysis and interviews. The analysis shows that there is need of capacity building of existing institutions to address the energy demand in climate change context. Detailed results of the analysis are in Annex 4.

a) DDC, Environment and Energy Unit (DEEU)

The DDC environment and energy unit in Makwanpur is charged with supporting access to and implementation of RETs in the district through subsidies. They currently have two fulltime members of staff although they are not perceived to be sufficiently skilled for DCEP activities to be undertaken by the DDC, although premises and access to information are deemed sufficient. They lack skills and trainings on issues of climate change.

In terms of relations with renewable energy stakeholders the organisation performs well with a positive public image, and links well with external stakeholders and policy makers in renewable energy. The DDC has systems in place to deal with gender equality including a specific gender policy. They are also successfully addressing social inclusion and minority imbalances. DDC has clear policy on GSI; it has social development unit and a separate unit for Dalit and ethnic committee. Periodic plans and programs have included gender responses to benefit disadvantaged groups including women.

The capacity of DEEU is generally lacking in terms of human resource availability to be able to deliver the DCEP. The DCEP implementation requires increased monitoring and evaluation besides subsidy disbursement, increase in promotion and awareness activities etc; therefore the current human resource capacity will be unlikely to handle such an increase in activities.

b) District Forest Office DFO

The DFO supports the community through subsidies and promotional activities related to RETs. They are currently not adequately staffed with little capacity to adapt to future increases in demand. Alongside a shortage of skilled staff there is also insufficient premises and equipment available. The DFO do have links to the wider district, with a good public image and links with stakeholders and policy makers. They also perform well in areas of GSI, with clear capacity to address these issues in their work place and their programs and projects, although they do not have a specific social inclusion policy.

c) District Irrigation Division Office (DIDO)

Although no specific plan on climate change and GSI, DIDO provides support within the district for irrigation that consequently promotes environmental protection, including from a climate change perspective. They currently have adequate skilled staff to operate and also sufficient equipment, premises and access to information, although it was deemed they would struggle to increase demand within the district. In terms of relations with external stakeholders, overall this was good, with systems in place to measure performance and quality of service provided. They operate clear gender equality policies within the workplace and are well suited to recognise and handle issues that arise. Although they have a specific social inclusion policy they currently do not sufficiently provide their projects and programs to minority groups.

d) Ghatta Owner Association (GOA) Makwanpur (IWM)

GOA distributes IWM in Makwanpur district. Their strategy is to improve socio-economic conditions of ghatta owners and the wider community in the district through the promotion of RETs. They currently employ five members of skilled staff which is deemed sufficient for their present levels of output; similarly current premises and access to information are also adequate. Having said this, it was felt that human resources were enough to deal with increasing demand, however financial and physical resources were found lacking. GOA has capacity to carry out increased RET intervention and other environment protection activities in DCEP.

In terms of relations with their customers they have satisfaction monitoring systems in place to ensure quality of the supplied IWMs and in general they have a good public image. They also have adequate relationships with regional and national policy makers and other relevant stakeholders.

Although GOA has no policy on climate change and gender social inclusion, but its activities are directed to support the issues and it has been planning to form a policy on gender social inclusion. In terms of GSI, men and woman are treated equally and the association has the ability to deal with gender related issue, even though there is not a specific gender policy in place. GOA conducts gender sensitization orientations in the district and has a provision of special discount in application charge for female owners. The application charge for male IWM owners is NRs. 300 while that for female owners is NPR. 200. However, the issue of social inclusion was found less pertinent within the association, there was not found to be any particular attention given to minority groups or a specific social inclusion policy.

e) Bio-fuel Research and Production (BIRP) Industry

BIRP Industry is involved in plantation and distribution of Jatropha in the district. BIRP has objectives to address the issues of climate change and gender inclusion. It has been working to produce enough fuel additives to reduce Nepal's reliance on imports from abroad, and to increase the productivity of cultivatable land by supplying compost fertilisers to farmers. Jatropha farming in the district is currently very limited and BIRP does not have the capacity for a significant increase in output. The three members of staff currently employed do not have enough skills to contribute the DCEP planned activities as well as for the implementation of their own strategy, although the premises and access to information is sufficient to do so. It has been however working in the lines of the DCEP plan by raising awareness on Jatropha plantation and technically supporting bio fuel plantation.

Overall external relations are excellent, with a good public image and established relationships with other stakeholders and policy makers. GSI issues are addressed within BIRP, with capacity to recognise and act on specific issues; they have a gender policy although not a specific social inclusion one. BIRP has engaged women especially minorities in Jatropha plantation and raring. Giving importance it has distributed the seedlings to women-headed community forest user groups for their social and economical empowerment.

f) Technology Upliftment & Engineering Centre (TUEC)

TUEC works significantly in climate change programs, manufacturing IWM, micro hydro and ICS. Their strategy is to increase the efficiency of water mills, to promote micro hydro in rural VDCs and to promote metallic ICS in high altitude rural VDCs, with the aim of easing rural life. Overall TUEC has sufficient resources to meet the demand, with 11 employees and adequate premises, financing and access to information. They are also in a good position to meet increases in future demand. Relationships with stakeholders and clients are good, with systems in place to measure satisfaction. Although TUEC has sufficient ability to deal with gender problems, even without a specific policy in place, they were found lacking in dealing with issues of social inclusion with no specific plan, and no particular attention to minority groups in their programs and projects. It has been supporting DCEP plan by promoting manufactured IWM, ICS and micro/Pico hydros.

g) Future Nepal (FN)

Future Nepal's aims are to promote the use of renewable energy in the district and to equip communities for a sustainable life against climate change. It has objective to work on climate change by advocating for adaptive measures to mitigate climate change. Though there have been no completed activities in climate change there are some projects in the pipeline. FN also contributed towards the DCEP preparation as the district focal organisation.

However FN has been working in the area of ICS in Makwanpur. It has 9 members of staff, with adequate premises and access to information; they are also in a good position to deal with an increase in demand for ICS in the district and to advocate for climate change mitigation. FN has been supporting DCEP plan by awareness raising for GSI, and promoting ICSs. Overall FN has a positive public image with systems in place to measure customer satisfaction for services provided. It also has strong relations with external stakeholders and policy makers.

The management treats men and woman equally, with a specific gender policy in place giving FN the capacity to recognise and deal with potential gender related issues. FN has an inclusion policy to include women, Dalits and disadvantaged groups in its activities and as per the policy women, Dalits and disadvantaged groups have been participating in its activities.

h) Rural Technology Promoter's Association (RTPA)

RTPA's aims are to promote biomass energy to mitigate the effects of climate change, to increase carbon sequestration by protecting natural forests and to improve the socio-economic condition of ICS users. They currently have 2 members of staff, which is sufficient for current and future activity. Premises and access to information are also sufficient although it is felt that the relationship between output and the cost of producing it in terms of human financial and physical resources is currently not acceptable.

It has been supporting DCEP plan by promoting installation of brick-mud ICSs in VDCs.

RTPA has a strong relationship with their customers and external stakeholders, with systems in place to measure levels of satisfaction for the services they provide. In terms of social and gender issues they do not have specific policies in place for either, and it was felt they are not sufficiently able to deal with issues of minority imbalance within the staff. RTPA has focussed on pro-poor groups including disadvantaged groups like women and ethnics in its all activities. Gender wise RTPA are able to recognise and deal with issues and woman and men are treated equal, even without a specific policy.

i) Federation of Community Forest Users, Nepal (FECOFUN), Makwanpur branch

Although FECOFUN, Makwanpur does not deal directly with RETs, they do operate in the field of climate change, with a core strategy to conserve Nepal's forests to reduce landslides, desertification and decreasing groundwater levels. The single employee at the district office is not perceived to have adequate skills to deal with issues in the district, although premises and access to information are there. There are no systems in place to measure the satisfaction of the operations of FECOFUN, Makwanpur locally although they have significant contact with policy makers and external stakeholders. Overall they are seen in a positive light by the local community.

It has been supporting DCEP plan by promoting conservation of forest resources.

Gender and social issues are dealt with adequately by the organisation, with equal treatment from management, the capacity to pick up and deal with issues, and a specific gender policy in place. They deal less well with social inclusion issues, and it was not perceived that the staffing policy deals sufficiently with the issue. FECOFUN, Makwanpur does target minority groups in their projects, and they have a specific social inclusion policy.

j) Dhaulagiri Solar Pvt. Ltd. (DSP)

DSP promote solar energy in order to replace kerosene lamps in the district, their target is to declare Makwanpur a *Tuki* free district. It has been supporting DCEP plan by promoting the supply of manufactured solar sets.

Currently the organisation has adequate staff, premises and access to information to operate effectively and it also perceived that they have the capacity to meet increasing future demands. However relations between output and cost of production, in terms of staff, financing and physical resources are not sustainable at present. Public perception of DSP is positive and they have systems in place to assess whether their target group is happy with the quality and level of service they receive. There are also adequate relations between DSP and external stakeholders and policy makers. Management are able to equally treat men and woman, and recognise and deal with any gender issues that may arise, even without a specific policy in place. The same goes for gender and social issues, there is no strategy in place but the staff policy nevertheless addresses minority issues, and programs and projects pay sufficient attention to socially excluded and minority groups in the district. It has targeted ethnic community including women as their service recipients.

4 District Energy Scenario Development/ Demand Projection

4.1 Introduction

Scenarios are self-consistent storylines which describe how an energy system might evolve over time in a particular socio-economic setting and under a particular set of policy conditions. For this planning LEAP was used for data entry and analysis. A 10 year planning period was established, from 2010, as the base year, to 2020 end year.

Process and Assumptions

Base-year residential energy consumption data was adapted from the Energy Poverty Study (EPS). This provides detailed energy consumption data for all major energy activities. Where available, up to date data was added to reflect the current situation, this includes installation rates of RETs which were sources from the relevant implementing organisations (CRT/N, BSP etc). Industrial and commercial values were sourced from the District Energy Perspective Plan. As per the source data, data was split into urban and rural populations, a yearly population growth rate of 2.2% was used overall as per national figures, and an urbanisation rate was used as per the EPS as follows.

Year	Rural HH %	Urban HH%
2010	73.24	26.76
2015	68.89	31.11
2020	64.1	35.9

To facilitate comparisons among the three scenarios (BAU, MAS, CRS) all of them share the same demographic assumption in which population growth rate is the same. The GDP rate is also taken to be the same across all the scenarios. The energy efficiencies of technologies are also the same across the scenarios however the uptake and penetrations of such technologies vary.

The three scenarios diverge in terms of the contributions of individual primary energy sources and technology used - what percentage of primary energy is supplied by biomass and what kind of technology, what percentage by hydro, and so forth. They also diverge in terms of consumption growth. Though the total energy demand is expected to rise as per the population growth, use of efficient technologies and clean energy is assumed to reduce the pace of the total consumption.

Climate change and its impacts to different energy resources and consumption have been considered in all the scenarios based on the past and projected trends in the districts. Although they are not quantified, consideration of the mix of different energy resources, technology and resources management considerations together provide impetus into a climate sensitive energy plan. Besides the trend of rainfall and temperature, other climate variables are based on the local stakeholders (communities and planners) perceptions and expert judgment. Therefore, considerations have been made to enhance efficiency of resources management and technologies to generate, transmit and utilize the energy resources.

Renewable Energy Technologies Linkages with Climate Change and GSI Issues

The DCEP study has focused on the residential sector which consumes the majority stake of energy in the district. It has been estimated that cooking consumed around 56 % of the total residential consumption of the district for the base year. Lighting is another basic end-use, which also promotes different basic and productive applications in households and communities.

A plan design workshop was organised to prioritise technologies and collect feedbacks of local stakeholders on their perception on climate change and vulnerability of energy sources and technologies. The technology assessment carried out in the districts as summarised in Section 3.5 of the report is the basic tool used to prioritise energy technologies. Technology prioritisations were carried out considering following aspects;

- Annualised cost
- Climate Change Aspects
    - Vulnerabilities of energy resources and technologies to climate related hazards and stresses (scored based on expert judgement and stakeholder perception)
    - Adaptation potential i.e. roles of renewable energy technologies in supporting in livelihood options to enhance resilience to changing consequences (scored based on expert judgement and stakeholder perception)
    - Climate change mitigation potential of particular technology
- Potential contribution to GSI issues (scored based on expert judgement and stakeholder perception)

Table 29: Technology linkages with climate change and GSI

Technology	Adaptation Potential and Vulnerabilities	Gendered and Social Aspects
Micro Hydro	Hydro technologies can support in diversifying livelihood options of vulnerable communities. Promotion of end-uses like agro-processing activities, poultry business and other income generating activities (IGA), which require electricity can be facilitated. Increased livelihood option means increased adaptive capacity to the effects of climate change. However, the	Energy is not only a pre-requisite commodity to support economic activities but also support in empowering women, reducing drudgery and in promotion of children and adult education, which are also some of the tools that support the adaptation process.

	variations in runoff may cause damages to power plants; thus proper structural and non structural adaptation process can be facilitated.	
IWM	IWM has been regarded a technology that can provide support to poor communities to increase livelihood options. Agro-processing activities, electrification possibilities and other end-use operation helps to promote IGA which help in building adaptive capacity. Vulnerabilities to the technology are associated with the water scarcity and high runoff, thus proper structural and non structural adaptation process can be facilitated.	IWM helps to reduce women drudgery associated with agro-processing activities. Poor and socially excluded people can be mainstreamed in the promotion of IWM.
Biogas	Biogas helps in increasing agricultural productivity through slurry, which increases soil fertility. Access to animal waste based cooking energy also means self sufficiency and reduces the dependency on fossil fuel, and fuel wood for cooking needs. The savings in cost through the use of the technology and income from its by-products helps if managed properly will provide support in climate change adaptation process. However the assessment of market based feasibility of biogas limits the development of the technology.	Biogas supports in reducing drudgery to women and supports in reducing the chances of Acute Respiratory Infection arising from kitchen smoke, which is normally high in women and children of households using traditional cook stoves.
Solar technologies	Solar technologies can support in a wide array of adaptation process. Solar water pumping can be use in areas affected by water scarcity. Solar technology benefits children with their education. There is also a rise in access to information which subsequently helps in capacity building of rural communities to cope with the changes. Development of private sector and entrepreneurs also helps in increasing adaptive capacity as affordability is expected to increase as in a free market economy.	Amongst other things solar technology helps in empowering women, adult and socially excluded people through proper means of communication and information. Dependency on kerosene for lighting is also reduced, which supports in reducing health related issues and income savings.
Improved cook stoves	ICS consume less fuel wood compared to traditional cook stove and thus aid in adaptation of communities residing in areas with high landslides incidences and increasing forest degradation Saving of fuel wood consumption in the long run helps in the sustainability of forest resources.	ICS support in reducing drudgery to women and support in reducing the chances of Acute Respiratory Infection, which is normally high in women and children using traditional cook stoves.

Similarly, the Table 24 and 26 and the findings summarized in section 3.5 have been best utilised to prioritise the technology on the basis of its significance towards the climate change, GSI and cost issues. It is not possible to quantify climate change and GSI issues at district level due to lack of statistical and disaggregated data so subjective scoring has been used based on expert judgement and stakeholder perception.

The description of the scenarios, in following sections, describes the scenarios whereas the divergence mentioned above in quantitative terms is presented in the table 30 below.

Scaling of Renewable Energy Technologies in the Scenario Development

Table 29 describes the projected household percentage share of technology usage in various scenarios for cooking and lighting in the year 2020. Energy shares for the year 2020 were established from which energy demand was estimated. The MAS and CRS scenarios were developed using the BAU case as a starting point. BAU is basically an extrapolation of current trends where as MAS and CRS take into account the need of addressing climate and change and GSI issues.

Urban lighting shares in all three scenarios are kept constant. This is primarily because most urban lighting demand is met through electricity supplied via the national grid. In rural lighting, extrapolating current trends, in BAU it was found that around 37% of all HHs will depend on electricity based sources for lighting and 63% from non electricity based sources. The technology share within electricity based sources was solar 37%, MH 8% and grid 55% which resulted in 18% of all rural HHs using SHS, 3% HHs micro or pico hydro and 16% meeting their lighting needs through the grid.

This share within electricity base sources in BAU was kept constant for MAS and CRS as well however the electricity base to non electricity base mix was changed to 40:60 and 20:80 in MAS and CRS respectively. This is primarily due to the "no regret" options determined through this study and the need for diversification of energy sources. As a result of which the current proportions within renewables (diversification) is maintained along with a shift from non-renewables to renewables (no regret). Within renewables, since SHS is less vulnerable to climate change compared to hydro systems and provide equal opportunity in terms of adaptation, current proportions which show a high uptake of SHS in rural areas is maintained.

Table 30: Makwanpur Scenario Household Shares (2020)

	Cooking					Lighting				
	RET	2010	BAU	MAS	CRS	RET	2010	BAU	MAS	CRS
Rural	Traditional Stoves	70.8	58	40	0	Non elec. Based	79	63	60	20
	ICS	5.2	7	40	70	Solar	7.7	18	20	30
	Biogas	18	25	10	10	MH	1.8	3	4	7
	Electricity	0	0	5	20	Grid based	11.5	16	16	43
	LPG	0	0	5	0					
	Kerosene	6	10	0	0					

	Fuel Mix	Mixed	Mixed	Mixed	100% RE	Fuel Mix	Mixed	Mixed	Mixed	Mixed
	RET	2010	BAU	MAS	CRS	RET	2010	BAU	MAS	CRS
Urban	Traditional Stoves	18.3	2	0	0	Non elec. Based	10	0	0	0
	ICS	5.2	7	5	10	Solar	4.5	5	5	5
	Biogas	18	25	0	0	MH	0	0	0	0
	Electricity	15	5	35	90	Grid based	85.5	95	95	95
	LPG	24.5	51	55	0					
	Kerosene	19	10	5	0					
	Fuel Mix	Mixed	Mixed	Mixed	100% RE	Fuel Mix	Mixed	100% RE	100% RE	100% RE

In cooking, MAS and CRS biogas share for cooking in rural areas is limited to 10%. This is taking into account the lifespan of a biogas plant (15 years) and the total remaining potential of biogas plants in Makwanpur (around 17,000 HHs with land and livestock) . For planning and scenario purposes it is necessary to determine the actual number of a functioning technology at that period of time. Since the repair and maintenance of biogas plants and the lifespan itself fall well off the calculations of this planning document, it will be only possible to determine the remaining scale of intervention that can be planned. Biogas plants provide for adaptation opportunities and GSI opportunities (see table 29) however is limited by the potential in the district. As seen in table below while a total of around 17,000 plants may have been installed only 7,000 would be operational (roughly providing for 10% HHs).

Year	Cumulative	Operational [19]
2005	9,652	
2020	16,570	6,918

In CRS beside the 10% share of biogas in cooking, 70% is from ICS and the remaining 20% from electricity. The 70% HH share in ICS both amounts from switching from traditional and kerosene stoves to ICS as well as consumption of wood fuel in which total wood fuel consumption for cooking tries to meet current wood fuel supply of 121,881.4 m^3 in Makwanpur. This allows for climate resiliency in terms of sustainable energy supply as well through cheap technology costs and reduction of GHG emission. The need to shift from traditional cook stoves to improved cook stoves is both required by the adaptation/mitigation opportunities it provides as well due to the need to move to efficient

[19] This number is found out by deducting the cumulative installation of 2005 from 2020. This represents a life span of 15 years.

and cleaner technologies. Due to limited potential of biogas, the full potential of ICS needs to be realised, however, keeping in mind the resource base that is available as well. The remaining demand for cooking in rural is expected to be met through electricity which is 20%. In urban areas, as 95% HHs already would be using grid based electricity for lighting around 90% HH will be using electricity for cooking purposes as well. The rest of the cooking demand will be met through improved cook stoves. With increased urbanisation it is expected that the HHs in urban areas rearing adequate livestock to provide input for biogas plants will be nominal.

In MAS, there is some penetration of LPG and some use of electricity for cooking compared to both CRS and BAU in rural areas. The share of kerosene is basically expected to be taken up by LPG and electricity. Traditional and improved cook stove shares are both equal (40%). This share shows an increase in uptake of ICS compared to BAU however far less compared to CRS. Therefore, MAS also serves as a mid-point between BAU and CRS. In urban areas it has been envisioned that kerosene shares from BAU are taken up by LPG, whereas biogas and cook stove shares taken up by electricity. Technology costs aren't a concern in MAS as much as adaptation potential is. Therefore LPG shares have been increase comparatively compared to CRS.

The detail explanation of the scenario is presented in the ensuing chapters.

4.2 Business as Usual Scenario (BAU)

4.2.1 Overview

BAU is based on current trends, assuming variables such as GDP, population growth, intervention rates etc continue at their current trend. This scenario is gender neutral and does not consider GSI issues beyond existing interventions.

It relies on existing strategies adaptation and mitigation and is used as a baseline scenario against which the other scenarios can be compared.

The energy consumption shall grow as per the current trend and shall be met by an energy mix of renewable and clean energy as well as fossil fuels and biomass. However, as per current trend the demand for cooking energy will be mostly met by biomass. The investment in clean energy will follow the current trends. The cost of efficient and clean technologies will remain as per the current trends.

4.2.2 Energy demand

The Table 30 summarises the final energy demand in the residential industrial and commercial sectors in Makwanpur for the target year range.

Table 31: Energy demand of sector in BAU

Year	Residential ('000 GJ)	Commercial ('000 GJ)	Industrial ('000 GJ)	Total ('000 GJ)
2010	4,876.70	116.6	813.8	5,807.20
2011	4,872.10	119.1	830.7	5,821.80
2012	4,866.40	121.6	848	5,836.00
2013	4,862.70	124.1	865.8	5,852.60
2014	4,861.10	126.7	884.1	5,871.90
2015	4,861.70	129.4	902.9	5,894.00
2016	4,809.20	132.2	922.2	5,863.50
2017	4,760.60	135	942	5,837.60
2018	4,716.10	137.9	962.4	5,816.30
2019	4,675.90	140.9	983.3	5,800.10
2020	4,640.40	144	1,004.80	5,789.10

Total residential energy consumption will decrease from 4.9 million GJ per year in the base year to 4.6 million GJ in 2020. The decrease is mainly due to the increase in urbanisation and subsequently the shift towards more efficient technologies by the wider population. As a result there is a decrease in energy consumption units in rural areas and increase in energy consumption in urban areas.

Rural energy consumption will decrease from 4.3 million GJ to 3.6 million GJ between 2010 and 2020. Similarly, urban demand will increase from 0.5 million GJ to 1.0 million GJ.

Table 32: Rural – Urban energy demand in BAU

Year	Urban ('000 GJ)	Rural ('000 GJ)
2010	549.82	4326.84
2011	587.54	4281.28
2012	627.10	4235.75
2013	668.59	4190.22
2014	712.06	4144.72
2015	757.59	4099.31
2016	809.28	3994.55
2017	863.63	3890.98
2018	920.76	3788.68
2019	980.80	3687.78
2020	1043.86	3588.39

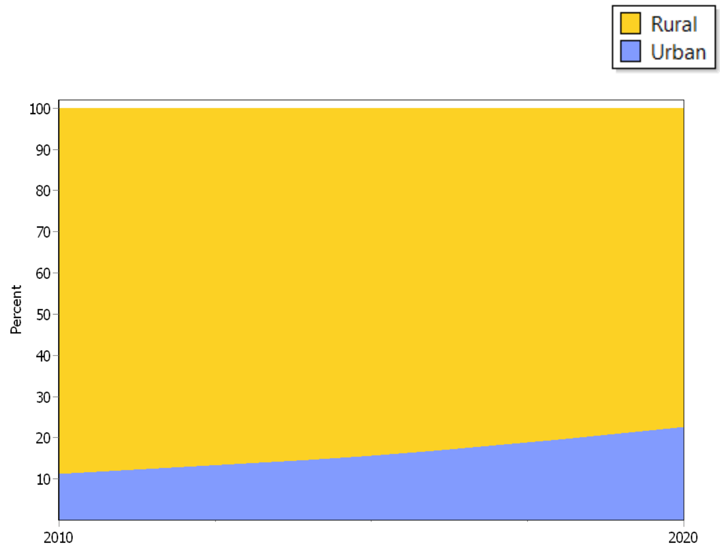


Figure 26: Energy demand by areas in BAU

In the context of rural areas energy consupmtion in cooking is seen to decrease significantly from 2.4 million GJ to 1.5 million GJ in 2020. This is mostly due to the current trends of promotion of ICS and biogas and the rural population making a shift from tradtional technology to more efficient and reliable technologies.

In terms of lighting in rural areas, of the total demand of 12,692,248 kWh in 2020, electricity provides for 4,834,296 kWh whereas non electricity based sources with current trends is found to provide for the remaining 7,857,951 kWh.

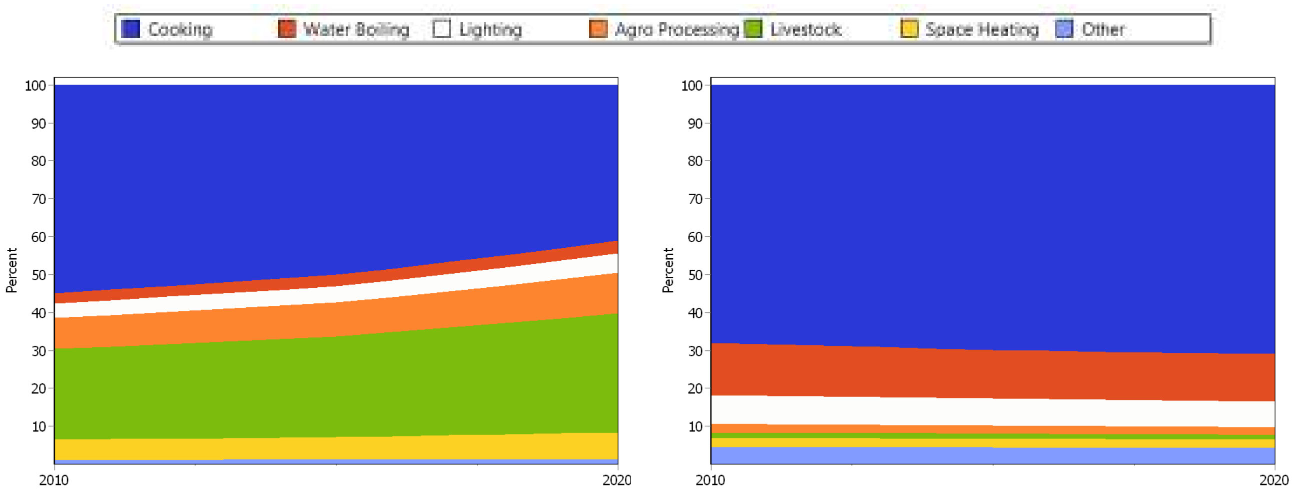


Figure 27 & 28: Rural and urban energy demand share by end-uses in BAU

4.2.3 Energy supply

Wood fuel will still remain as the major source of fuel for cooking in rural areas in 2020. It will provide for 1.1 million GJ of the 1.5 millon GJ of cooking energy demand in 2020 while current trends sees biogas providing for 0.2 millon GJ in 2020. The 4,991,827 kWh of electricity demand in 2020 is calculated to be met through a combination of grid based and non-grid based sources. Solar home systems will be providing around 741,609 kWh, micro and pico hyrdo systems around 606,017 kWh where as the NEA grid with its current expansion growth rate would meet the remaining 3,486,670 kWh of demand

Energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 6.1%
Biomass (firewood) = 55.9%
Fossil Fuel = 23.2%
Biomass (others) = 14.8%

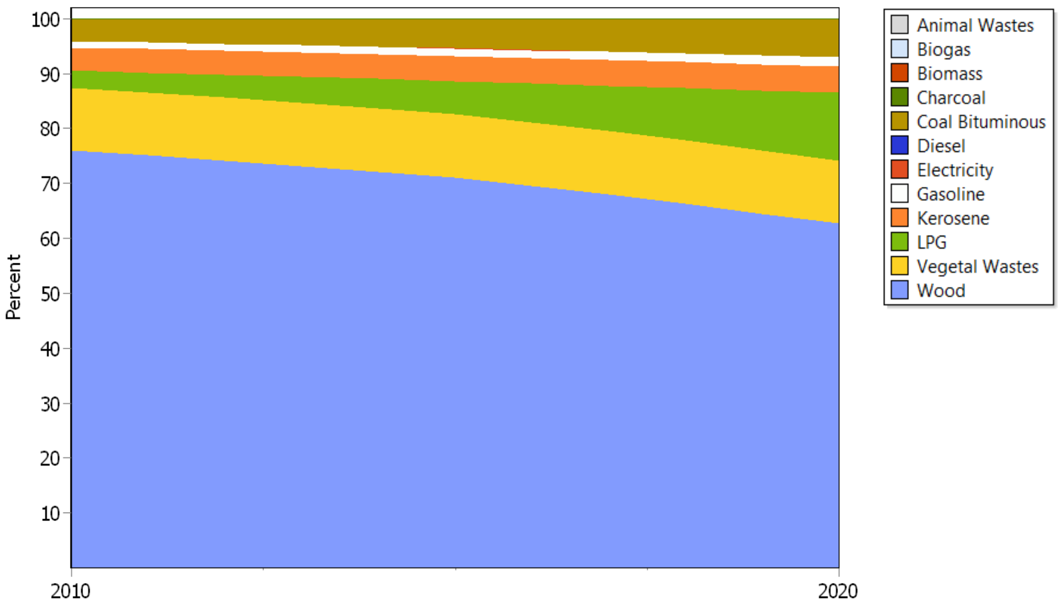


Figure 29 : Energy resource mix in BAU

Rural energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 0.6%
Biomass (firewood) = 79.0%
Fossil Fuel = 2.2%
Biomass (others) = 18.2%

Urban energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 5.6%
Biomass (firewood) = 6.7%
Fossil Fuel = 68.2%
Biomass (others) = 19.5%

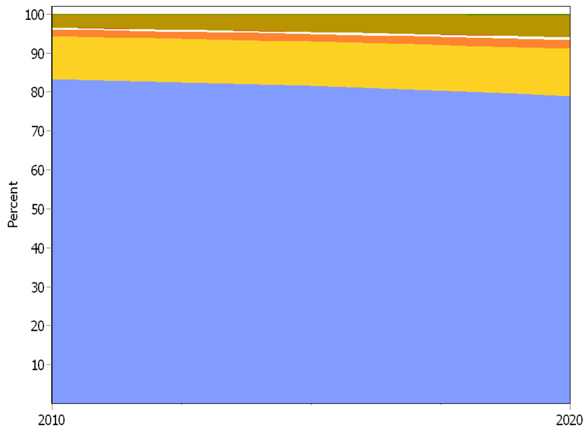


Figure 30: Rural resource mix in BAU

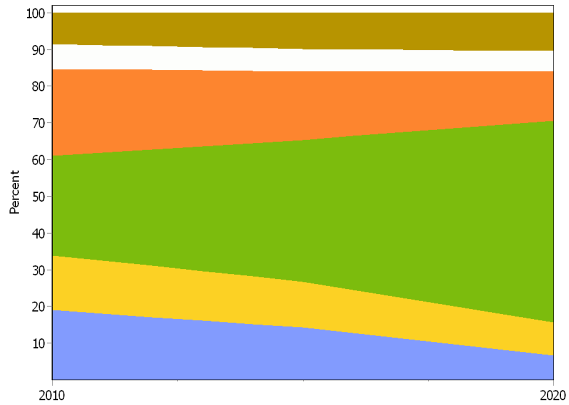


Figure 31:Urban resource mix BAU

4.3 Medium Adaptation Scenario (MAS)

4.3.1 Overview

MAS take into account the development of livelihoods by providing inclusive access to energy sources. Although it does not embrace a full-climate resilient strategy it will provide some adaptive measures and consider potential vulnerabilities of resources and technologies. This scenario also integrated GSI consideration into the scenario development process.

The energy demand shall be met by an energy mix of renewable and clean energy as well as fossil fuels and biomass. Biomass shall fulfil more cooking energy demand compared to BAU. Moving away from fossil fuel is deemed important because of its scarcity. There shall be higher than average investment (compared to BAU) in renewable energy. Some climate change mitigation strategies have been followed. MAS will promote more efficient and clean technologies will be less compared to BAU. Energy consumption of the district is assumed to grow at a lesser rate than of BAU, because of use of efficient technologies and clean energy. There shall be some investment in resource safeguarding and resource management. Supply side technology is also considered to be more efficient.

The consumption growth rate is as follows which have been reverse calculated through the resource mix that will fulfil the energy demand in MAS in 2020.

Energy consumption growth rate

Residential = -2.5%

Commercial = 1%

Industrial = -1.2%

4.3.2 Energy demand

The Table 32 summarises the final energy demand in the residential industrial and commercial sectors in Makwanpur for the target year range for the MAS.

Table 33: Energy demand of sector in MAS

Year	Residential ('000 GJ)	Commercial ('000 GJ)	Industrial ('000 GJ)	Total ('000 GJ)
2010	4,876.70	116.6	813.8	5,807.20
2011	4,780.30	117.7	822.2	5,720.10
2012	4,687.90	118.7	830.7	5,637.20
2013	4,594.50	119.7	839.3	5,553.50
2014	4,500.10	120.8	848.1	5,469.00
2015	4,404.80	121.8	857.1	5,383.80
2016	4,257.30	122.8	866.3	5,246.40
2017	4,119.10	123.9	875.6	5,118.70
2018	3,990.70	124.9	885.2	5,000.80
2019	3,872.50	126	894.9	4,893.40
2020	3,764.80	127.1	904.8	4,796.70

Overall energy demand will reduce significantly compared to BAU due to increase in efficient technologies. Significant savings are made by substituting wood fuel for more efficient energy sources such as hydro and/or LPG. Whereas CRS requires a large switchover to clean energy sources, MAS can account for some increases in fossil fuel usage in order to take into account the requirements and preferences of the end user. Total residential energy consumption will decrease from 4.9 million GJ per year in the base year to 3.8 million GJ in 2020. Rural energy will decrease from 4.3 million GJ to 3 million GJ between 2010 and 2020, urban demand will increase from 0.6 million GJ to 0.7 million GJ. In the context of rural areas energy consupmtion in cooking is seen to decrease significantly from 2.4 millon GJ to 1.1 million GJ in 2020. In terms of lighting of the total demand of 14.5 million kWh in 2020, electricity provides for 7.8 million kWh whereas non electricity base is found to provide for 6.7 million kWh.

Table 34: Rural – Urban energy demand in MAS

Year	Urban ('000 GJ)	Rural ('000 GJ)
2010	549.82	4,326.84
2011	559.72	4,222.21
2012	571.42	4,117.44
2013	582.14	4,012.60
2014	591.82	3,907.77
2015	600.36	3,803.04
2016	628.01	3,626.87
2017	656.71	3,458.95
2018	686.52	3,299.62
2019	717.5	3,149.18
2020	749.74	3,007.97

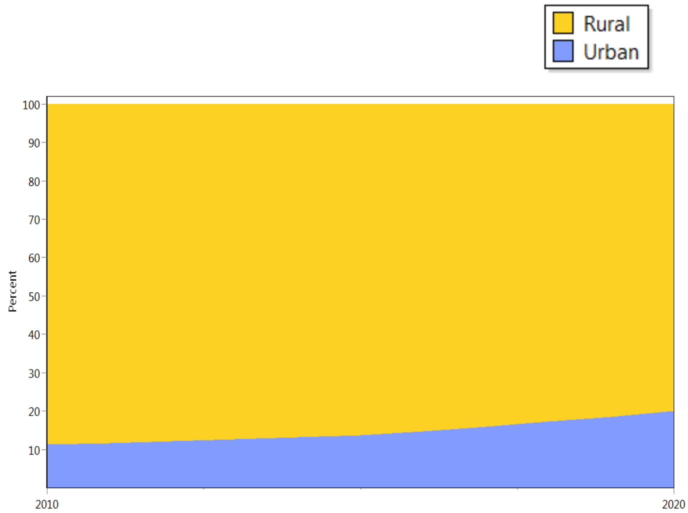


Figure 32: Energy demand by areas in MAS

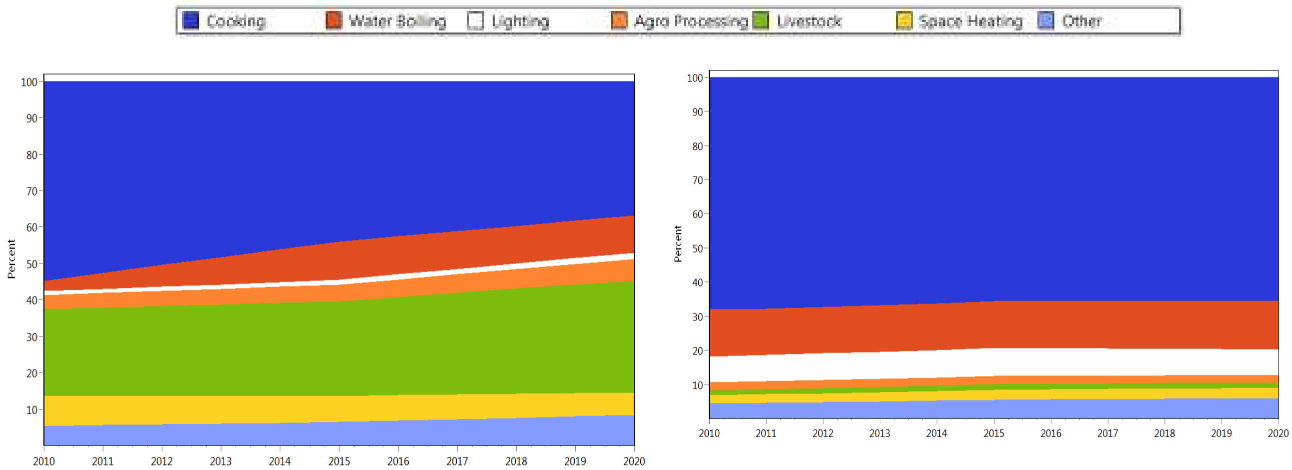


Figure 33 & 34: Rural and Urban Energy Demand by Activity in MAS

4.3.3 Energy supply

Wood fuel will still remain as the major source of fuel for cooking in rural areas in 2020. It will provide for 1 million GJ of cooking energy demand in 2020. The MAS also sees penetration of LPG more in rural areas compared to BAU. It is to provide for 23,134 GJ of cooking energy in 2020 amounting to 5% of HH reach. Whereas taking into the context of climate change and the decreasing availability of water and green pastures, as found out through focus group sessions in Makwanpur, biogas have a lesser operational share in 2020 compared to 2010, decreasing from 18% to 10% of all HH. Biogas will provide for 78,104 GJ of cooking demand compared to 128,967 GJ in 2010. It is also perceived that electricity will also contribute to the cooking needs of the rural population in 2020. Almost 5% of HH amounting to around to 9,097 GJ is expected to be met from electricity, mostly grid based source.

Electricity is calculated to provide for 40% of all lighting demand in MAS. The 7.8 million kWh of electricity demand in 2020 is calculated to be met through a combination of grid based and non-grid based sources. The national grid is calculated to account for around 6.2 million kWh.

The overall supply mix trend sees an increase in renewable sources as presented below.

Energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 11.2
Biomass (firewood) = 55.5
Fossil Fuel = 23.1
Biomass (others) = 10.2

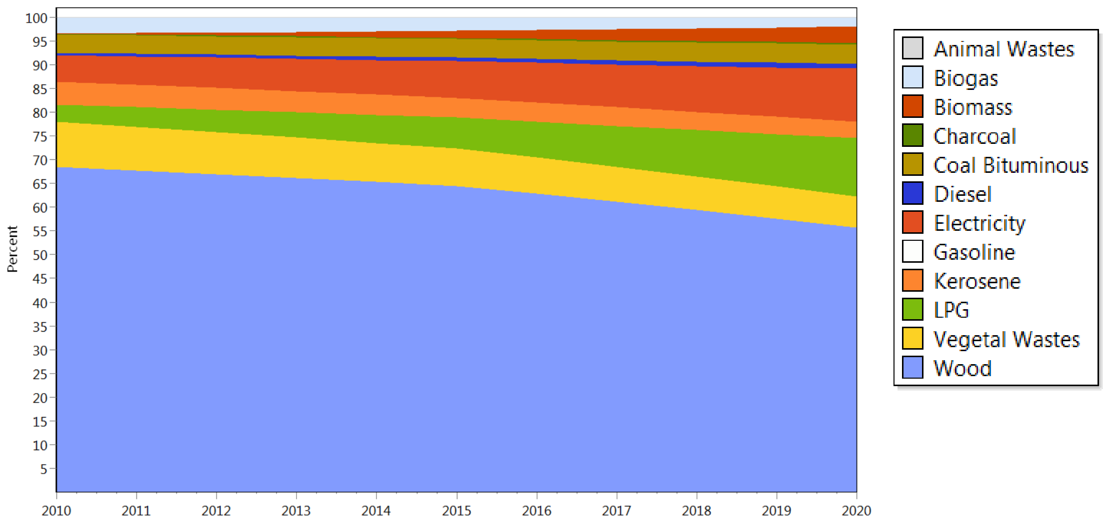


Figure 35: Resource Mix 2020 MAS

Rural energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 1.6
Biomass (firewood) = 79.4
Fossil Fuel = 1.8
Biomass (others) = 17.2

Urban energy sources supply mix (at 2020)
Renewable (Hydro and Solar) = 13.3
Biomass (firewood) = 7.7
Fossil Fuel = 72.5
Biomass (others) = 6.5

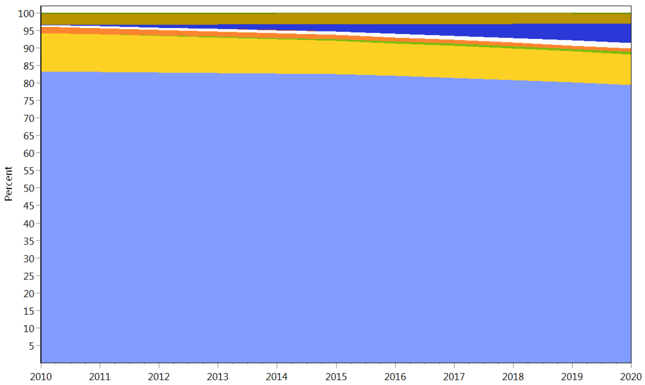


Figure 36: Rural Resource mix in MAS

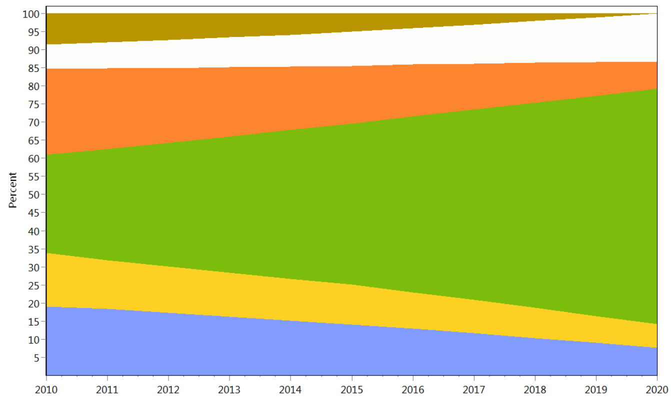


Figure 37: Urban Resource mix MAS

Animal Wastes, Biogas, Biomass, Charcoal, Electricity, Kerosene, LPG, Vegetal Wastes, Wood

4.4 Climate Resilient Scenarios (CRS)

4.4.1 Overview

The final scenario, CRS will support the development of livelihoods through the provision of inclusive access to energy. However in this case the assumption will be made that there is elevated substitution towards improved and climate proofing technologies compared. There will be minimal usage of fossil fuel for cooking and lighting purposes. This will be enforced through necessary subsidy policy changes in the implementation guide.

Whilst the CRS does not directly consider GSI in the scenario development it is assumed that increased resilience and adaptation measures will have indirect GSI impacts.

The energy demand shall be met mostly through renewable and clean energy. Use of fossil fuels will be insignificant, while there shall be some use of biomass as a form of renewable energy. Clean and efficient technology shall be utilised and maximum resource utilised on climate resilient development. It shall include substantial investment in clean and renewable energy. There shall be stringent environmental taxes and laws on carbon emissions. Cost of efficient technologies shall decrease considerably and result in wider uptake. The energy consumption shall grow in a slower pace compared to MAS.

The natural ecosystem will be fully safeguarded to ensure the sustainable supply for meeting likely demands. Substantial resource and investment will have been put to ground to manage the supply side of vulnerable resource like rivers and forests. Interventions are suggested to improve efficiency of energy technologies, improvement of energy resources and reducing vulnerability to hazards and stresses.

The consumption growth rate is as follows which have been reverse calculated through the resource mix that will fulfil the energy demand in CRS in 2020.

Energy consumption growth rate
Residential = -5%
Commercial = -0.2%
Industrial = -0.1%

4.4.2 Energy demand

The Table 34 summarises the final energy demand in the residential industrial and commercial sectors in Makwanpur for the target year range for the CRS.

Table 35: Energy demand by various sectors in CRS

Year	Residential ('000 GJ)	Commercial ('000 GJ)	Industrial ('000 GJ)	Total ('000 GJ)
2010	4,876.70	116.6	813.8	5,807.20
2011	4,781.50	116.4	812.2	5,710.10
2012	4,666.90	116.2	810.7	5,593.80
2013	4,532.40	116	809.3	5,457.70
2014	4,377.50	115.8	808.1	5,301.40
2015	4,201.90	115.5	807.1	5,124.50
2016	3,968.40	115.3	806.3	4,890.10
2017	3,729.80	115.1	805.6	4,650.50
2018	3,485.90	114.9	805.2	4,406.00
2019	3,237.00	114.7	804.9	4,156.70
2020	2,983.20	114.6	804.80	3,902.60

In CRS the shift from energy intensive and dirty technologies to clean and efficient ones will result in a significant drop in energy demand. There will be a full shift from predominantly traditional cooking stoves to ICS for cooking and water boiling in rural areas, with electric appliances also taking up a larger share. Urban cooking will be 90% electricity by 2020, with a remaining small number of ICS stoves making up the remainder. For both urban and rural lighting kerosene, lanterns and biogas lamps will be completely phased out, replaced by electricity from SHS and micro hydro.

Total residential energy consumption will decrease from 4.9 million GJ per year in the base year to 3 million GJ in 2020. The industrial sector and commercial sector outlook is also expected to be optimistic in CRS, with major industries making a switch to clean energy. Rural energy demand will decrease from 4.3 million GJ to 2.7 million GJ between 2010 and 2020, urban demand will also decrease from 0.5 million GJ to 0.23 million GJ.

In the context of rural areas energy consumption in cooking is seen to decrease significantly from 2.4 million GJ to 0.75 million GJ in 2020. Energy consumption for livestock is however not seen to decrease, however improved biomass stoves are expected to be used compared to the traditional three stone stoves that are in practice now. In terms of lighting of the total demand of 21 million kWh in 2020, electricity base provides for 19 million kWh whereas non electricity base is found to provide for 2 million kWh.

Table 36: Rural – Urban energy demand in CRS

Year	Urban ('000 GJ)	Rural ('000 GJ)
2010	549.82	4,326.84
2011	530.51	4,249.84
2012	508.34	4,156.21
2013	483.31	4,045.51
2014	455.39	3,917.34
2015	424.58	3,771.29
2016	392.28	3,568.92
2017	356.71	3,364.53
2018	317.87	3,158.24
2019	275.75	2,950.17
2020	230.35	2,740.44

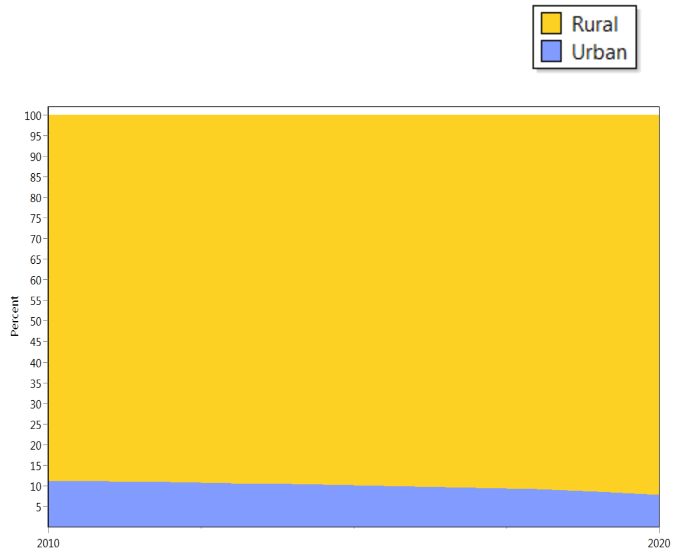


Figure 38: Energy demand by areas in CRS

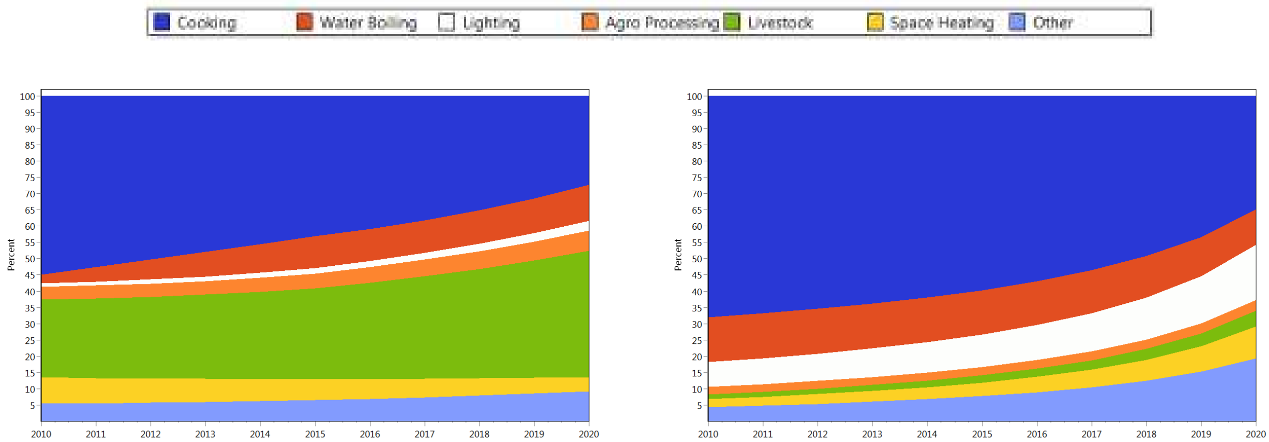


Figure 39 & 40: Rural and Urban Energy Demand by Activity in CRS

4.4.3 Energy supply

Wood fuel will still remain as the major source of fuel for cooking in rural areas in 2020. It will provide for 0.6 million GJ of the 0.75 million GJ of cooking energy demand in 2020. However the consumption of wood fuel is expected to be around the production capacity. LPG share in cooking in 2020 is accounted to be minimal, due to it being a dirty fuel as well as it being a source that is not available within the country thus raising its vulnerability to supply disruption Biogas will provide for 78,000 GJ of cooking demand compared to 128,967 GJ in 2010. It is also perceived that electricity will also contribute to at least 20% of the cooking needs, amounting to 72,700 GJ, of the rural population in 2020.Electricity is calculated to provide for 80% of all lighting demand in CRS in 2020. This is a complete turnaround from current trends where non electricity based accounts for 80% and electricity based sources accounts for 20% of the demand to be met.

Overall energy sources supply mix (at 2020)

Renewable (Hydro and Solar) = 22.2
Biomass (firewood) = 47.5
Fossil Fuel = 10.5
Biomass (others) = 19.8

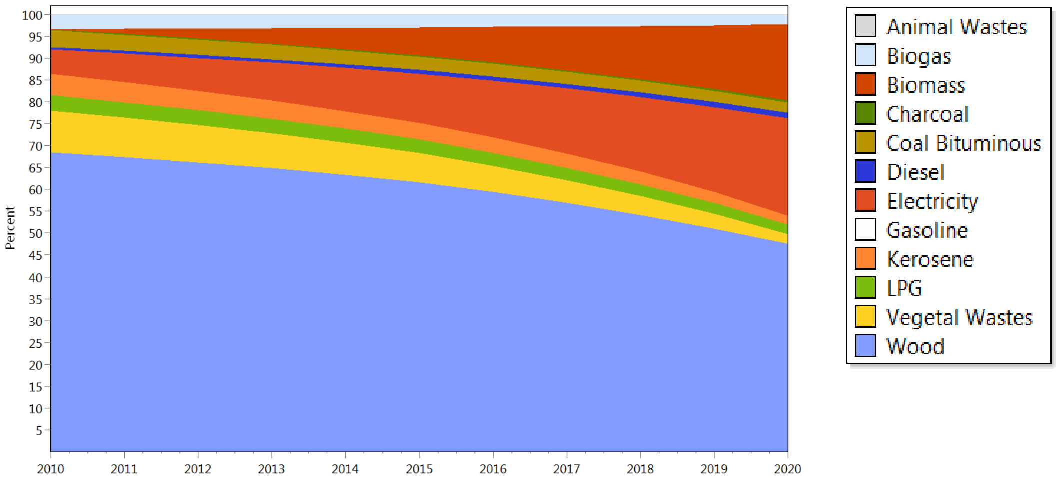


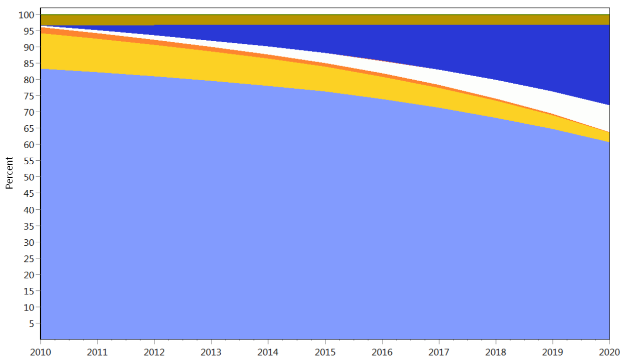
Figure 41: Energy resource mix of CRS

Rural energy sources supply mix (at 2020)

Renewable (Hydro and Solar) = 8.2
Biomass (firewood) = 60.7
Fossil Fuel = 0.3
Biomass (others) = 30.8

Urban energy sources supply mix (at 2020)

Renewable (Hydro and Solar) = 13.3
Biomass (firewood) = 7.7
Fossil Fuel = 72.5
Biomass (others) = 6.5



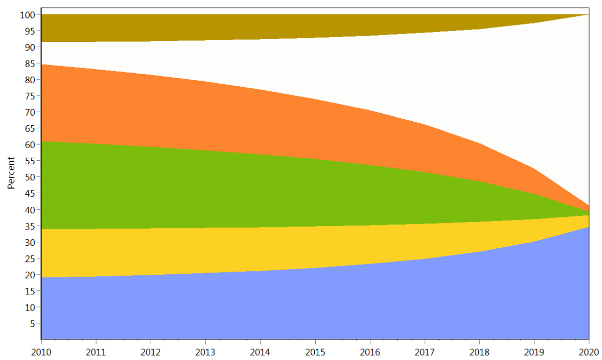


Figure 42: Rural Resource mix in CRS

Figure 43: Urban Resource mix CRS

4.5 Comparison

Figure 44 and 45 show a side by side comparison of the three scenarios in terms of the total energy demand and the GHG emission in the district of the three scenarios. Energy consumption is observed to decrease drastically from BAU to MAS to CRS due to adoption of cleaner and more efficient technologies and a general shift of the population from rural to urban areas.

It can be also be observed the BAU has the highest GHG emission in 2020 whereas as CRS has the lowest. MAS utilises a middle path thus is in between these two scenarios. This is also in line with the description of the scenarios. BAU has more inefficient and traditional technologies, MAS replaces some of these technologies thus has a lower GHG emission, whereas in CRS most inefficient and GHG emitting technologies are replaced by clean technologies. The GHG data is automatically derived from LEAP itself where it loads the technology/resources environment variable including its emission.

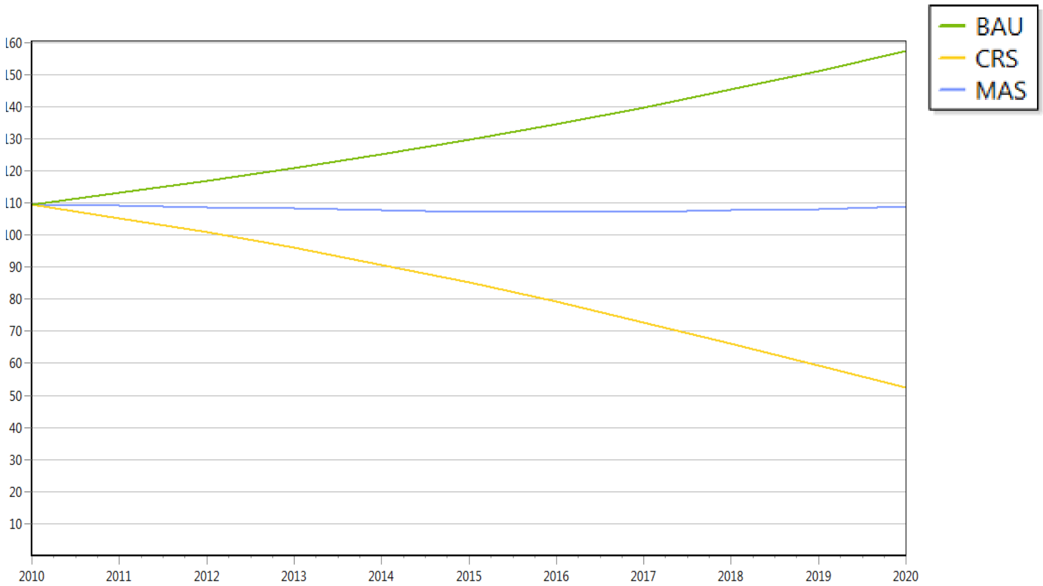


Figure 44: Overall GHG emissions for three scenarios

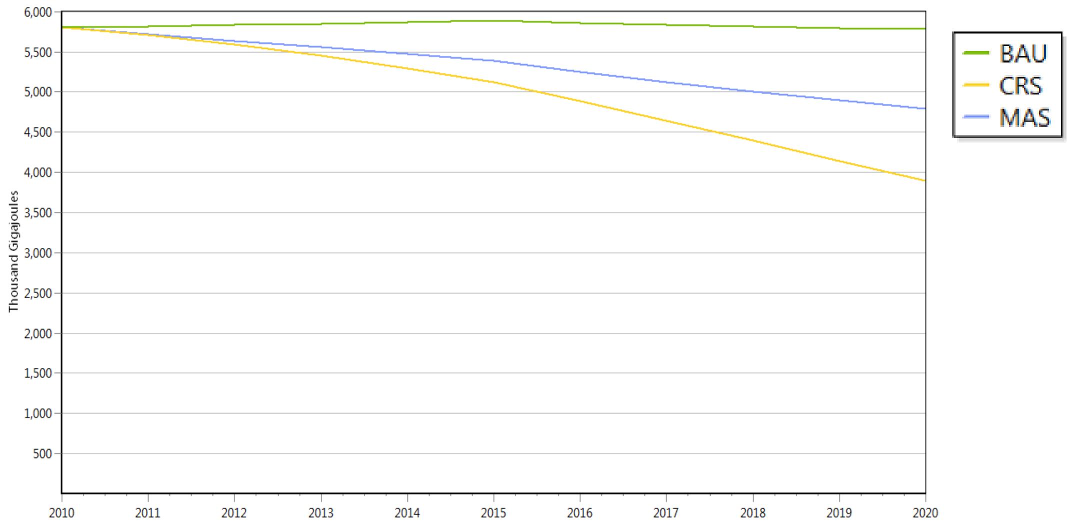


Figure 45: Overall energy consumption for three scenarios

The overall energy consumption can be further compared in terms of useful energy consumption in a particular end use per HH. The table below indicates the change in energy consumption in a HH per end use in various scenarios. These values below are based on final energy consumption. It also correlates with the need to substitute inefficient technologies with efficient ones.

Table 37: Comparison of final energy consumption per HH in cooking

	Year	2010	2015	2020
	Scenario	Energy consumption (GJ per HH)		
Rural	BAU	37.43	30.83	21.31
	MAS	37.43	25.11	16.04
	CRS	37.43	24.37	10.82
Urban	BAU	16.12	17.59	19.13
	MAS	16.12	13.10	12.65
	CRS	16.12	8.43	2.07

Table 38: Comparison of final energy consumption per HH in lighting

	Year	2010	2015	2020
	Scenario	Energy consumption (GJ per HH)		
Rural	BAU	0.73	0.71	0.66
	MAS	0.73	0.76	0.76
	CRS	0.73	0.93	1.14
Urban	BAU	1.04	1.09	1.15
	MAS	1.04	1.09	1.15
	CRS	1.04	1.09	1.15

Table 39: Comparison of final energy consumption % cooking

	Year	2010	2015	2020
	Scenario	Energy consumption (%)		
Rural	BAU	54.9	50.1	41.1
	MAS	54.9	44.9	36.9
	CRS	54.9	43.0	22.9
Urban	BAU	68.0	69.7	71.0
	MAS	68.0	65.7	65.4
	CRS	68.0	59.7	34.9

Table 40: Comparison of final energy consumption % lighting

	Year	2010	2015	2020
	Scenario	Energy consumption (%)		
Rural	BAU	1.1	1.1	1.3
	MAS	1.1	1.3	1.7
	CRS	1.1	1.7	2.9
Urban	BAU	4.4	4.3	4.3
	MAS	4.4	5.5	5.9
	CRS	4.4	7.8	19.4

5 DCEP Implementation Plan

5.1 Introduction

This chapter looks into the detailed planning for 3 years on the MAS and CRS scenarios. The planning for scenario is based on the inputs provided from the district planning workshop, fact finding field visits conducted in Makwanpur, DEPP for Makwanpur and all issues and impacts related to climate change. The planning will also look in to making the plan GSI inclusive.

The chapter will focus more on planning for rural residential sector. In line with the scenarios presented in Chapter 4, various scales of interventions have been set for a number of RET technologies, along with capacity building activities and other support activities needed for DCEP. The interventions that are put forward have been back cast from the energy shares that are prescribed for a scenario in 2020.

The planning for IWM has been carried out in such a way that all the potential traditional water mills in Makwanpur improved by the year 2020 in both the scenarios.

5.2 Existing policies to implement proposed plan

DDC has already adopted the DEPP that outlined renewable energy as a key intervention in providing energy services in the district. The key strategies adopted by DDC are:

- Development of RE resources based on community ownership and joint financing by community and local and central government.
- Conduct feasibility studies
- Increase awareness to increase growth of RE sector
- Prioritising RE projects for densely populated areas and
- Development of a clean energy village
- Utilisation of CDM mechanism where feasible

In addition to local government commitments, the central government has a national level programme under which the district can benefit as well. Renewable Energy Subsidy Arrangement provides for about 50% capital cost subsidy for installing micro and pico hydro. Dissemination of solar home systems, biogas and other renewable energy technologies are also provided with subsidy ranging from 25-40% of the installation costs on average.

These policies will have positive implication in implementing DCEP in micro hydro by assisting financing options. Policies at both central and local level also provide technical assistances for capacity building and awareness activities in the field.

5.3 Detail Implementation Plan

The framework below presents the detailed implementation plan for two scenarios, MAS and CRS, for three years starting from 2011/12 to 2013/14. The difference between the two scenarios can be observed by the scale of interventions, while most of the other capacity building and support activities remain the same.

With regards to delivery of the plan, all stakeholders need to operate in coordination for effective service and supply delivery. Besides the central government (AEPC) and DDC, other line agencies as well as NGOs, CBOs and the private sector need to play their role in delivering the targeted output. Some of the district based NGOs and private companies engaged in RE sector have already been mentioned in chapter 3. All RET service providers in Makwanpur are presented in Annex 11

Makwanpur has 15 companies providing biogas services and 20 solar companies eligible for carrying out manufacturing, installation and dissemination of SHS up to 100 kW under the RET subsidy program. There are also a total of 36 qualified solar companies for manufacturing, installation and dissemination of SSHS up to 5 kW capacity. For micro/pico-hydro installations, there are 17 companies eligible for carrying out manufacturing and installation of up to 100 kW capacity, 3 companies eligible for carrying out manufacturing and installation of up to 5 kW capacity and 2 companies eligible for carrying out installation of up 5 kW capacities (DEPP, 2009). In case of ICS, local NGOs and CRT/N are providing services for ICS promotion and dissemination.

There are a further 15 NGOs working in environment protection in Makwanpur that can mobilised to support DCEPs. 20 commercial banks have branches in Makwanpur, though most of them operate from Hetauda. There are more than 300 co-operatives of various interests in the district.

All these institutions can be mobilised and utilised within their capacity to fulfil the responsibility requirement to attain the desired target of the DCEP.

Table 41: Detail Implementation Plan for MAS and CRS

Description	Target(■: MAS ■: CRS)			Activity	How	Where	Who	Risk/Assumption
	2011/12	2012/13	2013/14					
Improved Cook Stove (units)	4012 / 6,109	3911 / 6,062	6143 / 10,387	Installation of ICS	Through ICS promoters based on demand.	Prioritized areas are Silwalik range VDCs and Kankada, Khairang and Raksirant VDCs	CBO, NGO, ICS Promoters	1. The assumption is that enough promoters are trained to install the required scale. However the risk is that in following years promoting ICS might not necessarily be a viable income generating activities. Thus private sector might need to be influenced for ICS dissemination through CDM.
				Financial support towards installation of ICS.	Promotion through financial support provided by DDC for installation. VDCs provide extra support for ethnic groups and indigenous group like Chepang.	Prioritized areas are Silwalik range VDCs and Kankada, Khairang and Raksirant VDCs	DEEU,NGO	
				Promotion and awareness of ICS and its benefits	Promotion and awareness through knowledge products on reduction of indoor air pollution through ICS, savings in wood fuel etc.	District wide	DEEU,NGO, CBO	
				Monitoring	DEEU assigns consultant for monitoring of scale of intervention as well as quality of intervention	Sample VDCs from prioritized and intervened areas	DEEU, Consultant	
	1	1	1	Training for ICS promoters	DEEU conducts training for new ICS promoters each year. An estimated 25 new promoters through each training event are needed to match the target set in MAS/CRS as well as the high dropout rate of promoters.	Hetauda	AEPC, DEEU	
Biogas (units)	97 / 97	97 / 97	97 / 97	Installation of biogas plant	Through biogas companies as per demand.	Aambhanjhyang, Bajrabarahi, Daman and Makwanpurgadhi VDCs which have a high untapped biogas potential	Biogas companies	1. The scale of interventions is just for new biogas plants. It might be the case that a HH might choose to install a new biogas plant to replace their old one. However such considerations have not been taken into account here.
				Subsidy provision as per subsidy policy	AEPC provides subsidy	Target areas spelled out in AEPC's subsidy policy	CREF/AEPC	
				Provide after sales service	Biogas companies	As per requirement of biogas owners	Biogas companies	
				Monitoring	DEEU assigns consultant for monitoring of scale of intervention as well as quality of intervention	Sample VDCs from prioritized and intervened areas.	DEEU, Consultant	
				Provide operation and maintenance training for biogas users	Biogas companies provide on-site training to users after installation	Installation site	Biogas companies	

Solar Home System (units)	**735** **1,458**	**782** **1485**	**828** **1512**	Installation of SHS	Through solar companies as per demand.	Prioritized areas are VDCs in north west Makwanpur and Tistung, Betini, Kankada, Dhandakharka, Dhiyal, Bharda, Raigaun, Sukaura VDCs	Solar companies	1. There is no such evidence on increasing cloud cover or increasing hailstorm incidence in Makwanpur which might adversely impact the performance of SHS, therefore it is assumed that current situations are likely to remain.
				Subsidy provision as per subsidy policy	AEPC provides subsidy	Target areas spelled out in AEPC's subsidy policy	CREF/AEPC	
				Promotion and awareness of SHS	Promotion through financial support provided by DDC for installation. VDCs provide extra support for ethnic groups and indigenous group like Chepang. Knowledge products also developed on SHS benefits including using it against kerosene.	Prioritized areas are VDCs in north west Makwanpur and Tistung, Betini, Kankada, Dhandakharka, Dhiyal, Bharda, Raigaun, Sukaura VDCs	DEEU, NGO, Solar Companies	
				Promotion and awareness of safe battery disposal	Knowledge products developed for battery disposal. Collection centres established for battery disposal.	District wide	AEPC, DEEU	
				Provide after sales service	Solar companies		Solar companies	
				Operation and maintenance training to SHS users	Solar companies provide user training to users after installation	Installation site	Solar companies	
				Monitoring	DEEU assigns consultant for monitoring of scale of intervention as well as quality of intervention	Sample VDCs from prioritized and intervened areas.	DEEU, Consultant	
Micro/ Pico Hydro (kW)is e	**14.3** **33.1**	**15** **33.7**	**15.7** **34.3**	Installation through micro hydro, pico hydro and IWM electrification	Installation through PQ companies. Sites are determined through feasibility study reports.	Feasible sites	Micro/Pico hydro companies, NGO	1. Micro/pico hydro and electrification through IWM has been lumped together for planning purposes. The planning is for electricity first and the through resource second.
				Provide subsidy as per subsidy policy	AEPC provides subsidy to pre-qualified manufacturers and installers	Target areas spelled out in AEPC's subsidy policy	CREF/AEPC	
				Financial Support for pico hydro systems and water mill electrification	DDC provides financial support for pico hydro and electrification through IWM	Feasible sites	DEEU	

				Feasibility study for micro hydro and IWM electrification potential.	Conduct feasibility study amongst other in Rapti, Bagmati, Bakaiya, Manahari and Lothar rivers for micro hydro potential. See Annex for detail list of rivers. Also conduct feasibility study of available long shaft IWM for electrification. The feasibility study also needs components of vulnerability assessment of infrastructure and resource.	District wide	Consultant	Therefore since these technologies all share the same resource and produce the same output, they have been put together.
				Promote end use diversification of micro hydro	DEEU allocates resources for promotion. NGO, AEPC provide incentive and awareness on diversified livelihood option through electricity.	Prioritized areas are VDCs in north west Makwanpur and Tistung, Betini, Kankada, Dhandakharka, Dhiyal, Bharda, Raigaun, Sukaura VDCs	NGO,AEPC, DEEU	
				Resources for micro-hydro rehabilitation, relocation and major repair and maintenance	AEPC provides 50% of the installation cost subsidy but not more than NPR 62,500 per kW generated for systems 5kW upward.		AEPC	
					DEEU needs to allocate resources for other needs of relocation and rehabilitation, major repair and maintenance of systems below 5 kW.	Sites identified through DEEU	DEEU	
				Monitoring	DEEU assigns consultant for monitoring of scale of intervention as well as quality of intervention	Installed sites	DEEU, Consultant	
Improved Water Mill	30 30	30 30	30 30	Installation of IWM	Through PQ IWM manufacturers and installers. GOA and service centre involved as per the installation and planning process of IWM.	Sites with traditional water mill as well as those where there could be potential.	NGO, CBO, PQ companies	1. Planning for IWM is only considered for agro processing purposes and not for other end uses.
				Subsidy provision(for grinding)	AEPC provides subsidy	Target areas from AEPC's subsidy policy	AEPC	
				Provide after sales service	IWM manufacturers and installers	As per requirement	IWM companies	
				Monitoring	DEEU assigns consultant for monitoring of scale of intervention as well as quality of intervention	Installed sites	DEEU, Consultant	
				Provide resources for IWM rehabilitation and relocation	AEPC to provide 50% of the installation cost for sites indentified through the DEEU for rehabilitation and relocation.	Identified sites	AEPC, DEEU	

				Promote end use diversification of IWM	AEPC provides support through subsidy.	Long shaft improved water mill.	IWM companies, NGO, AEPC	
Capacity building/ training				Promote and create access to finance for RETS.	Create awareness to promote RET as viable portfolios for finance institutions(FIs) Also invest in building capacities of FIs in RET. Provide other technical assistances (project appraisal, monitoring etc)	Kathmandu; Hetauda	CREF/AEPC	
	1			Training of RET stakeholders, including VDCs, on climate change related issues	DEEU conducts workshop/training on climate change related issues like impact, adaptation, mitigation, vulnerability and most importantly the implications on the renewable energy sector.	Hetauda	DEEU, NGO	
	1	1	1	Training on business development to RET companies including NGO and CBO	DEEU with the help from AEPC or other development agencies conducts training for RET companies on business development. Specific focus will be provided on business plan development and matching human resource, financial resources to demand in district	Hetauda	DEEU, AEPC,	
	1	1	1	Provide training on integrated water resource and forest management to VDCs and community based organisations	DEEU with the help from other development agencies and in liaison with government line agencies provides the training to selected CBOs, micro hydro associated cooperatives etc	Hetauda	NGO, AEPC, DEEU	
Support				Vulnerability assessment of VDCs	Community based vulnerability assessment	All VDCs	Consultant, NGO	
				Monitoring of climate adaptation need for prioritized intervention areas	Conduction of community based climate change vulnerability assessment of technology, resource, community intervention needs etc. Resource and technology based on water and forests have to be monitored for adaptation needs.	Highly vulnerable VDCs; Ultra poor VDCs from district poverty index; Site specific	DEEU, Consultant	

				Awareness of climate change issues through knowledge products including indigenous knowledge systems	DEEU generates knowledge products on climate change related issues like impact, adaptation, mitigation, vulnerability and most importantly the implications on the renewable energy sector. Also promotion of proven indigenous adaptation methods if any. Promote awareness of sustainable forests management through knowledge products	District wide	DEEU	
				Data collection to collate disaggregated data on RE based on gender and ethnicity	DEEU assign consultant to carry out a survey in sample VDCs.	District wide	Consultant	
				Liaison between government line agencies for hazard preparedness	Liaison between government line agencies like DDC, DFO, DIO, DADO for resource and infrastructure safeguarding through preparedness. One meeting every three months on learning and sharing and setting priority areas.	Hetauda	DDC,	
				Integrated watershed management	District Soil Conservation Office works in collaboration with DDC and DFO to safeguard watershed of major rivers of Makwanpur to address the issues of, soil erosion, hazards, deforestation, unsustainable community practices etc all of which affect the water quality and flow of the rivers.	Identified watersheds of important rivers. More specifically watersheds of Rapti, Bagmati, Bakaiya, Manahari and Lothar rivers.	District Soil Conservation Office, DFO, DDC, NGO	

5.4 Financing Plan

This section deals with investment requirement for three years to achieve the scale of interventions for the two scenarios MAS and CRS. Table 37 and Table 38 provide the budgetary requirement for MAS and CRS respectively. To carry out the analysis of investment required to implement the intervention in the two scenarios the inflation factor has been disregarded. This allows for a more thorough analysis of the cost requirements in the present context. The cost per unit of the technologies is listed below.

Technology	Cost (NRs.)
Improved Cook Stove	250
Biogas	48,600
Micro/Pico Hydro	265,00 per kW
Solar Home System	20,000 for 20 Wp
IWM	15,000

In case of pico-hydro systems it is difficult to disaggregate it for analysis are there exists various ranges of such systems. It has been amalgamated with micro hydro for planning purposes, as the cost per kilowatt or watt would be around the same figure. For the purpose of analysis it has also been taken into consideration that the subsidy amounts from AEPC and from DDC are also to remain constant throughout the planning years. The current subsidy policy for some of the technologies is presented in the table below.

Table 42: Subsidy policy for various RETs

Resource	Technology	Cost(NRs.)	Subsidy
Wood fuel	Improved Cook Stove	250	0
	Metallic Stove	7000	2700 for 2 pot 4000 for 3 pot
Biogas	Biogas Stoves (2,4,6cm^3)	48,600	12000 + 700 (2500 for marginalised) (4000 for toilet attached)
Solar	10-18 Wp	1000/Wp	5000
	20 Wp	20000	6000
	Institutional		75% not exceeding 15,000
Micro-Hydro	IWM	15000	12,000 for Grinding (27,000 for other end uses) (6000/HH up to 5kW up to 60,000 per kW)
	5 kW	265,000/kW	12000/HH no more than 97,500 per kW
	5kW to 500KW		15,000/HH no more than 125,000 per kW
	5kW to 500KW(rehabilitation)		50% of the installation cost subsidy will not be more than NPR 62,500 per kW generated.
	Institutional and community use		97,500 extra
	Transportation		500 per KM per kW, not exceeding 10KM and 30,000 per KW generated
	Productive use		10,000 per KW not exceeding 250,000 per project

Source: AEPC, 2009b

In addition to these subsidies the DDC also has allocated financial resources towards the promotion of RETs in the district. The support is directed towards particular VDCs and sector that are deemed important. The budgetary allocation of DDC for this fiscal year is summarised in the table below. In the investment analysis that is to follow the subsidy amount and the budget allocation of DDC has been taken into account as whole in regards to a particular RET and not separately as per target areas.

Table 43: Budget set aside FY 2010/11 by DDC

S.N.	Description	Resources Allocated
1	Peltric set	900,000.00
2	Rural Electrification from IWM	600,000.00
3	Solar Energy Programme	200,000.00
4	Solar Energy Programme in LGCDP 5 Programme VDCs	2,600,000.00
5	Solar Energy Programme for indigenous community (Kankada VDC)	300,000.00
6	Promotion of ICS in Chore range VDCs	100,000.00
7	Solar water pumping in Khairang VDC	400,000.00
	Subtotal A	5,100,000.00
8	Grid extension in Kulekhani affected areas (Upstream of Kulekhani HEP)	43,75,000
9	Grid extension in other VDCs of the district	38,50,000
	Subtotal B	82,25,000
	Total: Subtotal A + Subtotal B	**1,33,25,000**

Source: DDC Makwanpur

5.4.1 Medium Adaptation Scenario

In MAS from 2011/12 to 2013/2014 the there shall be a total of 14,066 ICS installed, the total cost of which shall be around 3.5 million rupees. It is recommended that the DDC allocate around 4 million rupees in three years for activities including promotion, awareness raising, monitoring and training to ICS promoters.

The total cost of biogas plants that are to be installed during this period is 14.1 million rupees whereas the subsidy disbursed through AEPC will be 3.7 million rupees. DDC shall allocate around 0.74 million rupees for monitoring purposes. The credit requirement is considered to be 2/3 of the deficit between subsidy user cost and subsidy. For biogas the credit requirement for three years is around 6.9 million rupees.

The total investment for users for SHS shall be around 46.9 million in three years. With this investment there shall be a total of 2,345 SHS installed in Makwanpur. AEPC's subsidy contribution shall be around 14 million where as the DDC shall allocate 6.8 million rupees for various purposes including promotion and awareness, development of knowledge products, financial support and monitoring. The credit requirement for the scale of intervention is calculated to be around 21 million rupees.

In the case of pico and micro hydro and estimated 12 million rupees initial investment is required to install capacity of 45 kW. AEPC's subsidy is estimated to be around 4.4 million rupees. However this calculation has taken into consideration subsidy as 97,500 rupees per kW. Dad's total investment shall be 4.7 million rupees. The credit requirement has been calculated to be around 5 million rupees. Similarly for IWM the user investment is 1.4 million rupees. AEPC's subsidy disbursement shall be around 1.1 million for 90 IWM.

A total of 1.8 million rupees is required for various capacity building activities where as it has been estimated that the requirement for other support activities is around 2.3 million rupees. The details of the financing requirement along with the financer responsible for medium adaptation scenario are presented in table 37.

Table 44: Financing requirement for MAS

Description	Activity	Unit Costs NPR	Budget responsibility	Budget in NPR 2011/12	2012/13	2013/14
Improved Cook Stove (units)	Installation of ICS	250	Users	1,003,000	977,750	1,535,750
	Financial support towards installation of ICS.	200	DDC	802,400	782,200	1,228,600
	Promotion and awareness of ICS and its benefits	10% of total cost	DDC	100,300	97,775	153,575
	Monitoring	20% of DDC investment (financial support+ promotion)	DDC	180,540	175,995	276,435
	Training for ICS promoters	100000	DDC	100,000	100,000	100,000
Biogas (units)	Installation of biogas plant	48600	Users	4,714,200	4,714,200	4,714,200
	Subsidy provision as per subsidy policy	12700	AEPC	1,231,900	1,231,900	1,231,900
	Provide after sales service	as per		as per	as per	as per
	Monitoring	20% of AEPC subsidy investment	DDC	246,380	246,380	246,380
	Provide operation and maintenance training for biogas users	as per		as per	as per	as per
Solar Home System (units)	Installation of SHS	20000	Users	14,700,000	15,640,000	16,560,000
	Subsidy provision as per subsidy policy	6000	AEPC	4,410,000	4,692,000	4,968,000
	Promotion and awareness of SHS	10% of total cost	DDC	1,470,000	1,564,000	1,656,000
	Promotion and awareness of safe battery disposal	2% of total cost	DDC	294,000	312,800	331,200
	Provide after sales service	as per		as per	as per	as per
	Operation and maintenance training to SHS users	as per		as per	as per	as per
	Monitoring	20% of DDC investment	DDC	352,800	375,360	397,440
Micro/ Pico Hydro (kW)	Installation through micro hydro, pico hydro and IWM electrification	265000	Users	3,800,100	3,977,650	4,157,850
	Provide subsidy as per subsidy policy	97500	AEPC	1,398,150	1,463,475	1,529,775
	Financial Support for pico hydro systems and water mill electrification	20% of total cost	DDC	760,020	795,530	831,570
	Feasibility study for micro hydro and IWM electrification potential.	as per		as per	as per	as per
	Promote end use diversification of micro hydro	10% of total cost	DDC	380,010	397,765	415,785
	Resources for micro-hydro rehabilitation,		AEPC	as per	as per	as per
	relocation and major repair and maintenance	2.5% of total cost	DDC	95,003	99,441	103,946
	Monitoring	20% of DDC	DDC	247,007	258,547	270,260

		investment				
Improved Water Mill	Installation of IWM	15000	Users	450,000	450,000	450,000
	Subsidy provision(for grinding)	12000	AEPC	360,000	360,000	360,000
	Provide after sales service	as per		as per	as per	as per
	Monitoring	20% of AEPC subsidy investment	DDC	72,000	72,000	72,000
	Provide resources for IWM rehabilitation and relocation	as per	AEPC	as per	as per	as per
	Promote end use diversification of IWM	27000	AEPC	as per	as per	as per
Capacity building/ training	Promote and create access to finance for RETS	5.0% of credit requirement	AEPC	533,750	111,834	116,836
	Training of RET stakeholders on climate change related issues	150,000	AEPC	150,000		
	Training on business development to RET companies including NGO and CBO	150000	AEPC	150,000	150,000	150,000
	Provide training on integrated water resource management to community based organisations	150000	AEPC	150,000	150,000	150,000
Support	Vulnerability assessment of VDCs	1,000,000	DDC	1,000,000		
	Monitoring of climate adaptation need for prioritized intervention areas	500,000	DDC		500,000	
	Awareness of climate change issues through knowledge products including indigenous knowledge systems	100,000	DDC	100,000	100,000	100,000
	Liaison between government line agencies for hazard preparedness	15000	DDC	60000	60000	60000
	Data collection to collate disaggregated data on RE based on gender and ethnicity	300,000	DDC	300,000		
	Total			39,611,560	39,856,602	42,167,502

5.4.2 Climate Resilient Scenario

In CRS from 2011/12 to 2013/2014 the there shall be a total of 22,558 ICS installed, the total cost of which shall be around 5.6 million rupees. The DDC shall allocate around 7.5 million rupees in three years for various activities including promotion, awareness raising, monitoring and training to ICS promoters.

The total cost of biogas plants that are to be installed during this period is 14.1 million rupees whereas the subsidy disbursed through AEPC will be 3.7 million rupees. DDC shall allocate around 0.74 million rupees for monitoring purposes. For biogas the credit requirement for three years is around 6.9 million rupees.

The total investment for users for SHS shall be around 89 million rupees in three years. With this investment there shall be a total of 4,455 SHS installed in Makwanpur. AEPC's subsidy contribution shall be around 26.7 million where as the DDC shall allocate additional 12.8 million rupees for various purposes including promotion and awareness, development of knowledge products, financial support and monitoring. The credit requirement for the scale of intervention is calculated to be around 41.2 million rupees.

In the case of pico and micro hydro and estimated 26.8 million rupees initial investment is required to install capacity of 101 kW. AEPC's subsidy is estimated to be around 9.9 million rupees. Dad's total investment shall be 10.4 million rupees which also includes support for pico hydro systems. The credit requirement has been calculated to be around 11.2 million rupees. Similarly for IWM the user investment is 1.4 million rupees. AEPC's subsidy disbursement shall be around 1.1 million for 90 IWM.

A total of 1.8 million rupees is required for various capacity building activities where as it has been estimated that the requirement for other support activities is around 2.3 million rupees. The details of the financing requirement along with the financer responsible for climate resilient scenario are presented in table 38.

Table 45: Financing requirement for CRS

Description	Activity	Unit Costs NPR	Budget responsibility	Budget in NPR		
				2011/12	2012/13	2013/14
Improved Cook Stove (units)	Installation of ICS	250	Users	1,527,250	1,515,500	2,596,750
	Financial support towards installation of ICS.	200	DDC	1,221,800	1,212,400	2,077,400
	Promotion and awareness of ICS and its benefits	10% of total cost	DDC	152,725	151,550	259,675
	Monitoring	20% of DDC investment (financial support+ promotion)	DDC	274,905	272,790	467,415
	Training for ICS promoters	100000	DDC	200,000	400,000	800,000
Biogas (units)	Installation of biogas plant	48600	Users	4,714,200	4,714,200	4,714,200
	Subsidy provision as per subsidy policy	12700	AEPC	1,231,900	1,231,900	1,231,900
	Provide after sales service	as per		as per	as per	as per
	Monitoring	20% of AEPC subsidy investment	DDC	246,380	246,380	246,380
	Provide operation and maintenance training for biogas users	as per		as per	as per	as per
Solar Home System (units)	Installation of SHS	20000	Users	29,160,000	29,700,000	30,240,000
	Subsidy provision as per subsidy policy	6000	AEPC	8,748,000	8,910,000	9,072,000
	Promotion and awareness of SHS	10% of total cost	DDC	2,916,000	2,970,000	3,024,000
	Promotion and awareness of safe battery disposal	2% of total cost	DDC	583,200	594,000	604,800
	Provide after sales service	as per		as per	as per	as per
	Operation and maintenance training to SHS users	as per		as per	as per	as per
	Monitoring	20% of DDC investment	DDC	699,840	712,800	725,760
Micro/ Pico Hydro (kW)	Installation through micro hydro, pico hydro and IWM electrification	265000	Users	8,763,550	8,925,200	9,084,200
	Provide subsidy as per subsidy policy	97500	AEPC	3,224,325	3,283,800	3,342,300
	Financial Support for pico hydro systems and water mill electrification	20% of total cost	DDC	1,752,710	1,785,040	1,816,840
	Feasibility study for micro hydro and IWM	as per		as per	as per	as per

	electrification potential.					
	Promote end use diversification of micro hydro	10% of total cost	DDC	876,355	892,520	908,420
	Resources for micro-hydro rehabilitation, relocation and major repair and maintenance		AEPC	as per	as per	as per
		2.5% of total cost	DDC	219,089	223,130	227,105
	Monitoring	20% of DDC investment	DDC	569,631	580,138	590,473
Improved Water Mill	Installation of IWM	15000	Users	450,000	450,000	450,000
	Subsidy provision(for grinding)	12000	AEPC	360,000	360,000	360,000
	Provide after sales service	as per		as per	as per	as per
	Monitoring	20% of AEPC subsidy investment	DDC	72,000	72,000	72,000
	Provide resources for IWM rehabilitation and relocation	as per	AEPC	as per	as per	as per
	Promote end use diversification of IWM	27000	AEPC	as per	as per	as per
Capacity building/ training	Promote and create access to finance for RETS	5.0% of credit requirement	AEPC	971,306	197,430	200,589
	Training of RET stakeholders on climate change related issues	150,000	AEPC	150,000		
	Training on business development to RET companies including NGO and CBO	150000	AEPC	150,000	150,000	150,000
	Provide training on integrated water resource management to community based organisations	150000	AEPC	150,000	150,000	150,000
Support	Vulnerability assessment of VDCs	1,000,000	DDC	1,000,000		
	Monitoring of climate adaptation need for prioritized intervention areas	500,000	DDC		500,000	
	Awareness of climate change issues through knowledge products including indigenous knowledge systems	100,000	DDC	100,000	100,000	100,000
	Liaison between government line agencies for hazard preparedness	15000	DDC	60000	60000	60000
	Data collection to collate disaggregated data on RE based on gender and ethnicity	300,000	DDC	300,000		

5.5 Monitoring and Evaluation Plan

The monitoring and evaluation plan for MAS is presented in table 39. Similar framework and indicators, means of verification, source of information can be used for CRS, as the only difference between the two is the scale of interventions.

DEEU together with DEECC in Makwanpur shall be the main coordinating and facilitating agency for monitoring and evaluation. Most of the activities and their outputs are to be monitored in an annual basis. DEEU shall assign consultant where necessary to carry out the monitoring necessary. The monitoring and evaluation of the interventions, quality, user satisfaction, promotion and awareness etc is not possible without adequate support from AEPC, implementing partners, RET companies, NGOs and CBOs.

Table 46: Monitoring and evaluation plan for MAS

MAS Description	Target 2011/12	Target 2012/13	Target 2013/14	Activity	Verifiable Indicators	Means of verification	Frequency of information collection	Responsible for verification	Support
Improved Cook Stove (units)	4012	3911	6143	Installation of ICS	Target number of ICS for each year are installed and are operational	End of year monitoring; ICS programme annual report	Annually	DEEU, Consultant	Implementing partner, NGOs, ICS promoters
				Financial support towards installation of ICS.	Finance required is reflected on DDC's annual budget for alternative energy and is spent as per implementation plan.	DDC annual budget	Annually	DEEU	
				Promotion and awareness of ICS and its benefits	At least two knowledge products developed on indoor air pollution and savings in firewood and dispersed in all VDCs	End of year monitoring	Annually	DEEU, Consultant	NGO
				Monitoring	A yearly monitoring report is produced on ICS with user survey, scale of intervention and quality of intervention	Monitoring and evaluation report	Annually	Consultant, DEEU	AEPC
	1	1	1	Training for ICS promoters	25 persons are trained on the process of ICS installation each year	Training completion report	Annually	DEEU	AEPC, NGO
Biogas (units)	97	97	97	Installation of biogas plant	Target number of Biogas for each year are installed and are operational	End of year monitoring; BSP annual report	Annual	DEEU,BSP, Consultant	Biogas companies
				Subsidy provision as per subsidy policy	All biogas plants installed through pre qualified companies have been provided subsidy as per AEPC's subsidy policy	Subsidy approval document	As when	DEEU	AEPC, BSP
				Provide after sales service	At least 95% of biogas installed HHs have access to after sales service and at least 80% are satisfied with the service	Biogas user survey; End of year monitoring report	Annually	DEEU, Consultant	BSP
				Monitoring	A yearly monitoring report is produced on Biogas with user survey, scale of intervention and quality of intervention	Monitoring and evaluation report	Annual	DEEU,BSP, Consultant	AEPC
				Provide operation and maintenance	At least one member of the biogas installed HH has been	Biogas user survey; End of	Annually	DEEU, Consultant	BSP

				training for biogas users	trained on operation and maintenance of biogas plants	year monitoring report			
Solar Home System(units)	735	782	828	Installation of SHS	Target number of SHS for each year are installed and are operational	End of year monitoring; ESAP annual report	Annual	DEEU,ESAP, Consultant	Solar companies
				Subsidy provision as per subsidy policy	All SHS installed through pre qualified companies have been provided subsidy as per AEPC's subsidy policy	Subsidy approval document	As when	DEEU	AEPC, ESAP, solar companies
				Promotion and awareness of SHS	Finance required is reflected on DDC's annual budget for alternative energy and is spent as per implementation plan; At least 50% increase in uptake of SHS in prioritised areas as per implementation plan	End of year monitoring	Annually	DEEU, Consultant	Solar companies
				Promotion and awareness of safe battery disposal	One brochure developed each for safe battery disposal and benefits of SHS against kerosene. Battery disposal collection centres established in Palung and Hetauda.	End of year monitoring	Annually	DEEU	AEPC,NGO
				Provide after sales service	At least 95% of SHSs installed HHs have access to after sales service and at least 80% are satisfied with the service	SHS user survey; End of year monitoring report	Annually	DEEU, Consultant	AEPC, Solar companies
				Operation and maintenance training to SHS users	At least one member of the SHS installed HH has been trained on operation and maintenance of SHS plants	SHS user survey; End of year monitoring report	Annually	DEEU, Consultant	AEPC, Solar companies
				Monitoring	A yearly monitoring report is produced on SHS with user survey, scale of intervention and quality of intervention	Monitoring and evaluation report	Annual	DEEU,AEPC, Consultant	Solar companies
Micro/Pico Hydro(kW)	14.34	15.01	15.69	Installation through micro hydro, pico hydro and IWM electrification	Target capacity for each year is obtained through install of micro hydro, pico hydro or through IWM electrification	End of year monitoring; AEPC annual report	Annual	DEEU, Consultant	Hydro companies
				Provide subsidy as per subsidy policy	All systems installed through pre qualified companies have been provided subsidy as per AEPC's subsidy policy	Subsidy approval document	As when	DEEU	AEPC, hydro companies

				Financial Support for pico hydro systems and water mill electrification	Finance required is reflected on DDC's annual budget for alternative energy and is spent as per implementation plan.	DDC annual budget	Annually	DEEU	
				Feasibility study for micro hydro and IWM electrification potential.	At least 5 sites are studied each for feasibility of micro hydro or IWM electrification	Feasibility study report; End of year monitoring report	As when	DEEU	Consultant
				Promote end use diversification of micro hydro	At least 25% of all HHs benefitting from micro hydro are using electricity for purposes other than lighting	End of year monitoring report Micro hydro user survey	Annually	DEEU	AEPC, Hydro companies
				Resources for micro-hydro rehabilitation, relocation and major repair and maintenance	All systems installed through PQ companies are provided financial support by AEPC for relocation and rehabilitation; DDC allocates additional resource as per financing plan for the same purpose for pico hydro as well	DDC annual budget; Subsidy approval sheet	As when	DEEU	AEPC
				Monitoring	A yearly monitoring report is produced on micro and pico hydro with user survey, scale of intervention and quality of intervention	Monitoring and evaluation report	Annual	DEEU,AEPC, Consultant	Hydro companies
Improved Water Mill	30	30	30	Installation of IWM	Target number of traditional water mills improved for each year is obtained.	End of year monitoring; Implementing partner annual report	Annual	DEEU, Consultant	IWM companies
				Subsidy provision(for grinding)	All systems installed through pre qualified companies have been provided subsidy as per AEPC's subsidy policy	Subsidy approval document	As when	DEEU	AEPC, IWM companies
				Provide after sales service	At least 95% of IWM owners have access to after sales service and at least 80% are satisfied with the service	IWM user survey; End of year monitoring report	Annually	DEEU, Consultant	AEPC
				Monitoring	A yearly monitoring report is produced on IWM with user survey, scale of intervention and quality of intervention	Monitoring and evaluation report	Annual	DEEU,AEPC, Consultant	IWM companies
				Provide resources for IWM rehabilitation and	DDC and or AEPC allocates additional resource as per financing plan for the same	DDC annual budget; Subsidy approval sheet	As when	DEEU	AEPC

				relocation	purpose for pico hydro as well				
				Promote end use diversification of IWM	At least 5 IWM each year adopt other end uses beside grinding	IWM user survey; End of year monitoring report; IWM annual report	Annually	DEEU, AEPC	IWM companies
Capacity building/training				Promote and create access to finance for RETS	Finance institution provide financing for RETs including biogas, micro/pico hydro and SHS	End of year monitoring	Annually	DEEU, AEPC	All private companies
	1			Training of RET stakeholders on climate change related issues	A district wide training is held through which at least 75 persons from 30 organisations are imparted knowledge on climate change issues.	Training completion report	Once	DEEU	AEPC, NGO
	1	1	1	Training on business development to RET companies including NGO and CBO	A district wide training is held each year through which each year at least 50 persons from 25 organisations are trained on business development aspects.	Training completion report; End of year monitoring	Annually	DEEU	AEPC, NGO
	1	1	1	Provide training on integrated water resource management and forest management to community based organisations	A district wide training is held each year through which each year at least 50 persons from 25 organisations are trained on integrated water resource management.	Training completion report; End of year monitoring	Annually	DEEU	AEPC, NGO
Support				Vulnerability assessment of VDCs	A community based vulnerability assessment report is produced	Assessment report for Makwanpur	Once	DEEU, AEPC	Consultant
				Monitoring of climate adaptation need for prioritized intervention areas	A report on adaptation needs of technology, resource, community intervention needs etc. Resource and technology based on water and forests are to be monitored for adaptation needs.	End of assessment report	Once	DEEU, AEPC	Consultant

				Awareness of climate change issues through knowledge products including indigenous knowledge systems	At least three knowledge products developed on impacts and vulnerability, adaptation and indigenous adaptation methods	Monitoring and evaluation report	Annually	DEEU	AEPC
				Liaison between government line agencies for hazard preparedness	Increase synergy between DEEU, DDC, DFO, DWIDP etc; DEEU member also part of District Natural Disaster Relief Committee	Monitoring and evaluation report	Annually	AEPC	DEEU
				Data collection to collate disaggregated data on RE based on gender and ethnicity	End of project report	End of project report	Annually	DEEU, Consultant	AEPC

5.6 Analysis of 10 year intervention required in different scenarios

5.6.1 Improved Cook Stoves

CRS has a higher level of intervention in terms of ICS compared to other scenarios. In 2020 it is estimated that 20,462 installations are needed, compared to 11,390 for MAS and 2607 for BAU. The higher level of installation is due to the increased share of ICS in rural homes in CRS. Wood fuel is promoted as a sustainable form of fuel, where supply meets demand.

Needless to say right measures need to be taken to ensure the sustainability of the supply. The numbers of installation also don't signify the total number of ICS operational in the district. In regards to CRS it was also calculated that there would have been by then a total of 132,056 installations in the district by 2020, of which a total of 52,301 ICS would be operational. The numbers however do not sound alarming in the case of BAU where the intervention level is low. It is therefore suggested that to be more cost effective, research and development focus also be put in the case of optimistic scenarios like MAS and CRS, to ensure the longevity of ICS among other things. R&D is also needed in terms of improving ICS's efficiency along with its longevity.

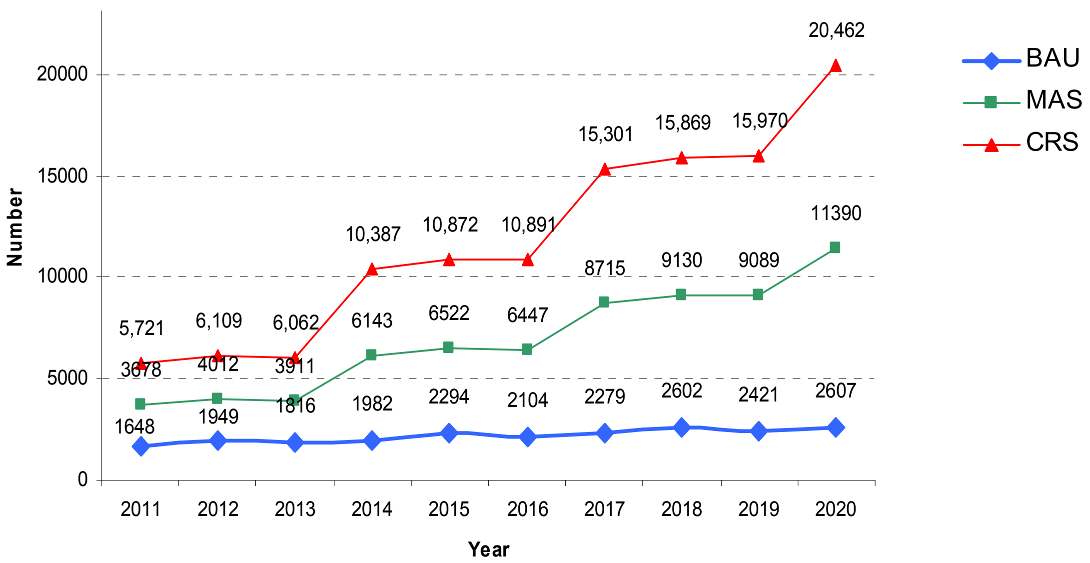


Figure 46: Improved cook stove Installation by year for scenarios

5.6.2 Biogas

Lifespan of biogas has been taken into consideration in developing the intervention level for the three different scenarios. BAU sees a higher level of biogas penetration compared to MAS and CRS. In terms of MAS and CRS biogas sees a lesser penetration due to the higher uptake of LPG for cooking in the case of MAS and ICS in the case of CRS. It has been envisioned that biogas's share in rural cooking in MAS and CRS only amounts to 10%. This is a departure from the current 18% that biogas has in cooking.

Therefore the intervention rates are relatively lowers in MAS and CRS as the intervention needed maybe only to replace a percentage of biogas plants that run their lifespan.

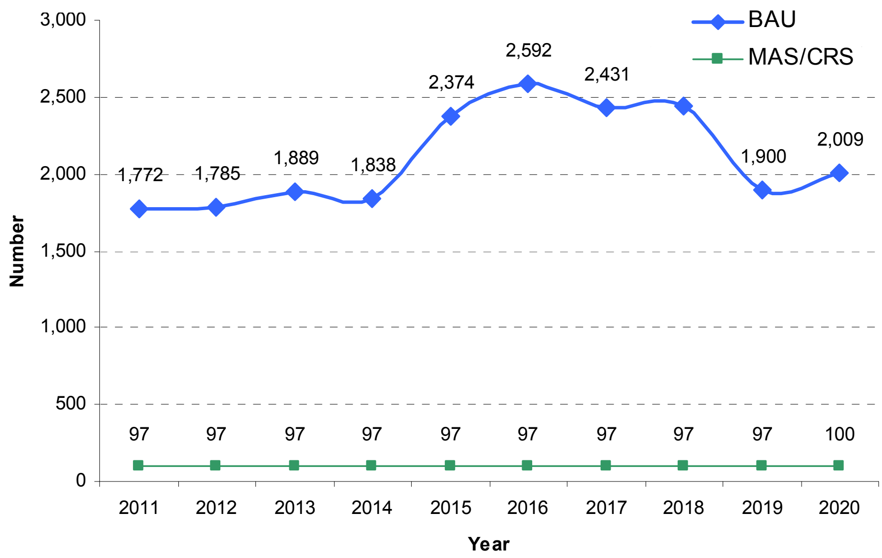


Figure 47: Biogas Installation by year for scenarios

5.6.3 Solar Home System

For planning purposes only intervention in rural areas are taken into consideration for solar home systems. The solar home systems are also considered to be systems rated at 20 Wp. The scenarios see an increased uptake from BAU to MAS to CRS in terms of SHS installation and utilisation for lighting purposes. However in terms of the total demand of electricity based lighting being met by SHS, it is actually a drop from BAU to CRS. This is primarily because it is envisioned that most demand is to be met through the national grid while at the same time there is a switch over from non electricity based sources too electricity based sources.

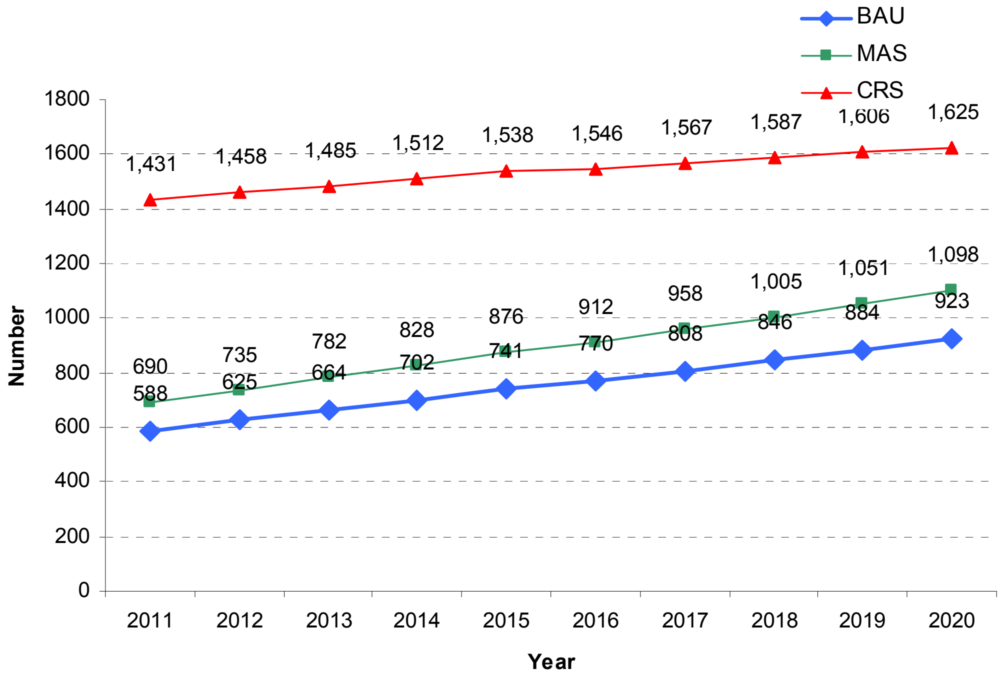


Figure 48: SHS Installation by year for scenarios

5.6.4 Micro Hydro/ Pico Hydro

Micro/Pico hydro intervention has been estimated for the context of rural lighting only. In the context of DCEP electrification through IWM has also been compounded here and not presented separately. The total consumption in terms of kWh was found which was subsequently divided by 8 (light hours). The ensuing figure in kW was subtracted from the installed capacity in the district to estimate the remaining capacity that needs to be added to meet the lighting demand. Install capacity increase in CRS by three times compared to BAU to meet the demand as the population move away from non electricity based dirty fuel like kerosene to clean and renewable source of energy for lighting.

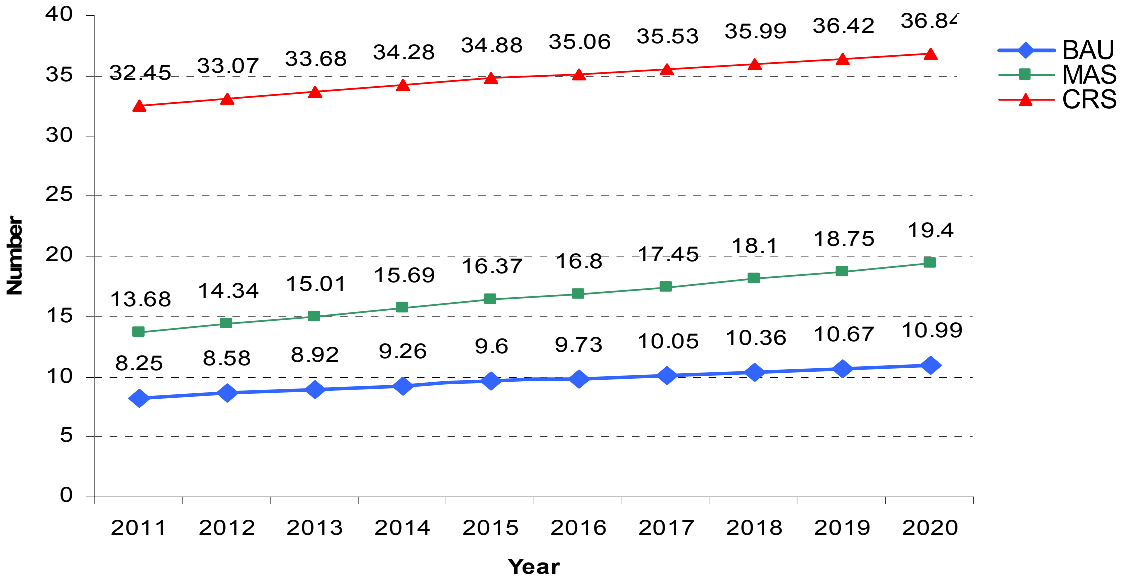


Figure 49: MH/PH capacity installation by year for scenarios

6 Recommendations

As a result of the study assessment and analysis, the study team is able to make specific recommendations to improve on the process of preparation of DCEP plan as well as on the implementation of DCEP on gender, technology, and climate change aspects.

Gender and Social Inclusion

- There should be a provision of gender and socially disaggregated data to monitor the progress on GSI issues. Currently not all the data are disaggregated by gender, class caste and ethnic group wise. The first step would be to create disaggregated data for the whole district in terms of who owns different RETs, who is trained on what RETs etc. Collection of these data systems should be the responsibility of DCEP implementing partners with the support from national level organizations like AEPC, SNV and others. There should be a compulsory mechanism to include and institutionalise GSI in all the reporting communication frameworks.
- Data collection surveys need to be designed so that they do not misrepresent data, for instance the head of a household may not be the owner of a specific technology so this information needs to be disaggregated.
- Data collection systems used by organisations including AEPC need to be revised so that they are more user friendly and systematic in order to access GSI specific data.
- It should be ensured that chosen technologies are accessible and affordable to women, women headed households, poor and other marginalized groups. Since accessibility and affordability of the technologies are the key variables to measure its adoptability, appropriate measures like additional subsidies to these groups of people should be made.
- Central funding sources should be sought to provide financial resources, and subsidies for women, women headed household, poor, ethnic groups, Dalit and other marginalized groups. Local level resource should additionally be made available where adequate central funding is not available. Such funding sources can include VDCs, local forest user groups, local saving credit groups and the like.
- A targeted approach for women, poor, ethnic groups and Dalits is required which is not the case in current service arrangements. At present, DDC provides services as per the demand from the households who have access to information and financial resources. Currently poor, marginalized and women headed households have not been able to exploit these benefits. This could be due to lack of both information on the available technologies and financial ability to invest in them. There needs to be a mandatory provision to allocate at least 50% of the

resources to women's ownership at least for household level energy technologies as women are the primary users and managers of household level energy. Here the category 'women' needs to be disaggregated by different caste and economic groups in line with the proportionate share of the population. Likewise, another 30% of the resources need to be spent on below poverty line (BPL) people (in line with national BPL average (32%). Remaining 20% can be allocated for the remaining category of people.

- It needs to be ensured that women, poor and marginalized groups have equitable access to information and skill development in operating and maintaining the chosen technologies. In Makwanpur district (as the information provided by the Biogas Company) 85% of the total trainee are women. In line with this in all cooking related RETs more than 75% of the training participants should be women. This number might exceed in the case of improved cook stoves as women seem confident to sell their skills after they have received Training of Trainers (ToT). It is strongly recommended that women and PBL groups are to be the target for ToT for improved cook stoves. As ICS fixation doesn't require any prior investment (except training) this might be one of the suitable income generation activities for these category of people.

- Make sure that women and poor have equitable say in decisions making processes in their respective institutions and networks. It is necessary to have at least 33-50% women's representation in all institutional mechanisms created for RETs promotion and development. Likewise, the percentage representation of poor, ethnic groups, Dalit and other caste groups are to be in line with the proportionate share of the population of their respective category.

- All technologies introduced should support reducing drudgery and workload of people particularly of women, poor and the marginalised. Since ICS is going to be one of the popular RETs for women, poor and marginalized, promotion of fuel wood species in the local community forest could support women, poor, ethnic groups and Dalit to get regular flow of firewood to run their ICSs. Plantation of fast growing fuel wood species both in community forest and private land is strongly recommended. For this there need to be strong collaboration with community forest user groups and district forest office. Likewise, promotion of fodder/forage in community forest and also in private land reduces drudgery and workload of people particularly of women. Fodder promotion in community forestry will support poor, women and other marginalised groups since these groups of people have limited private land holding to grow fodder in their farm land. Such interventions not only support the running of biogas by providing animal feed but also increase the income of the households by selling livestock and their product which in the long run increases the RET investment capacity of the participating households.

- To materialize all the above recommendations there needs to be a strong service delivery mechanism with strong GSI support at all levels (community, district and national level). There is a need to establish strong GSI focal unit with adequate resources and power delegation at all levels.

- For tracking the continued progress and for regular policy feedback there should be a strong GSI inclusive monitoring mechanism which will provide strong evidences and data for the formulation of GSI friendly energy policies at the national level.
- A more appropriate weighting system needs to be designed that more effectively qualifies the influence of GSI on energy planning in terms of access, reduced drudgery, Increased livelihoods and improved decision making

Technology

- A renewable energy fair should be conducted by DEEU annually in Hetauda to encourage the promotion and awareness of RETs
- Efforts should be made at the national level towards policy research into CDM mechanisms for improved cook stoves among other RETs and especially for investments to be made from the private sector. This will allow for more dedicated thrust for ICS dissemination as well as to reach higher intervention targets.
- There needs to be research and development into ICS lifespan and efficiency. This can be facilitated by AEPC and can be carried out by NGOs and private sector. As with current standards the lifespan of ICS is 3 years and efficiency fairly low albeit greater than traditional cook stoves. With ICS lasting longer and running more efficiently it would result in less stress on the dwindling forest resource as well as on the scale of interventions required to replace the defunct ICS. Overall it would add efficiency to the natural and financial resources.
- The current SHS technology is not capable of reproducing its efficiency in the scenario of increased cloud cover. Also SHS is fairly costly compared to other lighting technologies. Therefore engagement in technology transfer of efficient and less costly solar home systems is necessary.
- Though Makwanpur has shown some interest in bio-fuel plantations and production, no significant progress has been made on it so far. This may be due to generally lacking policies and practices including usage of bio-fuel. Investment therefore should be made by AEPC in bio-fuel policy and research.
- Research and development of improved biomass stoves needs to be carried out that so that stoves that use fuel other than wood can also be utilised for water boiling, preparing feed for livestock etc at greater efficiencies.
- Promote private sector led renewable energy investment in Makwanpur

- National RET programmes such as MGSP or the IWM programme could look at the vulnerability of RE systems and revise feasibility studies to include analysis of climate vulnerabilities and R+D could be carried out to look at climate proofing technologies

Climate change linkages

- Promotion of improved livestock keeping is required considering its potential. Currently potential of biogas is limited in the district despite the majority of households involved in agricultural livelihoods.
- Handover of potential community manageable forests to community user groups and work on the restoration of degraded hill slopes through the DFO. More resources need to be allocated for forest fire prevention and relief.
- Promote sloping agriculture technologies and conservation friendly farming. Also promote agro forestry and fodder and wood fuel species in farm land through District Agriculture Development Office. Diversify crops and varieties in agriculture
- Promotion of multi use water systems to counteract the seasonal variability of too much water too little water.
- The district needs effective mechanisms and institutional capacity for structural (check dams, embankment improvement etc) and non structural measures (disaster preparedness, mainstreaming disaster risk reduction into development planning, awareness etc) for hazard mitigation for climate induced hazards such as flood and landslides.
- Investigate opportunities through payment for ecosystem services approach for integrated watershed management in watershed of major rivers of Makwanpur.

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Annex 1 : Summary of Findings from VDCs

Hattiya VDC

Description of Hattiya VDC

Hattiya VDC is located next to Hetauda Municipality at an altitude of around 450 to 500m. It is accessible throughout the year by road. However during Monsoon times the road might be blocked by Monsoon floods, whose flood paths crisscross the road to Hattiya. National grid connection has already reached Hattiya. Mostly plain land bordered by Chure in the north and smaller hills in the south.

Key points

Two FGDs were conducted in Hattiya VDC participated by the VDC secretary, representatives of political parties, local biogas company, school teacher, social mobilisers and community members. The FGDs were conducted in the VDC building and Sri Nijananda Prathamik Vidhalaya. The key points of the FGDs are presented below.

Energy Demand and Supply

Lighting

There are around 2600 HHs in Hattiya VDC. Among them 77% HHs are connected to the national grid, around 10% (270) HHs have solar (lighting) and rest of the households use kerosene lamp for lighting. For grid connected load shedding is a major problem and is hindering productivity. The villagers are somehow counteracting it through using *Tukimara*, kerosene lamps and candle.

However the participants of the FGDs stressed the need for small pico and micro hydro systems or even electrification through water mills to meet the electricity demands. The villagers are demanding electricity from other sources and changes in policy which should increase in subsidy even in places where grid may have reached for relief from load shedding. There is a possibility of a MHP at Shakti Khola river and the VDC office wants to make investment on it if external support received. Use of TV, computers, refrigerators, mobile phone and CFL is pretty thorough throughout the VDC.

Cooking

For cooking energy needs utilizing a wide variety of fuel types and stoves was found to be prevalent. This was mostly due to need, fuel availability or cooking habit (rice cooker for rice, biogas for tea and firewood for vegetable etc). A lot of HHs were found to be using a mix bio-gas, ICS and LPG together. However no solar cookers have been used so far and agri-residue was found to be used mostly in the context of livestock feed. The most used fuel for cooking is firewood and then bio-gas. Almost 10% use LPG. Few households also use rice cookers when there is electricity.

In the past around 500 HHs (25%) had installed ICS but these are not functional anymore. The installations were during the last 3-4 years, however due to lack of proper training on building ICS or maintaining it, the quality of ICS were not good and they've stopped being efficient. As a result of which the impression of the community towards ICS is also not favorable. Recently about 110 ICSs have been installed, which are in use.

About 1000 HHs have biogas plants (of which 25% are not functional). Those that were non-functional were mostly larger than $8m^3$ plant size. Mostly biogas is popular due to its dual use (energy generation for cooking and septic tank). Most of the biogas plants in Hattiya are of $4m^3$ size.

The participants listed firewood as their primary choice of fuel for cooking, followed by rice-cooker and biogas. Bio-gas was however not perceived by the community to be a long term solution for cooking needs. Decrease in fodder has led to decrease in livestock rearing leading to decrease in feed for biogas. They also shared that operation of biogas had reduced the amount of manure as compared to the situation without biogas (the reason behind is that they can't mix the litter in biogas plant to increased the amount of manure). For them the ultimate answer to meeting cooking energy needs in Hattiya was in producing more firewood. It was perceived as the cheapest fuel and the easiest. Since the area is low lying, the site has comparative advantage of planting fast growing firewood species (bkaino is already practiced) for wood fuel production.

The participants mentioned that generally two cylinders of LPG and 60 *Bharis*[20] of wood fuel is consumed in a year if no biogas is used. The total days needed for 60 *Bharis* are 60 days. However the community forest is only open for 15 days in a year during the winter and collection time is from 5 am to 11 am during that time, which makes collection of 60 *Bharis* a very difficult ask. Most of the firewood collectors are women. In cases where biogas has been used time saved in the collection of firewood has been utilized for taking care of the children (e.g. education, feeding and others)

Space Heating

Need for space heating has decreased due to increase in income levels and people being able to afford warmer clothes. It may also have been due to the availability of cheap warm clothes or due to the difficulty of obtaining sufficient firewood. Use of ICS also limits the number of person (one) that can sit in front of the stove.

[20] 1 Bhari is the equivalent to 30 to 32 kg. Bhari in Nepali means load, therefore the amount that can be carried at once in the carriers back.

Climate change

Trend

There is a general perception that temperature has slightly increased in the last ten to twenty years. Erratic rainfall has also been observed during the Monsoon period. In recent times, contrary to historical trends, there were only two rainy days in Ashar month, while intense rainfall was observed in the months of Shrawan and Bhadra months; and it stops raining altogether from Ashoj.

Impacts

Severe hailstones some five years ago caused considerable damage to property and crops. People were forced to change their roofs from mud tile to GI tin. Drinking water scarcity has also been observed due to sources running dry. Of the 75 taps that were installed through "Bhrihat Khanepani Yojana" only 40 are functioning as of now. Water level in rivers and underground have decreased over the past few years, however instances of "Khare Kholas[21]" has increased. After 1993 there has been no such major water induced hazard but river cutting is regular phenomenon. The width of river is increasing year by year.

Due to delay in rainfall timings (dry), a forest fire broke out in the nearby forests of Hattiya in 2009. However if the historical trends are to be taken into account it can be observed that there has been a decrease in forest fires due to introduction of community forestry.

The VDC has also seen an increase in mosquitoes, which they put the introduction of biogas at fault. There has been a decrease in *Uddus* and increase in *Sankhe Kira* which has impact the agriculture productivity adversely.

Climate Change and Energy

The decrease in water levels has increased the norms of water pumping from wells and rivers using motors. No other significant impacts have been observed.

Climate Change Adaptation

Although there is an increase in agriculture productivity, regardless of decrease in water availability, due to application of new technologies and inputs erratic rainfall has stunted productivity to levels lower than expected. Crop varieties which can be harvested in short time period, that need less water etc have also been introduced from India. The villagers view that rain water harvesting could be use for ground water recharge through pool concept.

[21] Streams those are active only during Monsoon, carrying off the excess water from the Chure. Usually dry through out rest of the year. Usually turns agriculture land into rubble.

Socio-economic/ Livelihood related

- No evidence of new diseases has been observed. But few observations include:
- Difficulty to get pure water in summer season.
- Before 2048 BS (1991), there was no need of mosquito nets as there were no mosquitoes.
- Health post located nearby
- Impression towards ICS: more amount of the firewood required and more time needed. It was observed that the ICSs were installed by the local promoters so there were many shortcomings in the installation.
- Due to the provision of RET (e.g. biogas), increased time for rest specially for women
- Biogas is not common to Tamang households. They normally don't drink milk so don't have milking buffalo and cows. No enough raw materials for biogas feed.
- Lack of water is also the major constraint for biogas (per cubic meter biogas plant required 6 liters of water every day along with dung)
- Some of the small/ medium enterprises in the village are poultry (100-150), rice mill (20-22) and few furniture and grill. Likewise, a big cement factory is in construction phase.
- The rice mills and furniture and grill industries have however not been hampered due to load shedding as if they adapted by changing their working time
- Since there is no system and facility of irrigation it has hampered agricultural productivity
- More instances of common cold during warm and cold season overlaps
- Increase in miscarriages in women (don't know the reason)
- 19 co-operatives in the locality
- In terms of development priorities: Irrigation, Drinking water, road, education, health and sanitation, electricity(energy)

Gender Issues

As per the information provided by Mr. Basudev (a staff from National Bio Gas Company Ltd.), 85 % of their biogas usage trainees have been women. This is primarily because the primary users of biogas are women and if one is not functioning properly then women are the one to suffer so knowledge about biogas maintenance is a must to women.

Gogane VDC

Description of Gogane V.D.C

Gogane V.D.C is one of the remote VDCs of Makwanpur and sits at an altitude of approximately 900 to 2000m. Though the FGD was conducted in the ward no 2 of the VDC which lies at an altitude of around 1000m, the areas of the VDC also goes up to 2000m. It is further 24 km from Dandabas (Aagra VDC) which is approximately 10km from Palung, which lies on Tribhuwan Highway. The road network recently reached Gogane. Couple of wards in Gogane has seen connected to the national grid. There are around 600 HHs. Among them 75% are Tamang; 20 percent are Brahmin/Chhetri and 5 percent are Dalits. The DDC Makwanpur has promoting this village as a model clean energy village.

Key findings

One FGDs was conducted in Gogane VDC participated by around 14 people out of which 8 were women. The FGD was conducted in the VDC building in Ward Number 2. The key points of the FGDs are presented below.

Energy Demand and Supply

Lighting

Ward no 5 and 6 of Gogane VDC have recently been connected to the national grid. However only around 90HHs have been benefited from the grid connection. The grid expansion is still in progress and the DDC and VDC both have allocated additional fund for this purpose.

Almost 50% of HHs in Gogane have solar home systems. There is high adoption due to availability of high subsidy. There has been additional NPR 6000/system subsidy (additional to national subsidy) from the DDC. Use of kerosene for lighting is prevalent. Kerosene has to be portered from “Dandabas”. One litre of kerosene costs NPR 80. Average monthly use of kerosene is from 3-5 liters per HH.

Cooking

Around 50 HHs in Gogane have bio-gas plants. But these HHs also use firewood mostly to cook *khole*[22] for livestock. Managing raw materials (sand etc.) for bio-gas is hard, time taking and costly mostly to those low income level households which are located at the top of the hills (far from the rivers and stream downhill). It is one of the major reasons for not constructing bio-gas plants by many households.

Around 100 HHs have installed improved cooking stoves. Villagers liked the ICS and therefore there is a high demand to install ICS in the village but it is being delayed as there are very few number of skilled resource person in the village. While talking with women

[22] Livestock feed

members during FGD, they mentioned that women seemed interested to perform the tasks if they get skill development training on ICS installation. In current situation, most of the trained persons are also men. Firewood is readily accessible in few places while it is difficult to others. In overall, there is difficulty in firewood collection. Use of firewood is 4 Bharis a month (48 Bharis/year). Agri-residue is also used for cooking mostly used for preparing livestock feed and during Monsoon season due to wet firewood.

There has been a decrease in consumption of firewood for cooking through various reasons including through the introduction of energy efficient technologies like ICS. Introduction of community forestry might have also contributed to change energy consumption behavior of the villagers from less efficient to more efficient firewood consumption technologies.

Climate change

Trend

The villagers informed that Gogane has been experiencing colder winter mornings and hotter winter days in recent times. A changing rainfall pattern has also been observed in Gogane. In recent time Monsoon has shorter rainfall periods and starts from Shrawan end and ends in Ashoj, while the most rainfall is in Bhadra. Snowfall which was a regular phenomenon in winter season at Dandabas (top ridge of the village), until three years ago has not been observed in the last 2-3 years. There is also no instance of “Kalo Tusharo” from last 3 years

Impacts

There has been an increase in occurrence of flash flood in Gogane. Including loss of lives there were big damages of property (roads and water mills) and agriculture lands in 1993 and 2009 flood. There has been some decrease in instances of major forest fires, due to introduction of community forestry, as community members are now responding quickly to such cases.

Production of maize has been decreased due to unavailability of water during corn/grain development phase. Production of paddy has also decreased while paddy that was before planted during Ashar is now being planted in Shrawan. Aaloobokhara which is/used to grow in the Besi now grows in Dandabas (Lek). Dandabas has however seen growth of vegetables that would only grow in Lek. According to Mr. Sitaram Gurung (a local farmer) “*The people from Lek used to come Besi to buy chilies but nowadays it is grown in their place so they do not come here to buy.”*

There is increase in plant disease and insects. Need to use pesticides have been increasing. There is also increase in mosquitoes. The villagers think it is due to the introduction of biogas plants and/or vehicles.

Climate Change and Energy

Over the years there has been a decrease in the water available for operation of IWM. In one hand there is a decreasing trend in water flow as well as an increase in demand of water for drinking and irrigation purposes. As those needs falls under the people's priority and a single resource is used, thus less water is available for water mills. As a result, the number of water mills is decreasing every year while a diesel operated mill has come in operation recently. However the diesel mill is used during emergency situations only.

Socio economic and livelihoods

- Agriculture is the main occupation of the village. Most of the households sell vegetables.
- Lack of irrigation facilities.
- Three co-operatives are operating out of which 2 are agriculture development cooperatives and one is women development cooperative.
- Some projects on drinking water through Plan international and MDI.
- Need to go to Dandabas or Daman for better health facilities though there is a health post in the village.
- Since there is no electricity in the local health post, the vaccines can only be used in 4 days
- There is one secondary, one lower secondary, and 6 primary schools in the village
- Decrease in number of livestock in the village. Mainly due to lack of adequate human resource (trend of going abroad for job) and decreasing availability of fodder.
- There was high migration rate before road construction mainly in search of better livelihood. After road construction, there is decrease in this trend.
- Priorities of the villagers include: All weather road, irrigation, electricity and skill development training. There is good potential of crusher (aggregate) industry.
- No women staff in the local health post, women not been able to utilized health post facility specially in Gyne related problems
- It was also found that the school drop out ratio of girls is high. Because of the high workload of their mothers, daughter child's performance in education is also low. They have to drop out from school to assist their mothers.
- Grinding is the time consuming and heavy tasks for the villagers who reside on top of the hills as all the water mills are located at the bottom of the hills. They have to spend almost 2 hours (travel time and waiting for turn) for a head load of grains which they have to perform every week. Most of the time men carry the task.

Gender issues

Currently women have to spend 2 hours (two way) and wait for their turn to grind flour. This is largely because most of the settlement is at the top of the hill while water mills are at the bottom of the hills. Most of the time, men have to carry the load. In an average the water mills is visited once a week.

Also though there is a very high demand of ICS, there aren't enough trained personnel in the locality who can construct ICS. Most of the trained persons are also men only. As opined by women participant women can also perform this task if they get training.

It was also found that the school drop out ratio of girls is high. Because of the high workload of their mothers, daughter child's performance in education is also low. They have to drop out from school to assist their mothers.

Institutional

Though the community desired to install a micro-hydro in their area, they didn't know whom to contact as there was no presence of organizations promoting MHP. They had to resort to holding discussions with the institution promoting and selling solar home systems. Needless to say the promotion of micro-hydro would be bad business to an institution promoting solar.

Ward no 5 and 6 have registered community forest. However, in other wards there are local forest management committees but they have not been formally registered. Ward no 2 (V.DC building located area) have a "Forest Committee". Money from the committee goes to building school, roads etc (but not in energy sector). They have decided not to register as community forest as they find the current arrangement satisfactory.

Khairang VDC

Description of Khairang VDC

Khairang VDC is surrounded by Kakanda (West), Raksirang & Bharta (South), Dandakharka (East) and Dhading (North). It sits at an altitude of approximately 1400 – 2100 m. It has no road transportation and only foot roads are available. The nearest highway is Manahari which is about 30 Km far and it takes 5-7 hours to reach the VDC on foot. The foot roads are also disturbed by landslides during monsoon. The life is very difficult because of geography. It's cold round the year and frost covers the VDC. No national grid connection has reached the VDC. Agricultural land is very low and no irrigation is done to the available cultivable land and cultivation is monsoon fed. There are 544 HHs. Among them 53% are female. Out of 3,225 population around 72% are ethnic groups and Tamang dominates them while as 4% Dalits and 24% others including Chhetri/Brahmins and Chepang (aborigines) are dwelling there. DDC has classified the village as very poor and remote in the district.

Key findings

One FGDs was conducted in Khairang VDC participated by around 10 people including VDC secretary, representatives of political parties, students, representatives of ICS project, FUG, school teacher etc. The key points of the FGDs are presented below.

Energy Demand and Supply

Lighting

Khairang VDC has no grid connection for electricity. Peltric sets are the most common systems used for electricity generation and altogether around 250 HHs are using it. Likewise solar is another main source of electricity for lighting around 150 HHs have solar home systems installed. There is also high usage of kerosene lamp and *Diyalo*', made from branch of spruce tree. Availability of subsidy from AEPC/DDC have resulted in high adoption of peltric sets and solar systems.

There is limited use of electric appliances and use of TV is limited to a few households. Mobile phone and CFL use is however high. All the appliances have to be run and charged from power from peltric and solar systems. Participants of the FGD stressed the need for small pico and micro hydro systems or even electrification through water mills. In Khairang VDC there is possibility of a MHP at Gorandi river and wind energy generation potential at Bhimbung.

Cooking

For cooking energy needs most people in Khairang use firewood as it is found in abundance in nearby forests and is cost effective as well. Around 30 HHs have improved cook stoves. There is no evidence of encouraging adoption of bio-gas and LPG. No solar cookers have been used so far. Though livestock rearing is common in the village, biogas is not used due to lack of knowledge of its utility and due to the transportation costs of non local materials.

Firewood is also the common fuel for space heating due to its ready availability. There are altogether 12 to 15 traditional water mills in the village which as used for grinding and making flour.

Climate change

Trends

There is a perception that temperature has increased in Khairang in recent years. Colder winter morning and hotter winter days are also being observed in Khairang. Khairang also experience erratic and unusual rainfall during Monsoon and other seasons. In Chaitra, 2065 a heavy rainfall for about 15 minutes ruined the VDC and took life of two persons as well as causing heavy damage of property and agricultural lands. On the other hand less rainfall is being observed in the month of Ashar, while increase in intensity of rainfall was observed in Shrawan and Bhadra months. Generally Monsoon is observed to be getting shorter. Snowfall was regular phenomenon in winter season until last year but it hasn't snowed this year.

Impacts

Underground water level and water level in rivers have been found to have decreased. Drinking water sources in high hills are also running dry. Water induced hazard has been increasing and soil erosion by rivers and *Khare Kholas* were found to have increased. Cutting by river was also to have found increased and there are increases in *Khare Kholas* as well.

Agricultural productivity has not met expectations this year due to erratic rainfall which incidentally also produced a situation of food insecurity in the VDC. Mosquito and flies that had never been seen till last year are found now in Khairang. Tigers and white cranes not seen before are being seen since last year. Rhododendron, whose normal flowering time is Falgun flowered in Magh the past couple of years.

Climate Change and Energy

In recent times, there has been a higher demand for irrigation due to decrease in ground water level as well as increased dryness of cultivable land. Water mills have also been laid down in the path of threat, as any water that is available is first diverted for drinking water and then irrigation purposes. In general water availability has decreased for water mills putting them under the threat of being defunct or relocating.

Climate Change Adaptation

The use of peltric and solar system for lighting could be thought of as their adaptive feature in the absence of national grid supply. The villagers have also started to conserve the forest to increase ground water level and sources of drinking water.

Socio-economic/ Livelihood related

- The village is agrarian and most of the people do daily labor.
- No evidence of new diseases has been observed. But few observations include:
- Difficulty to get pure water in summer season.
- Before 2065 BS, there was no need of mosquito nets as there were no mosquitoes.
- The report of cases of Jaundice infection has been increased since last year.
- Health post located nearby.
- Since there is no system and facility of irrigation it has hampered agricultural productivity.
- No enterprises in the village.
- More instances of common cold during warm and cold season overlaps.
- Forest user groups (FUG) recently organized. An agriculture related co-operative is operating.
- Vaccines for human needs can't be stored longer because of no electricity in the local health post.
- Eight schools- one secondary, one lower secondary, and 6 primary schools.
- Decrease in number of livestock in the village. Mainly due to lack of adequate human resource (trend of going abroad for job) and decreasing availability of fodder.
- Development priorities: transportation, Irrigation, skill development training, education, health and sanitation, electricity (energy).

Gender Issues

As per the information provided by Mr. Man Bahadur Waiba, a staff of ICS promotion project, most women have accepted the installation of ICS in their kitchen. Installation of ICS has also resulted in fewer incidences of respiratory problems in women due to reduction of smoke in the kitchen. Son-in-laws and daughters were also found to be helping out in collecting firewood from Chaitra and Baishakh for the rest of the year.

Currently women have to spend 45 minutes (two way) to reach water mill and they have to wait for one day for their turn to grind. Men and women share the load carrying during the visit to the water mill.

Institutional

DDC has allocated budget for solar home systems and drinking water for the year. The VDC has no plan for energy preparation/adaptation. Though the community desired to install a micro-hydro (potentiality at two points of the main river i.e. Gorandi) in their area, lack of presence of organizations promoting MHP has not made this a reality.

Annex 2: Intervention scale of RETs from 2010 to 2020 in three scenarios (LEAP derived)

Business as Usual

Improved Cook Stoves

Year	Installation	Cumulative	Operational ICS
2010	1493	14412	4482
2011	1648	16060	4780
2012	1949	18009	5090
2013	1816	19825	5413
2014	1982	21807	5747
2015	2294	24101	6092
2016	2104	26205	6380
2017	2279	28484	6677
2018	2602	31086	6985
2019	2421	33507	7302
2020	2607	36114	7630

Biogas

Year	Installation/year	Cumulative	Operational biogas plants
2010	-	15,597	15,597
2011	1,772	17,369	16652
2012	1,785	19,154	17746
2013	1,889	21,043	18880
2014	1,838	22,881	20056
2015	2,374	25,255	21275
2016	2,592	27,847	22340
2017	2,431	30,278	23442
2018	2,446	32,724	24582
2019	1,900	34,624	25762
2020	2,009	36,633	26981

Solar Home System

	Rural			Urban		
	Installation /year	Cumulative installations	Consumption (kWh)	Installation /year	Cumulative	Consumption (kWh)
2010		4,901	291,876		1,043	62,142
2011	588	5,489	326,890	71	1,114	66,315
2012	625	6,114	364,132	73	1,187	70,690
2013	664	6,778	403,643	77	1,264	75,275
2014	702	7,480	445,460	81	1,345	80,077
2015	741	8,221	489,620	84	1,429	85,106
2016	770	8,991	535,464	93	1,522	90,618

2017	808	9,799	583,572	96	1,618	96,391
2018	846	10,645	633,959	102	1,720	102,434
2019	884	11,529	686,636	106	1,826	108,758
2020	923	12,452	741,609	111	1,937	115,374

Micro/Pico Hydro

	HHs benefitting	Consumption (kWh)	Added Consumption(kWh)	Capacity (kW)	Added Capacity(kW)
2010	1,111	324,530	0	111.14	
2011	1,194	348,618	24,088	119.39	8.25
2012	1,280	373,675	25,057	127.97	8.58
2013	1,369	399,713	26,038	136.89	8.92
2014	1,461	426,742	27,029	146.14	9.26
2015	1,557	454,772	28,030	155.74	9.60
2016	1,655	483,185	28,413	165.47	9.73
2017	1,755	512,519	29,334	175.52	10.05
2018	1,859	542,771	30,252	185.88	10.36
2019	1,966	573,939	31,168	196.55	10.67
2020	2,075	606,017	32,078	207.54	10.99

Medium Adaptation Scenario

Improved cook stove

Year	Installation	Cumulative	Corrected(functional)
2010	1493	14410	4480
2011	3678	18088	6808
2012	4012	22100	9181
2013	3911	26011	11601
2014	6143	32154	14066
2015	6522	38676	16576
2016	6447	45123	19112
2017	8715	53838	21684
2018	9130	62968	24292
2019	9089	72057	26934
2020	11390	83447	29609
Total installation	69037		
Average yearly installation	6903.7		

Biogas

Year	Number Installed	Cumulative	corrected
2010		15,597	15,597
2011	97	15,694	14,990
2012	97	15,791	14,333
2013	97	15,888	13,622
2014	97	15,985	12,857
2015	97	16,082	12,035
2016	97	16,179	11,146
2017	97	16,276	10,194
2018	97	16,373	9,174

2019	97	16,470	8,082
2020	100	16,570	6,918

SHS

	Rural			Urban		
	Installation/year	Cumulative	(kWh)	Installation/year	Cumulative	(kWh)
2010		4,901	291,876		1,043	62,142
2011	690	5,591	332,979	71	1,114	66,315
2012	735	6,326	376,778	73	1,187	70,690
2013	782	7,108	423,322	77	1,264	75,275
2014	828	7,936	472,659	81	1,345	80,077
2015	876	8,812	524,832	84	1,429	85,106
2016	912	9,724	579,136	93	1,522	90,618
2017	958	10,682	636,189	96	1,618	96,391
2018	1,005	11,687	696,010	102	1,720	102,434
2019	1,051	12,738	758,613	106	1,826	108,758
2020	1,098	13,836	824,010	111	1,937	115,374

Micro/Pico Hydro

	HHs benefitting	Consumption (kWh)	Added Consumption(kWh)	Capacity(kW)	Added Capacity(kW)
2010	1,111	324,530		111.14	
2011	1,248	364,471	39,941	124.82	13.68
2012	1,392	406,339	41,868	139.16	14.34
2013	1,542	450,161	43,822	154.16	15.01
2014	1,699	495,963	45,802	169.85	15.69
2015	1,862	543,769	47,806	186.22	16.37
2016	2,030	592,834	49,065	203.03	16.80
2017	2,205	643,789	50,955	220.48	17.45
2018	2,386	696,640	52,851	238.58	18.10
2019	2,573	751,385	54,745	257.32	18.75
2020	2,767	808,022	56,637	276.72	19.40

Climate Resilient Scenario

Improved cook stove

Year	Installation	Cumulative	Corrected(functional)
2010		14412	4,480
2011	5,721	20,133	8,853
2012	6,109	26,242	13,323
2013	6,062	32,304	17,892
2014	10,387	42,691	22,558
2015	10,872	53,563	27,321
2016	10,891	64,454	32,150
2017	15,301	79,755	37,064
2018	15,869	95,624	42,061
2019	15,970	111,594	47,140
2020	20,462	132,056	52,301

Biogas

Year	Number Installed	Cumulative	corrected
2010		15,597	15,597
2011	97	15,694	14,990
2012	97	15,791	14,333
2013	97	15,888	13,622
2014	97	15,985	12,857
2015	97	16,082	12,035
2016	97	16,179	11,146
2017	97	16,276	10,194
2018	97	16,373	9,174
2019	97	16,470	8,082
2020	100	16,570	6,918

SHS

	Rural			Urban		
	Installation/year	Cumulative	(kWh)	Installation/year	Cumulative	(kWh)
2010		4,901	291,876		1,043	62,142
2011	1,431	6,332	377,107	71	1,114	66,315
2012	1,458	7,790	463,956	73	1,187	70,690
2013	1,485	9,275	552,407	77	1,264	75,275
2014	1,512	10,787	642,445	81	1,345	80,077
2015	1,538	12,325	734,047	84	1,429	85,106
2016	1,546	13,871	826,121	93	1,522	90,618
2017	1,567	15,438	919,436	96	1,618	96,391
2018	1,587	17,025	1,013,946	102	1,720	102,434
2019	1,606	18,631	1,109,602	106	1,826	108,758
2020	1,625	20,256	1,206,351	111	1,937	115,374

Micro/Pico Hydro

	HHs benefitting	Consumption (kWh)	Added Consumption(kWh)	Capacity(kW)	Added Capacity(kW)
2010	1,111	324,530		111.14	
2011	1,436	419,297	94,767	143.59	32.45
2012	1,767	515,863	96,566	176.67	33.07
2013	2,103	614,210	98,347	210.35	33.68
2014	2,446	714,321	100,111	244.63	34.28
2015	2,795	816,171	101,850	279.51	34.88
2016	3,146	918,547	102,376	314.57	35.06
2017	3,501	1,022,302	103,755	350.10	35.53
2018	3,861	1,127,385	105,083	386.09	35.99
2019	4,225	1,233,744	106,359	422.52	36.42
2020	4,594	1,341,317	107,573	459.36	36.84

Annex 3: Hazard information of Makwanpur

Chronological order of natural hazards occurred in Makwanpur

2011 BS: heavy rainfall. Ruined northern territories like Bhimphedi i.e. old HQ. Several lives and capitals lost.

2018 BS heavy rainfall. Ruined northern territories in whole Makwanpur. Several lives and capitals lost.

2036 BS: heavy rainfall. Ruined northern territories in whole Makwanpur. Several lives and capitals lost.

2050 BS: Heavy rainfall. Northern territories like Daman and Palung VDCs effected with death of 242 people.

2059 BS: Heavy rainfall. Southern north VDCs (Kankada and Manahari) effected with death of 112 people.

2061 BS: heavy rainfall. Ruined whole Makwanpur. Several lives and capitals lost.

Between 2002 to 2004 AD, the list of hazards hit VDCs are,

Year	VDCs
2002	Aambhanjhyang -1, Bhainse-7, Basamadi, Chatiwan -4, Churiamai, Hadikhola – 8, Hattiya, Kankada -4, Kaliktar -2,9, Khairang -4, Kogate – 8, Manahari -1,3, Makwanpurgadhi, Palung-2, Padampokhari, Epa -2,6, Rakshirang -8, Sarikhet – 2,4,7, Shikharpur – 6, Sukaura
2003	Chatiwan-8(Benighat), Hadikhola-8,9, Jyamire -7, Makwanpurgadhi, Manahari, Namatar -9, Raigaun, Phaparbari, Padampokhari -1,8
2004	Aambhanjhyang -2, Bhainse, Basamadi-4, Bhimphedi, Chatiwan, Dhinyal, Hadikhola -2, Hanimadi, Hattiya, Kankada, Kulekhani, Makwanpurgadhi -9,1, Manahari, Shikharpur -5, Phaparbari -6, Sukaura, Thingan, Hetauda-10,11

Description of damages by hazards

Description	2062/2063	2063/2064	2064/2065
Death	n/a	12	7
Injured		23	10
Affected households		183	158
Distribution of aid (NPR)		5,76,110	6,60,000
Total damages (NRs)		115,22,200	132,05,200

Water-induced hazard probability

SNo	VDCs/Municipality	Total Area (Km^2)	Landslide Hazard potential			Flood Hazard Potential			Overall Status
			HHP	MHP	LHP	HHP	MHP	LHP	
1	Ambhanjyang	40.0036	*				*		HHP
2	Bhainse	59.8693	*				*		HHP
3	Makwanpur Gadhi	51.5568	*				*		HHP
4	Nibuatar	31.7113	*				*		HHP
5	Palung	17.3258	*				*		HHP
6	Tistung	35.7686	*					*	MHP
7	Sarikhet	58.2323	*			*			VHHP
8	Raksirang	50.5766	*					*	HHP
9	Kankada	73.5157	*					*	HHP
10	Kalikatar	34.3214	*					*	HHP
11	Namtar	100.5551	*				*		HHP
12	Agra	40.9246	*					*	HHP
13	Gogane	52.2411	*					*	HHP
14	Chhatiwan	164.1740	*			*			VHHP
15	Phaparbari	176.3225	*			*			VHHP
16	Rai Gaun	95.7693	*				*		HHP
17	Budhichaur	27.3177	*					*	HHP
18	Sukoura	25.1284	*					*	HHP
19	Thingan	66.2485	*					*	HHP
20	Shikharpur	40.6352	*					*	HHP
21	Manthali	18.6829	*					*	HHP
22	Betini	27.3634	*					*	HHP
23	Churiyamai	35.1190	*				*		HHP
24	Padampokhari	37.7002	*				*		HHP
25	Handikhola	106.7174	*			*			VHHP
26	Basahamadhi	74.1113	*				*		HHP
27	Hetauda Mun	47.7443	*				*		HHP
28	Hatiya	34.0706	*				*		HHP
29	Harnamadhi	36.7599	*				*		HHP
30	Kogare	10.3470			*			*	VLHP
31	Manahari	256.5655			*	*			HHP
32	Khairang	47.8425			*			*	HHP
33	Dandakharka	35.9487			*			*	LHP
34	Daman	43.6284			*		*		MHP
35	Chitlang	33.1561			*			*	LHP
36	Dhinyal	116.7056	*					*	HHP
37	Ipa Panchkanya	47.2719		*				*	MHP
38	Sisneri	25.0703			*			*	VLHP
39	Bajrabarahi	17.6344			*			*	MHP
40	Bharta	24.5750			*			*	MHP
41	Kulekhani	21.6044		*				*	MHP
42	Phakhel	33.8453			*			*	MHP
43	Markhu	19.4910			*			*	MHP
44	Bhimphedi	49.1766		*				*	MHP

(**HHP** = High hazard probability; **MHP** = Medium Hazard Probability; **LHP** = Low Hazard Probability; **VHHP**= Very High Hazard Probability).

Human casualties, loss of properties due to water-induced disasters by VDCs:

S No	VDCs / Municipality	Total Population	Population density (No. /Km^2)	Exposed population	Total no. of human casualties		Total no. of damaged HHs		Land slide severity	Flood hazard severity
					03	04	03	04		
1	Ambhanjyang	8724	218	8200	3	5	274	266	Very high	High
2	Bhainse	6807	114	6399	4	1	266	53	Very high	Moderate
3	Makwanpur Gadhi	14003	272	9000	0	6	0	141	Very high	High
4	Nibuatar	4889	154	1956	0	0	0	0	Very high	Moderate
5	Palung	7355	425	4413	0	0	0	0	Very high	High
6	Tistung	6749	189	2700	0	0	0	0	Very high	Moderate
7	Sarikhet	6292	149	5914	10	0	165	22	Very high	Very high
8	Raksirang	7550	124	7097	19	0	210	5	Very high	Moderate
9	Kankada	8684	103	8163	52	0	414	80	Very high	Moderate
10	Kalikatar	4259	124	4003	3	0	67	0	Very high	Moderate
11	Namtar	9375	93	5625	0	0	0	0	Very high	High
12	Agra	8660	212	3464	0	0	0	0	Very high	Moderate
13	Gogane	5603	107	2241	0	0	0	0	Very high	Moderate
14	Chhatiwan	22948	839	13769	2	0	89	221	Very high	Very high
15	Phaparbari	16735	95	10041	0	1	63	58	Very high	Very high
16	Rai Gaun	11736	123	7042	0	0	0	223	Very high	High
17	Budhichaur	2285	84	914	0	0	0	0	Very high	Moderate
18	Sukoura	4476	178	1790	0	0	0	198	Very high	Moderate
19	Thingan	4216	64	1686	0	0	0	47	Very high	Moderate
20	Shikharpur	5326	131	5006	5	1	19	15	Very high	Moderate
21	Manthali	2692	144	1077	0	0	0	0	Very high	Moderate
22	Betini	3177	116	1271	0	0	0	0	Very high	Moderate
23	Churiyamai	13730	391	549	0	0	0	0	Very high	Moderate
24	Padampokhari	12697	456	7618	0	0	0	15	Very high	High
25	Handikhola	17189	183	10313	0	6	0	2	Very high	Very high
26	Basahamadhi	19536	171	7814	0	1	0	4	Very high	Moderate
27	Hetauda Municipality	51689	1083	31013	0	0	0	48	Very high	High
28	Hatiya	12687	372	5075	0	0	0	28	Very high	Moderate
29	Harnamadhi	6684	182	2674	0	0	0	0	Very high	Moderate
30	Kogare	1595	154	348	0	0	0	0	Moderate	Moderate
31	Manahari	13575	53	8824	4	1	266	36	Moderate	High
32	Khairang	3110	65	678	0	0	0	0	Moderate	Moderate
33	Dandakharka	4058	113	885	0	0	0	0	Moderate	Moderate
34	Daman	8158	187	2529	0	0	0	0	Moderate	High
35	Chitlang	7736	233	1686	0	0	0	0	Moderate	Moderate
36	Dhinyal	6640	40	1448	0	0	0	80	Moderate	Moderate
37	Ipa Panchkanya	3099	66	676	0	0	0	9	Moderate	Moderate
38	Sisneri	3767	150	851	0	0	0	0	Moderate	Moderate
39	Bajrabarahi	7420	421	1618	0	0	0	0	Moderate	Moderate
40	Bharta	3542	144	772	0	0	0	0	Moderate	Moderate
41	Kulekhani	3854	178	3000	0	1	0	0	Moderate	Moderate
42	Phakhel	5410	160	1179	0	0	0	0	Moderate	Moderate
43	Markhu	4367	224	952	0	0	0	0	Moderate	Moderate
44	Bhimphedi	6198	126	3000	0	1	62	0	Moderate	Moderate

Annex 4: Institutional assessment tools

Coverage Matrix

(Biomass) RET	Organisation															
Services	DEEU	Government			MFI	MFI	Bank	Bank	NGO	FECOFUN	INGO	INGO	Pvt. Sec	Pvt. Sec	Other 1	Other 2
		Central	District	Lo-cal												
Specify were necessary→		AEPC	DDC, DFO, DAO, DFCC						Future Nepal/ RTPA		SARI/E					
Subsidy support		XXX	XX						XX	XX	XX					
Financing																
RET Promotion/Awareness	X	XXX							XX	XX	XX					
RET Dissemination	X	XXX							XX	XX						
Technology usage Tr		XXX							XX	XX						
Technology installation Tr		X							XXX	XX						
Savings & credit																
Afters Sales/ Major Retrofitting									XX	XX						
Institutional Development			X						XX	XX						
Training of Trainers									XX	XX						
R & D																
Monitoring and Evaluation	X	XX	XX						XX	XX	XX					
Sustainable management of RET resources																
Hazard mitigation(resources)																
Others																

(Solar) RET	Organisation															
Services	DEEU	Government			MFI	MFI	Bank	Bank	NGO	NGO	NGO	Pvt. Sec	Pvt. Sec	Pvt. Sec	Other 1	Other 2
		Central	District	Lo-cal												
Specify were necessary→		AEPC	DDC						Future Nepal			Dhaulagiri Solar Pvt. Ltd.	TUEC			
Subsidy support		XXX	XX						XX			XX	XX			
Financing																
RET Promotion/Awareness	X	XXX							XX			XX	XX			
RET Dissemination	X	XXX							XX			XX	XX			
Technology usage Tr	X	XXX							XX			XX	XX			
Technology installation Tr		XX							XXX			XXX	XXX			
Savings & credit																
Afters Sales/ Major Retrofitting									XX			XX	XX			
Institutional Development			X						XX			XX	XX			
Training of Trainers		XX							XX			XX	XX			
R & D																
Monitoring and Evaluation		XX	XX						XX			XX	XX			
Sustainable management of RET resources																
Hazard mitigation(resources)		XX	XX													
Others																

(Micro Hydro) RET	Organisation															
Services	DEEU	Government			MFI	MFI	Bank	Bank	NGO	NGO	NGO	Pvt. Sec	Pvt. Sec	Pvt. Sec	Other 1	Other 2
		Central	District	Local												
Specify were necessary→		AEPC	DDC	VDC								TUEC	WMA			
Subsidy support		XX	X									XX	XX			
Financing												X	X			
RET Promotion/Awareness	X	XX	XX									X	X			
RET Dissemination	X	XX	X									X	X			
Technology usage Tr	X		X									X	X			
Technology installation Tr			X									XX	XX			
Savings & credit																
Afters Sales/ Major Retrofitting												X	X			
Institutional Development			X									X	X			
Training of Trainers												X	X			
R & D												X	X			
Monitoring and Evaluation		XX	XX									X	X			
Sustainable management of RET resources		X	X									X	X			
Hazard mitigation(resources)		X	X	X								X	X			
Others																

(Bio-fuel-rich plantation) RET	Organisation															
Services	DEEU	Government			MFI	MFI	Bank	Bank	NGO	FECOFUN	INGO	Pvt. Sec	Pvt. Sec	Pvt. Sec	Other 1	Other 2
		Central	District	Local												
Specify were necessary→		AEPC	DDC, DFO, DAO	VDC					Bihani Nepal		GEF	BIRP Industry				
Subsidy support									XX	XX	XX	XX				
Financing		XX	X						XX	XX		XX				
RET Promotion/Awareness	X	XX	X						XXX	XXX	XX	XX				
RET Dissemination	X	XX							XXX	XX		XX				
Technology usage Tr	X								XX	XX		XX				
Technology installation Tr									XX	XX		XX				
Savings & credit																
Afters Sales/ Major Retrofitting									XX			XX				
Institutional Development									XX	XX		XX				
Training of Trainers		XX							XX	X		XX				
R & D		XX							XX			XX				
Monitoring and Evaluation				X					XX	X	XX	XX				
Sustainable management of RET resources									X	X		X				
Hazard mitigation(resources)		X							X	X		X				
Others																

Blank - no involvement
X - Some involvement XX - substantial involvement XXX - major involvement ?- involvement unknown
Note: TUEC- Technology Upliftment Engineering Centre, BIRP-Bio-fuel Research & Production Industry, RTPA- Rural Technology Promoters' Association & WMA- Water Mill Association.

SWOT Analysis

Organisations	Strength	Opportunities	Weakness	Threats
DEEU	Motivated staff: 1 High commitment from Top management: Yes	RETs in high demand: Yes Energy sources availability: Yes	Untrained staff : Lack of resource: Lack of supports: Yes	Possibility of change of DDC's commitment
Government	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	
Government (DDC, DADO, DIDO,DFO, DAO, DFCC)	Motivated staff: many High commitment from Top management: Yes	RETs in high demand: Yes Energy sources availability: Yes	Untrained staff : Lack of resource: Yes Lack of supports: Yes	
MFI	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	
MFI	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	
Bank	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	
NGO (Future Nepal, RTPA, Behan Nepal)	Motivated staff: 25 High commitment from Top management: Yes	RETs in high demand: Yes Energy sources availability: Yes	Untrained staff : Lack of resource: Yes Lack of supports: Yes	Possibility of phase out of project
FECOFUN	Motivated staff: Fogs High commitment from Top management: Yes	RETs in high demand: Yes Energy sources availability: Yes	Untrained staff : Yes Lack of resource: Yes Lack of supports: Yes	Participation from FUGs
Pvt. Sec (TUEC, BIRP, WMA)	Motivated staff: 11 High commitment from Top management: Yes	RETs in high demand: Yes Energy sources availability: Yes	Untrained staff : Lack of resource: Yes Lack of supports: Yes	
Pvt. Sec	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	
Other	Motivated staff: High commitment from Top management:	RETs in high demand: Energy sources availability:	Untrained staff : Lack of resource: Lack of supports:	

CHECKLIST FOR CAPACITY ASESSMENT OF ORGANISATIONS IN RE SECTOR

Institution: Ghatta owner Association Makwanpur (IWM)

OUTPUTS/RESULTS
It distributes with IWMs only.
Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable? : Cost of production in terms of human is acceptable. But physical a financial are lacking.
Can the organisation meet increased demand for products/services in the region?: It has been supplying as per demand.

INPUTS
Is there a sufficient number of staff? If so how many?: 5
Is there sufficient skilled staff?: Yes
Are the premises and equipment adequate? : Yes
Is there sufficient access to necessary information?: Yes

ACTORS/EXTERNAL RELATIONS
Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?: Yes
Are the relations with other relevant stakeholders adequate?: Yes
Does the organisation have adequate relations with relevant policy makers in the region and the country?: Yes
Does the organisation have a good public image?: Yes

STRATEGY
What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?: To improve socio-economic condition of Ghatta Owners; to improve socio-economic conditions of Ghatta Owners and community through the promotion of RTIs.
Is the staff adequately involved in planning and monitoring?: *No*

GENDER
Does the management equally treat women and men?: Yes
Does the organisation have the capacity to recognise and handle gender issues?:Yes
Does the organisation have a specific gender policy and/or strategy?:No

SOCIAL INCLUSION
Does the staff policy adequately address minority group imbalances?:No
Is there adequate attention to minority groups in the programs and projects?:No
Does the organisation have a specific social inclusion policy and/or strategy?:No

CLIMATE CHANGE
Does the institution work in climate related programs?:Yes
Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. human resources, financial and physical resources are lacking.

Institution: BIRP Industry

OUTPUTS/RESULTS
Does the organisation offer relevant products/services in RE? If yes then what?:Plantation and distribution of Jatropha.
Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable?:Yes
Can the organisation meet increased demand for products/services in the region?:No

INPUTS
Is there a sufficient number of staff? If so how many? :3. Not sufficient.
Is there sufficient skilled staff?:No.
Are the premises and equipment adequate? :Yes
Is there sufficient access to necessary information?:Yes

ACTORS/EXTERNAL RELATIONS
Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?: Yes
Are the relations with other relevant stakeholders adequate?: Yes
Does the organisation have adequate relations with relevant policy makers in the region and the country?:Yes
Does the organisation have a good public image?: Yes

STRATEGY
What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?: To produce enough fuel additives to reduce Nepal's expert from 3rd world; to increase the productivity of cultivable land by supplying manufactured compost fertilizers to farmers.
Is the staff adequately involved in planning and monitoring?: *No*

GENDER
Does the management equally treat women and men?:Yes
Does the organisation have the capacity to recognise and handle gender issues?: Yes
Does the organisation have a specific gender policy and/or strategy?:Yes

SOCIAL INCLUSION
Does the staff policy adequately address minority group imbalances?:Yes

Is there adequate attention to minority groups in the programs and projects?:Yes
Does the organisation have a specific social inclusion policy and/or strategy?:No

CLIMATE CHANGE
Does the institution work in climate related programs?:Yes
Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. financial and physical resources are lacking.

Institution: Technology Upliftment & Engineering Centre

OUTPUTS/RESULTS

Does the organisation offer relevant products/services in RE? If yes then what?: Manufacturing IWM, Family Hydro and metallic ICS.

Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable?: Yes

Can the organisation meet increased demand for products/services in the region?:Yes

INPUTS

Is there a sufficient number of staff? If so how many?:11

Is there sufficient skilled staff?:Yes

Are the premises and equipment adequate?:Yes

Is there sufficient access to necessary information?:Yes

ACTORS/EXTERNAL RELATIONS

Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?:Yes

Are the relations with other relevant stakeholders adequate?:Yes

Does the organisation have adequate relations with relevant policy makers in the region and the country?:Yes

Does the organisation have a good public image?:Yes

STRATEGY

What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?

•to enhance the efficiency of Water Mills so as to ease rural life.

• To promote family hydro in rural VDCs.

• To promote metallic ICS in rural high VDCs.

Is the staff adequately involved in planning and monitoring?:Yes

GENDER

Does the management equally treat women and men?:Yes

Does the organisation have the capacity to recognise and handle gender issues? :Yes

Does the organisation have a specific gender policy and/or strategy?:No

SOCIAL INCLUSION

Does the staff policy adequately address minority group imbalances?:No

Is there adequate attention to minority groups in the programs and projects?:No

Does the organisation have a specific social inclusion policy and/or strategy?:No

CLIMATE CHANGE

Does the institution work in climate related programs?:Yes

Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. financial and physical resources are lacking.

Institution: Future Nepal

OUTPUTS/RESULTS

Does the organisation offer relevant products/services in RE? If yes then what?:Yes. ICS.
Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable?:Yes
Can the organisation meet increased demand for products/services in the region?:Yes

INPUTS

Is there a sufficient number of staff? If so how many?:9
Is there sufficient skilled staff?:Yes
Are the premises and equipment adequate?:Yes
Is there sufficient access to necessary information?:Yes

ACTORS/EXTERNAL RELATIONS

Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?:Yes
Are the relations with other relevant stakeholders adequate?:Yes
Does the organisation have adequate relations with relevant policy makers in the region and the country?:Yes
Does the organisation have a good public image?:Yes

STRATEGY

What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?
To create renewal energy district.
To equip community for sustained life against climate change.
Is the staff adequately involved in planning and monitoring?:Yes

GENDER

Does the management equally treat women and men?:Yes
Does the organisation have the capacity to recognise and handle gender issues? :Yes
Does the organisation have a specific gender policy and/or strategy?:Yes

SOCIAL INCLUSION

Does the staff policy adequately address minority group imbalances?:No
Is there adequate attention to minority groups in the programs and projects?:Yes
Does the organisation have a specific social inclusion policy and/or strategy?:Yes

CLIMATE CHANGE

Does the institution work in climate related programs?:Yes
Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. financial and physical resources are lacking.

Institution: RTPA

OUTPUTS/RESULTS

Does the organisation offer relevant products/services in RE? If yes then what?:Mud ICS.

Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable?:No.

Can the organisation meet increased demand for products/services in the region?:Yes

INPUTS

Is there a sufficient number of staff? If so how many?:2

Is there sufficient skilled staff?:Yes

Are the premises and equipment adequate? :Yes

Is there sufficient access to necessary information?:Yes

ACTORS/EXTERNAL RELATIONS

Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?:Yes

Are the relations with other relevant stakeholders adequate?:Yes

Does the organisation have adequate relations with relevant policy makers in the region and the country?:Yes

Does the organisation have a good public image?:Yes

STRATEGY

What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?

To promote biomass energy to mitigate effect of climate change.

To increase carbon sequestration by protecting natural forest.

To improve socio-economic condition of ICS promoters.

Is the staff adequately involved in planning and monitoring?:Yes

GENDER

Does the management equally treat women and men?:Yes

Does the organisation have the capacity to recognise and handle gender issues? :Yes

Does the organisation have a specific gender policy and/or strategy?:No

SOCIAL INCLUSION

Does the staff policy adequately address minority group imbalances?:No

Is there adequate attention to minority groups in the programs and projects?:No

Does the organisation have a specific social inclusion policy and/or strategy?:No

CLIMATE CHANGE

Does the institution work in climate related programs?:Yes

Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. financial and physical resources are lacking.

Institution: Dhaulagiri Solar Pvt. Ltd.
OUTPUTS/RESULTS
Does the organisation offer relevant products/services in RE? If yes then what?:Solar.
Is the relation between the output and the cost of producing it, in terms of human, financial and physical resources, acceptable?:No.
Can the organisation meet increased demand for products/services in the region?:Yes

INPUTS
Is there a sufficient number of staff? If so how many?:3
Is there sufficient skilled staff?:Yes
Are the premises and equipment adequate? :Yes
Is there sufficient access to necessary information?:Yes

ACTORS/EXTERNAL RELATIONS
Has the organisation developed a satisfaction measurement tool to estimate if the target group is satisfied with the quality of products and services delivery?:Yes
Are the relations with other relevant stakeholders adequate?:Yes
Does the organisation have adequate relations with relevant policy makers in the region and the country?:Yes
Does the organisation have a good public image?:Yes

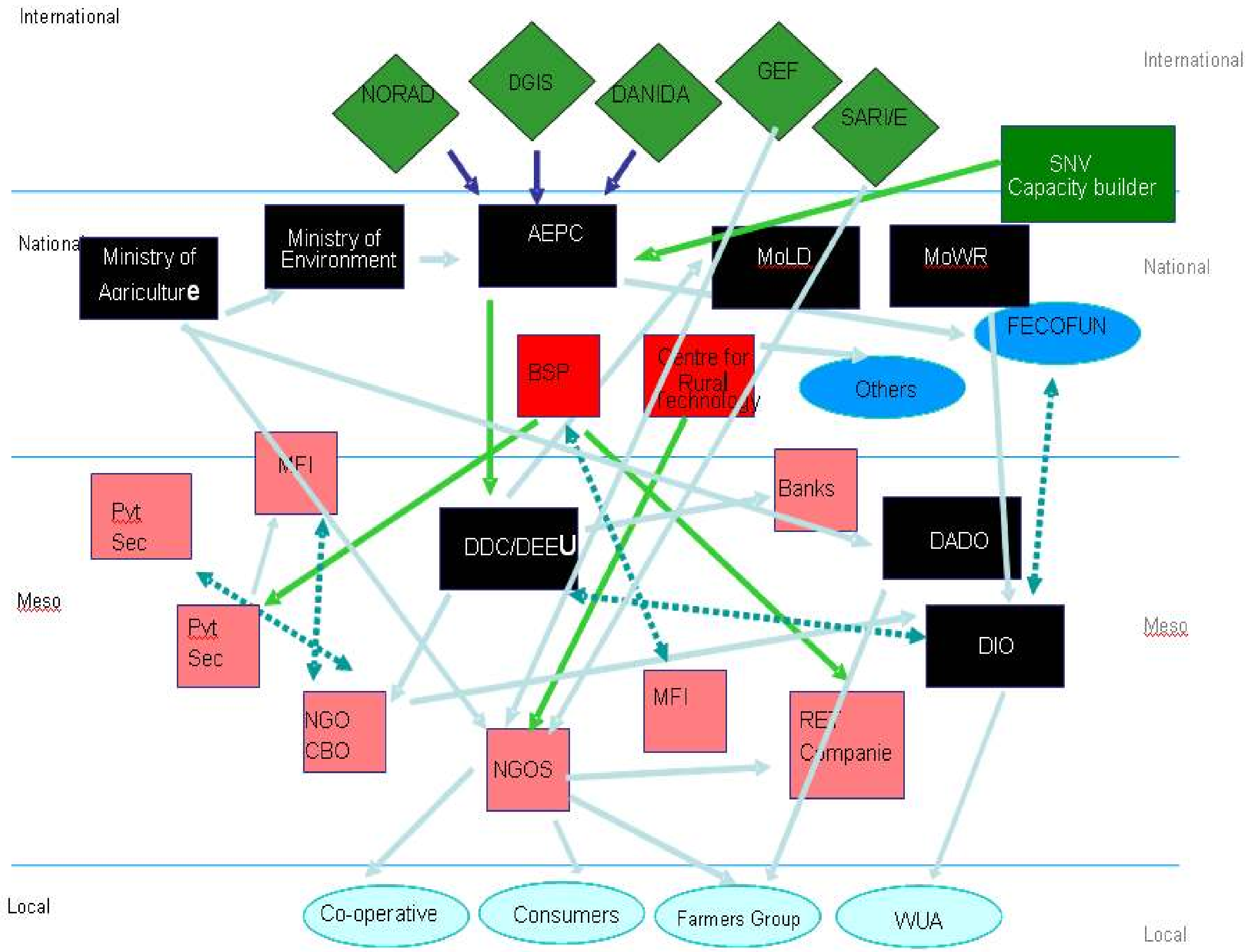
STRATEGY
What is the strategy of the organisation? Is the strategy translated in a clear realistic annual plan?
To promote solar energy to replace kerosene lamp
To declare Tuki free district
Is the staff adequately involved in planning and monitoring?:Yes

GENDER
Does the management equally treat women and men?:Yes
Does the organisation have the capacity to recognise and handle gender issues? :Yes
Does the organisation have a specific gender policy and/or strategy?:No

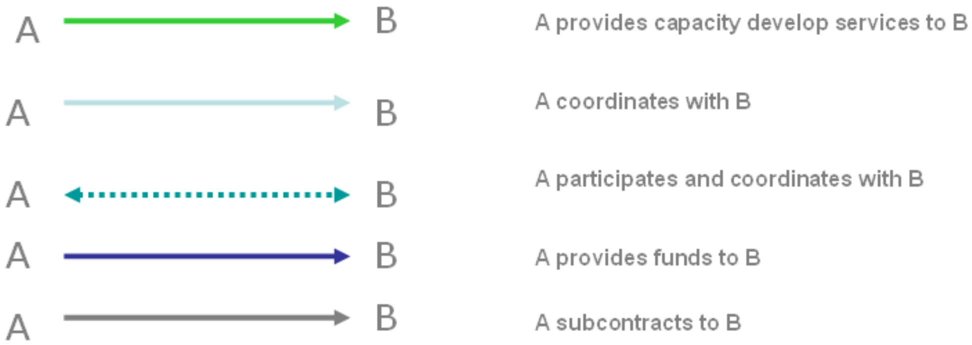
SOCIAL INCLUSION
Does the staff policy adequately address minority group imbalances?:Yes
Is there adequate attention to minority groups in the programs and projects?:Yes
Does the organisation have a specific social inclusion policy and/or strategy?:No

CLIMATE CHANGE
Does the institution work in climate related programs?:Yes
Is the institution adequately positioned to undertake climate change related projects? If not then what are the areas lacking (human resource, financial resource, physical resource)?:No. financial and physical resources are lacking.

Actor Constellation Map



Meaning of the arrows in this constellation



Meaning of the symbols

Annex 5: Checklist for FGD

Social Related Questions

List of participants
What are the different marginalised groups in the community?
Categorise the marginalised group according to economy level
What is their main source of income and amount by marginalised, gender and economy level?
What is their education level by marginalised, gender and economy level?
What is the trend of girl's education level over the five years period?
What is their main energy source by marginalised, gender and economy level?
Location of health posts what are different service one gets there and energy use
Location of school and energy use situation

Energy

What kinds of RETs exist in the community? Their uses and benefits?
What is the source of energy for technologies used? What resource is abundant/scarce?
What has been the situation of the different energy resources in terms of availability the last 5 years
What has been the situation of the different energy resources in terms of price the last 5 years?
Situation of operation and maintenance especially in the case of public/community owned systems
Availability of spare parts if not where do you go for collecting them what is the lag-time before the system is in operation again
Who is involved in the operation, maintenance, management, repair and collection of tariff (also give by marginalised, gender and economy groups?)
What are the problems encountered with respect to availability of energy forms; sufficiency, reliability, operation maintenance, replacement, of the technologies and how did you address it?
If you have/ will have sufficient and reliable energy source for operation of different end use enterprises, what kind of opportunities do you see in your region??
Who is involved in the management of traditional energy resources and who is involved in the management of current energy sources that you use now?
Which RETs are most suitable for your community and why?
Who promotes RETs in your locality?
Do you have information about available subsidies for various RETs?
What is your perception on present subsidy delivery mechanism? Are you satisfied with the present mechanism and amount? (Marginalised, gender and economy level)
What could be the alternative mechanism to benefit the women, poor, Dalit and ethnic groups?
Do you think that RETs help in improving quality of life of the women, poor, Dalit and ethnic groups? E.g. time saved improved education of the children etc.
Do you have any suggestions on how women, poor, Dalit and ethnic groups will have easy access to RETs?

Climate Change and energy

Exposure and hazards relating to climate change:

Have the communities perceived change in temperature, precipitation, season and other climate components over the years (as much as in last 30 years)
What are the extents of the changes?
How have the changes occurred?
What are the major hazards related to climate change?

Sensitivity assessment

What are the impact of climate change on key energy supply and access?
What are the magnitude, frequency and seasonality of impacts of climate change on energy?
What are the response measures of the community to impacts of climate change?

Adaptive capacity:

Are sources of feed stock/energy fuel sensitive to climate change and variability?
Is the availability and access sustainable/affordable?
Will the demand increase/decrease in the future climate scenario? (If yes, see the Energy resource vulnerability)
Which one is the best alternatives that community/industry will prefer?
What are the options of the community to deal with impacts of climate change to satisfy demand?
What are the gaps between needs and availability of resources?

Planning for adaptation

What are the priority actions for securing resources, livelihoods?
What resources are necessary to implement adaption plans?
Who are the stakeholders involved in planning and adaptation of the plan?
What is the composition of the stakeholders in terms on women (institutions), Dalit (federation) and ethnic (federation) and poor?

Institutional Aspects

Opportunity of Trainings and who conducts them
What are some of the current strategies to involve different social and gender groups in terms of developing skills, maintenance and their overall management?
Who (in terms of gender, class, and ethnic group) has got most of the training for what technologies and what should be improved in the future?
Existence of after sales services
Impact on Livelihoods including income if applicable?
Availability of financial institutions (community based, district level etc)?

Benefits

Comparison with previous technologies/energy forms in use (to be collected for marginalised, gender and economy groups):
Health (smokeless kitchen through the use of clean energy),
Increased savings
Saved time (contribution to education (be it child education or for adult literacy),
Decreased drudgery (ease of work)?
Environment (neighborhood/local) - increased greenery
What are some of the social /community benefits from the use of RET?
Positive/negative impact on household economy?

Acceptance

Are you satisfied with the technology in use?
If not why and how would you address it? What do you expect from the government?

What do you suggest for improving the situation?
How do you see your community's role in addressing the energy problem in your place?

Social and natural resource map:
Social map of the VDC - highlighting main settlements by different caste and ethnic group, economic class and women headed households if significant in the area energy (mainly for lighting & cooking) use in practice etc.
Main occupation (may indicate scale of energy demand in future) of the community, migration pattern if any (by gender, economic class and ethnicity if possible)
Natural resource map of the VDCs (highlighting forests, rivers with potentiality of micro-hydro; hazards – landslides, river cutting etc.)

Annex 6: Checklist for Key Informants for DCEP in District

What is the coordination between your organization and the RE delivery organization such as DEEU? (ESAP, AEPC, REDP)
Are there any upcoming big schemes in your sector (related or unrelated to RE) in the district?
What do you think is the main necessity in the district (energy, water, …)
Are you able to meet all the demand of RET from the district?
Do you think if the institutional setup for delivery of RETs service is sufficient in the district?
If not what should be done to facilitate smooth delivery of RET services in district?
In which RETs are you currently working on?
Do you have any plan to work on new types of RETs which you have not worked till now?
What are the plans and targets of your organization in the district? In RETs if it applies?
What is the trend of forest/agriculture/ water usage etc in your district?
Any climate induced hazards? Or effects of climate change noticed in the sector?”
How does your organization participate in sustainable resource management?
What measures does your organization take in hazard mitigation(of the resources that you work with)
What can you say about access of the community to the resources that you work with?
Any other views on climate and energy?

Annex 7 : Survey license for hydropower

Application for Survey License for hydropower (Below 1 MW)

S No	Project	Capacity (MW)	River	Latitiude N		Longitude E		VDC/District
1	Kogate Khola	0.998	Kogate	27° 31' 48"	27° 32' 30"	85° 12' 16"	85° 16' 15"	(Makawanpur)
2	Jyamire Khola	0.7	Jyamire	27° 31' 00"	27° 32' 30"	85° 07' 00"	85° 08' 00"	(Makawanpur)
3	Dodhare Khola	0.795	Dodhare	27° 33' 30"	27° 35' 05"	85° 12' 45"	85° 14' 00"	(Makawanpur)
4	Rapti Khola	0.998	Rapti	27° 30' 00"	27° 30' 53"	85° 03' 09"	85° 04' 51"	(Makawanpur)
5	Chakhel Khola	0.5	Chakhel	27° 34' 00"	27° 37' 00"	85° 10' 00"	85° 10' 12"	(Makawanpur)
6	Dodhare Khola	0.98	Dodhare	27° 33' 00"	27° 34' 32"	85° 12' 46"	85° 13' 42"	(Makawanpur)
7	Palun	1	Palun	27° 37' 30"	27° 38' 30"	85° 05' 30"	85° 08' 30"	(Makawanpur)
8	Manahari Khola SHP	0.98	Manahari	27° 32' 46"	27° 33' 45"	85° 00' 00"	85° 01' 28"	Namtar (Makawanpur)
9	Kali Khoa SHP	1	Kali Khola	00° 00' 00"	00° 00' 00"	00° 00' 00"	00° 00' 00"	Gogane (Makawanpur)
10	Churling	0.75		00° 00' 00"	00° 00' 00"	00° 00' 00"	00° 00' 00"	Sarikhet Palase (Makawanpur)
11	Samari Khola SHP	0.412	Samari Khola	27° 25' 40"	27° 26' 30"	85° 00' 05"	85° 09' 20"	Ambhanjyang,Makwanpurgadhi (Makawanpur)
12	Gorandi Khola SHP	0.96	Gorandi	27° 34' 00"	27° 37' 30"	84° 52' 30"	84° 54' 00"	Khairang (Makawanpur)
13	Kali Khoa SHP	0.8	Kali Khola	27° 35' 00"	27° 30' 30"	84° 54' 30"	84° 56' 30"	Dadakharka (Makawanpur)
14	Manahari Khola SHP	0.998	Manahari	27° 32' 00"	27° 36' 30"	84° 55' 40"	85° 00' 00"	Kalikatar (Makawanpur)
15	Chyyanduri Khola SHP	0.999	Chhyanduri	27° 37' 30"	27° 40' 00"	84° 53' 45"	84° 57' 30"	Dadakharka (Makawanpur)
16	Mel Khola SHP	0.5	Mel Khola	27° 41' 27"	27° 42' 30"	85° 03' 53"	85° 06' 39"	Tistung Deurali (Makawanpur)
17	Kali Khola SHP	0.99	Kali Khola	27° 35' 00"	27° 37' 30"	84° 55' 00"	84° 57' 30"	Dadakharka,Gogane (Makawanpur)
18	Kalika Khola SHP	0.99	Kalika	27° 37' 30"	27° 42' 00"	84° 57' 30"	85° 00' 00"	Gogane (Makawanpur)
19	Gorandi Khola SHP	0.995	Gorandi	27° 35' 00"	27° 37' 30"	84° 52' 30"	84° 55' 00"	Khairang (Makawanpur)
20	Mahadev Khola SHP	0.995	mahadev	27° 32' 30"	27° 35' 00"	84° 57' 30"	85° 00' 00"	Namtar (Makawanpur)
22	Chalti Khola HPP	0.995	Chalti	27° 38' 42"	27° 42' 29"	85° 01' 54"	85° 03' 56"	Agara (Makawanpur)
23	Lapse Khola SHP	0.5	Lapse	27° 38' 59"	27° 40' 00"	85° 00' 00"	85° 01' 49"	Agara (Makawanpur)
24	Khani Khola SHP	0.999	Khani	27° 40' 00"	27° 42' 30"	85° 00' 00"	85° 01' 49"	Agara (Makawanpur)
25	Gorandi Small HPP	0.996	Karnali	27° 37' 30"	27° 37' 53"	84° 52' 30"	84° 54' 06"	Raksorang,Khairang (Makawanpur)
26	Reuti	0.85	Reuti	27° 37'	27° 38'	84° 45'	84° 45'	Kankada

	Khola SHP			57"	35"	17"	55"	(Makawanpur)
27	Manahari Khola SHP	0.99	Manahari	27° 32' 18"	27° 34' 14"	84° 49' 54"	84° 52' 50"	Sarikhet Palase,Raksorang (Makawanpur)
28	Samari Khola SHP	0.55	Samari	27° 25' 27"	27° 27' 08"	85° 07' 48"	85° 08' 37"	Ambhanjyang (Makawanpur)

Application for Survey License for hydropower (1 to 25 MW)

S No	Project	Capacity (MW)	River	Latitiude N		Longitude E		VDC/District
1	Lower Bagmati	2.57	Bagmati	27° 34' 33"	27° 45' 00"	83° 30' 26"	83° 34' 00"	(Makawanpur)
2	Khortar Khola	1.5	Manahari	27° 26' 45"	27° 29' 30"	85° 07' 30"	85° 09' 38"	(Makawanpur)
3	Rapti	9	Rapti	27° 28' 10"	27° 30' 33"	85° 02' 30"	85° 04' 21"	(Makawanpur)
4	Mid Bagmati	4.9	Bagmati	27° 21' 41"	27° 24' 24"	85° 26' 44"	85° 29' 10"	(Makawanpur)
5	Rapti	2.185	Rapti	27° 30' 04"	27° 30' 53"	85° 03' 09"	85° 04' 51"	(Makawanpur)
6	Manahari Khoa HPP	15	Manahari	27° 34' 25"	27° 40' 00"	84° 42' 30"	84° 45' 00"	Sarikhet Palase (Makawanpur)
7	Lothar Khola HPP	11	Lothar	27° 31' 04"	27° 35' 00"	84° 47' 30"	84° 55' 38"	Kankada (Makawanpur)

Survey License for hydropower (Below 1 MW)

S No	Project	Capacity (MW)	River	Latitiude N		Longitude E		VDC/District
56	Manhari Khola	0.46	Manhari/Chyau	27° 33' 41"	27° 37' 00"	85° 01' 10"	85° 03' 05"	(Makawanpur)
57	Chakhel Khola Small	0.225	Chakhel	27° 36' 08"	27° 37' 00"	85° 11' 23"	85° 12' 30"	(Makawanpur)
91	Thado Khola	0.89	Thado	27° 35' 34"	27° 36' 15"	85° 07' 41"	85° 09' 18"	(Makawanpur)
96	Sankhamul Khola (Daman) SHP	0.65	Sankhamul	27° 37' 30"	27° 38' 15"	85° 05' 39"	85° 07' 30"	(Makawanpur)
110	Bakaiya Nadi SHP	0.998	Bakaiya	27° 14' 17"	27° 15' 55"	85° 10' 17"	85° 11' 30"	(Makawanpur)

Survey License for hydropower (1 to 25 MW)

S No	Project	Capacity (MW)	River	Latitiude N		Longitude E		VDC/District
1	Bagmati Nadi	17	Bagmati	27° 30' 20"	27° 32' 30"	85° 13' 43"	85° 15' 20"	(Makawanpur)
2	Tallo Bagmati	2.57	Bagmati	27° 29' 35"	27° 30' 18"	85° 14' 02"	85° 15' 13"	(Makawanpur)
3	Poldumki Khola	1.6	Poldumki	27° 29' 30"	27° 30' 33"	85° 04' 43"	85° 06' 00"	(Makawanpur)
4	Upper Bagmati	6	Bagmati	27° 32' 35"	27° 35' 00"	85° 14' 35"	85° 16' 40"	(Makawanpur)
5	Manahari Khola	3.6	Manahari	27° 33' 37"	27° 35' 14"	84° 52' 52"	84° 55' 18"	Kalikatar,Raksorang (Makawanpur)
6	Rapti Khola	2.185	Rapti	27° 30' 04"	27° 30' 53"	85° 03' 09"	85° 04' 51"	Bhaise,Nibuwatar (Makawanpur)

Source: Department of Electricity Distribution, Government of Nepal

Annex 8: Energy demand and supply balance

S.N	Fuel Type	Residential Sector		Industrial Sector		Commercial Sector		Overall	
		Unit	'000 GJ	Unit	'000 GJ	Unit	'000 GJ	Unit	GJ
1	Wood fuel,MT	221,212	3,705.30	14,197	237.8	1,773	29.7	237,182	3,972.80
2	Agri. Residue and Animal waste MT	45,732	574.4	-	0	-	0	45,732	574.40
3	Biogas,'000cu.m.	8,083	185.9	-	0	-	0	8,083	185.90
4	LPG,MT	3,036	149.5	1,115	54.9	57	2.8	4,208	207.20
5	Kerosene, KL	5,676	205.8	554	20.1	1,503	54.5	7,733	280.40
6	Electricity, MWH	15750	56.7	64,639	232.7	8,250	29.7	88,639	319.10
7	Coal/Coke, MT	0	0	8,834	221.9	-	0	8,834	221.90
8	Charcoal, MT	33.64	1	394	11.7	-	0	427	12.70
9	Petrol, KL	0	0	8	0.3	-	0	8	0.30
10	Diesel, KL	0	0	910	34.5	-	0	910	34.50
11	Others, GJ							-	0.00
	Total		**4,878.60**		**813.9**		**116.7**	-	**5,809.20**

		000' GJ							
	Energy type	**Wood fuel**	**Agriculture Residue and Animal Waste**	**Biogas**	**Electricity**	**Kerosene**	**Fossil fuels(Diesel, Petrol, Coal etc)**	**LPG**	**Total**
Consumption	Residential	3,705.30	574.4	185.9	56.7	205.8	1	150	4,878.60
	Industrial	237.8	0	0	232.7	20.1	268.4	54.9	813.9
	Commercial	29.7	0		29.7	54.5		2.8	116.7
	Total	**3,972.80**	**574.4**	**185.9**	**319.1**	**280.4**	**269.4**	**207**	**5,809.20**
Supply		**1,428.45**	**246.63**	**1,080.27**	**2.40**	0	0	0	2,757.75
Surplus/Deficit		**(2,544.35)**	**(327.77)**	**894.37**	**(316.70)**	**(280.40)**	**(269.40)**	**(207.20)**	**(3,051.45)**

Annex 9: List of participants in focus group sessions

जिल्ला विकास समितिको कार्यदलको निर्णयानुसार गोगने गाविसमा ऊर्जा तथा जलवायु परिवर्तनबारे अध्ययनकार्यको लागि FGD को उपस्थिति :

क्र.सं.	नाम थर	संस्था	सम्पर्क नम्बर	दस्तखत
१.	Niels Campman	Practical Action		
२.	नवराज थापा	प्र्याक्टिकल एक्सन नेपाल		
३.	लालबहादुर थिङ	जि. स्वा. का.	९८४५०२७८९८	
४.	रामचन्द्र दाहाल	CCDN	9845137695	
५.	सीताराम गुरुङ	गोगने २ स्थानीय	—	
६.	श्याम बहादुर थिङ	[illegible] गोगने [illegible]	९८४५०६२५०२	
७.	कर्सिङ लामा	गोगने-५ स्थानीय	—	
८.	गौरी लो	गोगने-२ स्वयंसेविका	—	
९.	~~[illegible]~~ निरा अधिकारी	गोगने ९	९८४५६०१२६९	
१०.	फुलमाया गुरुङ	गोगने २ स्थानीय		
११.	मिलन गुरुङ	गोगने २	9845462998	
१२.	भिम कुमार	गोगने २	9808693050	
१३.	चन्द्रकुमारी गुरुङ	गोगने-२	—	
१४.	देवकुमारी गुरुङ	गोगने-२	—	
१५.	राममाया गुरुङ	गोगने-२	—	
१६.	सुनिता ढकाल	गोगने ९ स्वयंसेविका	९८४५६००८००	
१७.	दीप ब. गुरुङ	गोगने-२		
१८.	उत्तर बे. गुरुङ	गोगने २	—	
१९.	भीमाया मोक्तान	गोगने-३ स्वयंसेविका		
२०.	तपन न्यौपाने	प्राक्टिकल एक्सन	९८४११११५८८	
२१	वसुन्धरा अधिकारी	"	९८४१०५८८९५	
२२	मिन बिक्रम मल्ल	"	९८४१०८१३१८	
२३	प्रतिमा श्रेष्ठ	गोगने - ९		
२४	विष्णुमाया गुरुङ	गोगने-२	०५६६२०८०५ ९८४५२५२५८८	
२५	कविता पलामी	गोगने ६	—	
२६	शान्ति मोक्तान	गोगने - ३		
२७.	अमिका गौतम	गोगने-५ सामाजिक परिचालक	९८४५०६६३२९	
२८	गोविन्द [illegible]	सर्व [illegible] गोगने	९८४५१९८००३	
२९	शम्भु आर्याल	जिल्ला मकवानपुर	९९१५६०१६०५	

क्र.सं.	नाम थर	संस्था	सम्पर्क नम्बर	हस्ताक्षर
३०.	भानुकान्छी लामा	स्वयंसेविका		

मिति : २०७१।८।२८

जिविसको इओ योजना अन्तर्गत दलियको ~~[illegible]~~ गाविस यस

हाख्यामा सरोकारवाला सहित छलफलको (FGD) का सहभागी विवरण।

क्र.सं.	नामथर	प्रतिनिधि संस्था	सम्पर्क नम्बर	हस्ताक्षर
१.	दामोदर द्विवेदी	नेपाली कांग्रेस	९८५५०००३८०	
२.	[illegible]	[illegible]	९८४५०३६९०५	
३.	राम बहादुर नेपाली	ए.ने.क.पा. माओवादी	९८४५३००४६२	नेपाली
४	वसुन्धरा भट्टराई	प्राक्टिकल एक्सन	९८५४०५४८६५	
५,	वासुदेव ढंगाल	आर.डि.सि. हेटौंडा	९८४५०३५८३३	
६	लोकनाथ चौलागाईं	[illegible] संघ सदस्य [illegible]	९८४५०३४६०९	
८	साधुराम थापा	शिक्षक —	९८४५०३५८३५	
९	दिवाकर पुडासैनी	[illegible] नेपाल	९८४५२२२०३२	
१०	लक्ष्मण प्र० बास्तोला	[illegible] हेटौंडा	९८४५१०३५६८	
११,	कुबेर प्रसाद खतिवडा	ए.ने.क.पा. माओवादी	९८४५१०५५५८	
१२,	सागरनाथ कोइराला	[illegible] कं०		
१३	तपस्य न्यौपाने	प्राक्टिकल एक्सन	९८४५०२८८३८	
१४.	निल विक्रम मल्ल	" "	९८५१११९४२८	
१५	Nils Campman	" "	९८५१०८३२९६	
१६	कल्पना प्र० दहाल	[illegible]	९८४५९३५६६०	

मिति: २०६६ पौष १८

जिल्ला जलवायु तथा ऊर्जा योजना तयारी कार्यक्रम अन्तर्गत रैराङ आसपासका सरोकारवालाहरु बिचको Focal Group Discussion का सहभागी विवरण

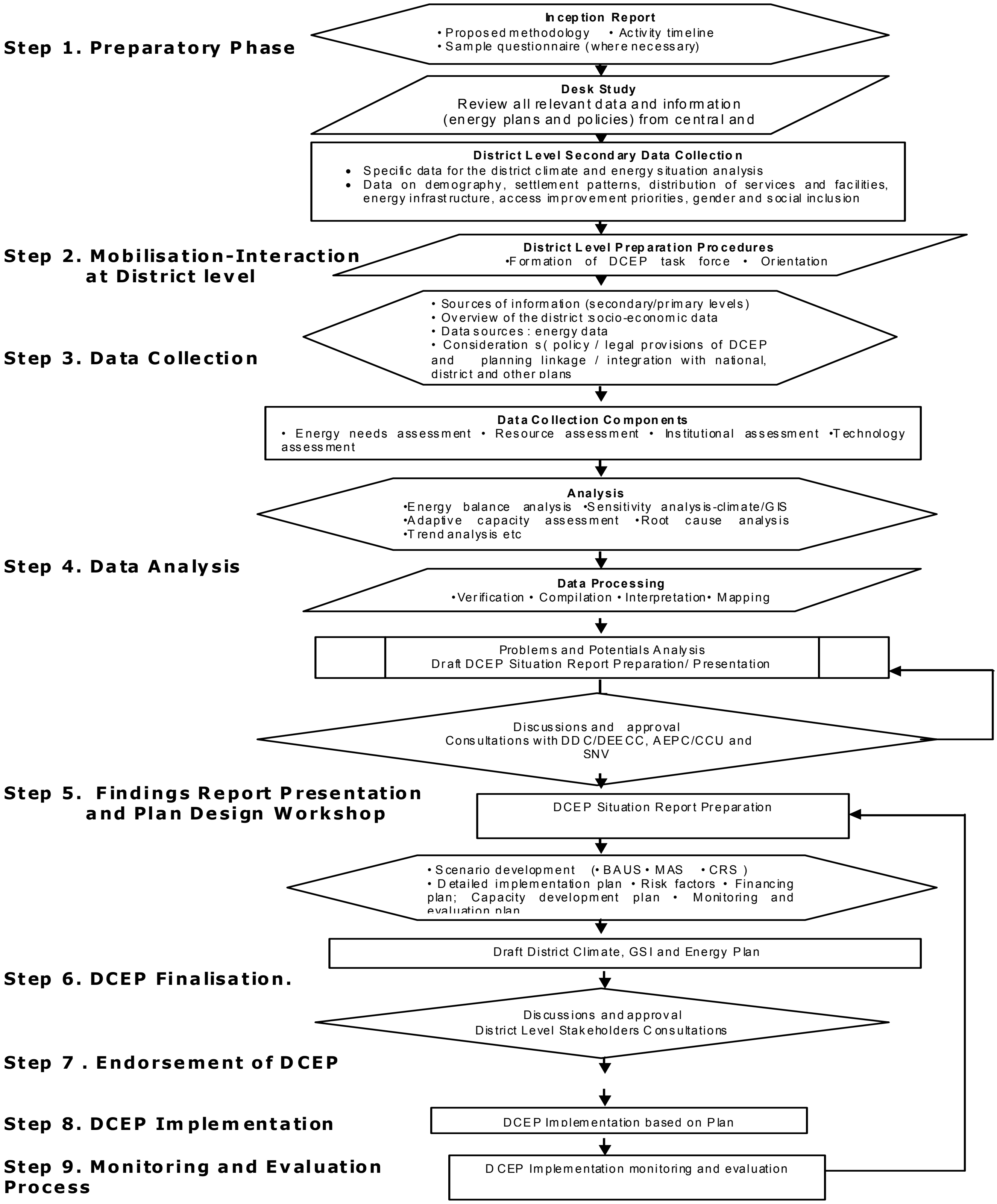
सङ्केत	नाम थर	संस्था/ठेगाना	हस्ताक्षर
१.	राम प्रसाद भट्टराई	गा.वि.स. सचिव, रैराङ	
२.	[illegible] कुमार [illegible]	रैराङ	
३	दिवाकर पुडासैनी	फ्यूचर नेपाल	
४	[illegible] कुमार सिंह	रैराङ - ८	
५	मान बहादुर [illegible]	रैराङ - ९	
६	[illegible] बहादुर विश्वकर्मा		
७	राम नाथ [illegible]	रैराङ - ७	
८.	[illegible] गौतम	" - ६	
९.	मान सिं लामा	" - ९	मान सिं
१०.	नवराज थापा	फ्यूचर नेपाल	

जिल्ला जलवायु तथा ऊर्जा योजना तयारी कार्यक्रम अन्तर्गत हटिया गाविसका सरोकारवालासँग बिच छलफल कार्यक्रमको उपस्थिति।

मिति: २०६६ मंसिर २६

क्र.सं.	नामावली	प्रतिनिधि संस्था	सम्पर्क नम्बर	हस्ताक्षर
१	दिवाकर पुडासैनी	प्र्याक्टिकल नेपाल	9845290049	
२	रविन्द्र थापा		9806874837	
३	पार्क गजुरेल			
४	लालुमाया राई		9845433495	
५	हरि प्र. गजुरेल		9845293318	
६	निर्मल कुमार पौडेल		9845388295	
७	Niels Campman	Practical Action		
८	घनश्याम ढकाल प्र.अ.	श्री निजानन्द प्रा.वि. हटिया-६	९८४५०२५८११	
९	कमला मिश्र	" " " "	९८४५०२८६६९	
१०	सरमिला लामा	" " " "	९८४५२८५०४५	
११	उर्मिला घिमिरे	" " " "		उर्मिला
१२	भवानी सापकोटा	शान्तीसमाजको सदस्य	9845207504	भवानी
१३	श्री रामकृष्ण तिवारी	श्री निजानन्द प्रा.वि. अध्यक्ष	९८४५५०८०८	
१४	यशोदा खतिवडा	शान्तीसमाज हटिया-६	९८०६४६८९५	यशोदा

Annex 10: DCEP Preparation process



Annex 11: List of PQ companies in RET

1. IWM related companies in Makwanpur

Name of the Company	Address	Contact Number	Service
GOA - Makwanpur		057-210833	IWM Service Centre; GOA
Mahalaxmi Engineering Workshop	Hetauda	9845028282	IWM Manufacturer
Prabidhi Utthan Engineering Kendra	Hetauda	057-522880	IWM Manufacturer

2. List of Qualified Solar PV Companies for dissemination of Small Solar Home System (SSHS) Only

Name of the Company	Address	Contact number
Bio Energy Pvt. Ltd.	Balaju Chowk, Kathmandu	01-6225310, 081-526837, 081-550580 (Nepaljung)
Clean Home's Energy Pvt. Ltd	Kathmandu 15, Sano Bharyang	01-4673198,01-4673212
Deep Light Energy Pvt. Ltd.	Morang, Biratnagar 14, Mahendra Chowk	021-528427, 4381503
Dhaulagiri Solar and Electronics Company Pvt. Ltd.	Balaju, Kathmandu	01-4365376, 012093109
Dibya Urja Pvt. Ltd.	Kathmandu, Maharajgunj 4, Narayan Gopal Chowk	01-4720996
Energy and Construction Company Pvt. Ltd.	Kalanki, Kathmandu	16220189
Energy International Pvt. Ltd.	Jawal, Lalitpur	5543482
Energy Prabardhan Company Pvt. Ltd.	Kathmandu Gongabu 7, Manohar Awas Chhetra	01-4353697
Everest Solar Energy Pvt. Ltd.	Gogabu, Tokha Road Kathmandu	4360086
Karnali Solar and Hydropower Company Pvt. Ltd.	Jumla, Chandannath 6, Bijayanagar	087-520188
Kathmandu Power Company Pvt. Ltd.	Kapan Marga, Kathmandu	4107716, 01-2111162
Kinetic Energy Pvt. Ltd.	Chabhil, Kathmandu	081-525484, 4499668
Krishna Grill and Engineering Works Pvt. Ltd.	Bhumiparsasan Chowk, Biratnagar	021-525492, 021-535904, 4650919
Lasersun Energy Pvt. Ltd.	Pulchowk Lalitpur	5536171, 5549607
Lek Bensi Sourya Urja Tatha Gobar Gas Sewa Company Pvt. Ltd.	Rupandhei, Butwal	071-542538
Looja Nepal Company Pvt. Ltd.	Kathmandu 2	01-4427264
Lotus Energy Pvt. Ltd.	Bhatbhateni, Kathmandu	4418203
MET and GUP Pvt. Ltd.	Kathmandu 14, Gankhel	01-4279111, 01-4273128
Nabajyoti Urja Pvt. Ltd.	Maharajung, Chakrapath, Kathmandu	4363506
Nepal Energy Development Company Pvt. Ltd.	Bharatpur-10, Chitawan	056521563, 5525332
Perennial Energy Nepal Pvt. Ltd.	Thribam sadak, Naxal, Kathmandu	4414363, 4414674
Premiere Energy Pvt. Ltd.	Morang, Biratnagar 14, Himalayan Road	021-537198
Rural and Alternative Energy Pvt. Ltd.	Samakhushi, Kathmandu	065-560573, 4388604, 4388605
Scientific Technology Pvt. Ltd.	Tangal, Kathmandu	4423638, 4419179
Solar Electricity Company Pvt. Ltd.	Bagbazar, Kathmandu	4225253
Sourya Energy Pvt. Ltd.	Kathmandu 7, Gopikrishna Nagar, Chabahil	01-6216650

Sourya Urja Nepal Pvt. Ltd.	Kathmandu, Dhumbarahi 4	01-6225365
Sprint International Pvt. Ltd.	Baluwatar, Kathmandu	4412338
Sun Power company	Baluwatar, Kathmandu	4440354, 4426658
Sunrise Energy and Accessories Works	Kathmandu, Ichangu Narayan 6, Sano Bharyang	01-4891451
Sunshine Energy Pvt. Ltd.	Samakhushi, Kathmandu	4353538
Suryodaya Urja Pvt. Ltd.	Dhapasi VDC-2, Lilanagar	4379000
Swabhiman Urja Bikash Company Pvt. Ltd.	Mahandra path Baglung	068-520818, 068-520718
Swogun Energy Pvt. Ltd	Samakhushi, kathmandu	4362505
Urja Ghar Pvt. Ltd.	Balaju, Devakota Margh, Kathmandu	4384725
Renewable Energy Nepal		
Alternative Energy Pvt. Ltd.		
North Energy Company		
Sun Light Solar Company		

3. List of Qualified Solar PV Companies for dissemination of Solar Home System (SHS)

Name of the Company	Address	Contact number
Bio Energy Pvt. Ltd. , Nepaljung, Banke	Balaju Chowk, Kathmandu	01-6225310, 4387026, 081-550580 (Nepaljung)
Clean Home's Energy Pvt. Ltd., Banasthali, Kathmandu	Kathmandu 15, Sano Bharyang	01-4673198,01-4673212
Deep Light Energy Pvt. Ltd.	Morang, Biratnagar 14, Mahendra Chowk	021-528427, 4381503
Dhaulagiri Solar and Electronics Company Pvt. Ltd.	Balaju, Kathmandu	01-4365376, 012093109
Dibya Urja Pvt. Ltd., Maharjung, Kathmandu	Kathmandu, Maharajgunj 4, Narayan Gopal Chowk	01-4720996
Energy and Construction Pvt. Ltd.	Kalanki, Kathmandu	16220189
Energy International Pvt. Ltd., Jawagal, Lalitpur	Jawal, Lalitpur	5011019
Everest Solar Energy Pvt. Ltd., Samakhshi, Kathmandu		4360086
GUP Pvt. Ltd.	Kathmandu 14, Gankhel	01-4279111, 01-4273128
Kinetic Energy Pvt. Ltd	Chabhil, Kathmandu	01-4462982/4499668
Krishna Grill and Engineering Works Pvt. Ltd., Biratnagar, Morang	Bhumiparsasan Chowk, Biratnagar	021-525492, 021-535904, 4650919
Kathmandu Power Company Pvt. Ltd., Maharajgunj, Kathmandu	Shanti Nagar, Baneswor, Kathmandu	4650395, 01-2111162
Lek Bensi Sourya Urja Tatha Gobar Gas Sewa Company Pvt. Ltd., Butwal, Rupandehi	Rupandhei, Butwal	071-542538, 4384725
Lasersun Energy Pvt. Ltd., Pulchowk, Lalitpur	Pulchowk Lalitpur	5536171, 5549607
Lotus Energy Pvt. Ltd., Bhatbhatani, Kathmandu	Bhatbhateni, Kathmandu	4418203
Manasalu Energy Pvt. Ltd.	Koteswor, Kathmandu	01-6203012
North Energy Company	Butwal	071-698440
Nepal Energy Development Company Pvt. Ltd., Bharatpur, Chitwan	Bharatpur-10, Chitawan	056521563, 5525332

Nabikaraniya Urja Pvt. Ltd.	Balaju-16, Kathmandu	01-4387026
Perennial Energy Nepal Pvt. Ltd., Naxal, Kathmandu	Thribam sadak, Naxal, Kathmandu	4414363
Rural and Alternative Energy Pvt. Ltd., Damauli, Tanahu	Samakhushi, Kathmandu	065-560573, 4388604, 4388605
Rastriya Gramin Tatha Baikalpik Urja Vikas Pvt. Ltd.	Janakitol-18, Mahendranagar, Kanchanpur	099-520068/521699
Renewable Nepal Alternative Energy Pvt. Ltd.	Balaju, Kathmandu	4381445
Swabhiman Urja Bikash Company Pvt. Ltd., Mahendra Path, Baglung	Mahandra path Baglung	068-520818, 068-520718, 4384632
Suryodaya Urja Pvt. Ltd., Dhapasi, Kathmandu	Dhapasi VDC-2, Lilanagar	4379000
Solar Electricity Company Pvt. Ltd., Bagbazar, Kathmandu	Bagbazar, Kathmandu	4225253
Sourya Energy Pvt. Ltd., Chabahil, Kathmandu	Kathmandu 7, Gopikrishna Nagar, Chabahil	01-6216650
Sunrise Energy and Accessories Works	Kathmandu, Ichangu Narayan 6, Sano Bharyang	01-4891451
Sun Light Solar Company	Kalanki, Kathmandu	4282698
Sprint International Pvt. Ltd., Kamalpokhari, Kathmandu	Baluwatar, Kathmandu	4412338
Sunshine Energy Pvt. Ltd., Samakhshi, Kathmandu	Samakhushi, Kathmandu	4353538
Suntech Energy Co., Pvt. Ltd	Kuleswor, Kathmandu	01-4281995
Scientific Technology Pvt. Ltd., Tangal, Kathmandu	Tangal, Kathmandu	4423638, 4419179
Sourya Urja Nepal Pvt. Ltd.	Kathmandu, Dhumbarahi 4	01-6225364
Sun Power company	Baluwatar, Kathmandu	4440354, 4426658
Swogun Energy Pvt. Ltd., Samakhushi, Kathmandu	Samakhushi, kathmandu	4362505
Urja Ghar Pvt. Ltd., Balaju, Kathmandu	Balaju, Devakota Margh, Kathmandu	4388438, 016911556

4. List of Pre-Qualified of Consulting Companies for Survey & Design of the Micro Hydropower Projects

Company Name	Address	Contact Numbers
DL Energy Concern Pvt. Ltd.	Kathmand-29, Mitranagar, Nepal	01-4354398, 9841535366
Motherland Energy Group Pvt. Ltd.	Banasthali, Balaju, Nepal GPO Box No: 20506, Kathmandu.	01-4385585, 01-4350580
Technical Engineering Design Consultancy & Construction Pvt. Ltd.	Kalanki, Kathmandu	01-4671657
CADS Consultancy & Hydro Research Pvt. Ltd.	Jwagal -10, Lalitpur	01-5542051
Great Nepal Pvt. Ltd.	Jwagal, Kupondole, Lalitpur, Nepal GPO Box No : 9957, Kathmandu	01-5546859; 01-5011213
Lamjung Electricity Development Company Pvt. Ltd.	Lazimpat, Kathmandu, Nepal GPO Box No : 20290, Kathmandu	01-4414519
Integrated Rural Development Services (IRDS) Pvt. Ltd.	Balkhu, Kathmandu Nepal GPO Box No : 1346 Kathmandu	01-4279111;01-4273128
DE Consultancy Pvt. Ltd.	Old Baneshwor, Kathmandu GPO Box No : 8973,NPC-585, Kathmandu	01-4470866; 9851023573

Masina Continental Associates Pvt. Ltd.	Baneshwor, Kathmandu GPO Box No :2995, Kathmandu	01-4473163
Professional Engineering Consultant (PEC)	Ichangu 6, Sanovryang, Kathmandu.	9841419189
Multiscope Consultancy Pvt. Ltd.	Baneshwor, Kathmandu,Nepal GPO Box No :8975 EPC 435, Kathmandu	01-6912467
Integrated Management And Engineering Research Consultacy Pvt. Ltd.	Kupondole, Lalitpur, Nepal GPO Box No :3178	01-5542613
Nepal Engineering & Power Development Consultants Pvt. Ltd.	Thapathali, Kathmandu GPO Box No : 746, Kathmandu	01-4222202
Pioneer Architect & Consulting Engineers Pvt. Ltd.	Kupondole, Lalitpur. GPO Box No : 20263, Kathmandu	01-5549954
Green Consult Pvt. Ltd.	Kathmandu-32,Nepal	9841330142
Team Nepal Engineering Consultancy and Research Centre Pvt. Ltd.	Kupondole, Lalitpur,	01-2291140; 9841515761
Energy Development Services Pvt. Ltd.	Sitapila-2, Kathmandu Nepal GPO Box No5565 Kathmandu	01-4033016;9841209736
Energy Links Pvt. Ltd.	Dhapasi-08,,Kathmandu, Nepal	01-4356587
Complete Engieers' Innovaton Pvt. Ltd.	Gwarko, Lalitpur, Nepal GPO Box No : 12092, Kathmandu	9851107585
North Engineering Company Pvt. Ltd.	Minanagar, Butwal, Nepal GPO Box No : 54, Kathmandu, Nepal	071-550181
B. N. Consultancy Pvt. Ltd.	New Baneshwor, Kathmandu GPO Box No :2037, Kathmandu	01-4109789; 01-6204058
Gramin Urja Tatha Prabidhi Sewa Kendra Pvt. Ltd.	Kumaripati, Lalitpur,Nepal GPO Box No :3628	01-557556
D. A. T. Engineering Consultancy Pvt. Ltd.	Syuchatar, Adarhanagar, Kalanki, Kathmandu GPO Box No: 5794. Kathmandu	01-4032687
Abiral Development and Research Consultancy Pvt. Ltd.	Ichangunarayan-8, Kathmandu	01-2130277
Multi Power Construction Company Pvt. Ltd.	Minbhawan-34, Kathmandu,Nepal GPO Box No: 20997, Kathmandu.	01-4462931;01-2043686
Center For Resource Conservation Nepal Pvt. Ltd.	Kirtipur-1, Amritnagar, Kalanki	01-4333312
Remote Area Development Engineerig Consultacy Pvt. Ltd.	Sitapaila-1, Kathmandu.	01-4276507
Alliance Consultants Pvt. Ltd.	New Baneshwor, Kathmandu. GPO Box No: 10728, Kathmandu.	01-6916772
Rural & Alternative Energy Pvt.	Damauli, Tanahaun, Nepal	065-560573; 056-560873
Energy Prabardhan Company Pvt. Ltd.	Gongobu-7, Kathmandu.	01-4353697
Center for Appropriate Technology Nepal Pvt. Ltd	Battishputali, Sahitya Marh, 158 GPO Box No: 2883, Kathmandu.	01-21316066
Oshin Power Service Pvt. Ltd.	Butwal Municipality-6, nepal GPO Box No : 30, Kathmandu	071-545217
Everest Engineering Consultant	Old Banseshowr, Kathmandu. GPO Box No: 19103, Kathmandu.	01-4493785; 01-4481449
Universal Consultant Services Pvt. Ltd.	Balaju Chowk, Kathmandu.	01-4350580; 01-4385585
Engineering and Educational Services Pvt. Ltd. & AID Engineering Consultancy Pvt. Ltd. (JV)	Maharajgunj, Kathmanu Chakupat , Lalitpur	01-4721295; 9841278739

Hydro Energy Concern Pvt. Ltd.	: Samakoshi, Kathmandu	01-4355416; 01-4354186
Modern Hydropower & Energy Development Pvt.	Ichangunarayan-6, Kathmandu.	01-4890593
EPSOM Engineering Consultancy Pvt. Ltd.	Kupondole, Lalitpur. GPO Box No : 8973 NPC-585, Kathmandu	01-5546792; 9851070202
Housing Services Company Pvt. Ltd.	Natole-20, Pulchowk, Lalitpur. GPO Box No: 176, Lalitpur.	01-5547485; 01-5541864
Inculsive Consultants Pvt. Ltd. JV Strength Engineering Company	Anamnagar, Kathmandu Baneshwor, Kathmandu,Nepal GPO Box No : 3426, Kathmandu	01-2023679;01-4783183
SITARA Consultant Pvt. Ltd.	Kupondole ,Lalitpur,Nepal GPO Box No: 8973, NPC-763, Kathmandu.	01-5520630; 01-6914281
MEC Consultancy Pvt. Ltd.	Dhapasi, Basundhara, Kathmandu	01-6915612
Consultancy For Engineering Works and Development Pvt. Ltd.	Kirtipur-08, Kathmandu. GPO Box No: 19647, Kathmandu	01-4332368
Hulas Steel Industries Limited	Kamladi, Kathmandu GPO Box No :4129, Kathmandu	01-4445732; 01-4445735
Forum for Energy & Enviroment Development Pvt. Ltd.	Krian Bhawan, Sanepa, Lalitpur. GPO Box No :12756 Kathmandu	01-5521238; 01-5548938
K.P. Business Service Pvt. Ltd. JV Synergy Company Pvt. Ltd.	Birendranagar 6, Surkhet.	083-521428; 9848029365
Krishna Grill & Engineerng Works Pvt. Ltd.	Main Road South Bhumiprasasan Chowk, Biratnagar, Morang. GPO Box No :150 Kathmandu	021-525492
GOGEC Nepal Pvt. Ltd. JV ECoCoDE Nepal Pvt. Ltd	Buddhanagar, Kathmandu Tinkune,Gairigaun, Kathmandu. GPO Box No : 20800, Kathmandu	01-4783060
Sagarmatha Engineering Company & Consultancy Pvt. Ltd.	Kupondole, Lalitpur.	01-5011588
Village Development & Working Consultancy Centre Pvt. Ltd.	Kalanki, Kathmandu. GPO Box No : 26096, Kathmandu	01-22969239
Design Point Pvt. Ltd.	Kupondole, Lalitpur.	01-5011104
Himchuli Consultancy Pvt. Ltd. JV Novel Creation Engineering Consultancy Pvt.	Banepa-5, Kavre Maitririnagar-2, Kirtipur.	011-680435; 9841805432

5. List of Pre-Qualified Installation / Construction Companies for Improved Water Mills (IWM) Electrification / Pico / Micro Hydropower Project

Eligible to carry out Installation/Construction of Micro Hydropower Projects up to 100 kW capacity

Company Name	Address	Contact Numbers
Hulas Steel Industries Limited	Kamaladi 01, Kathmandu, Nepal GPO Box No :4129 Kathmandu	01-4445732/35
Nepal Machine & Steel Structure	Bhuwaneshwori Marg06. Butwal Rupendhei, Nepal GPO Box No :22 Butwal Rupendehi	071-542522
Krishna Grill & Engineering Works PL	Main Road South, Bhumiprasasan Chowk 13, Biratnagar Morang, Nepal GPO Box No : 150, Biratnagar	021-525492

Oshin Power Services P L	BTI Complex, Campus Road, Butwal 02, Rupendhei,Nepal GPO Box No :30,Butwal	071-545217
North Engineering Company P L	Kalika Path, Manila Nagar 04. Rupandhei,Nepal GPO Box No : 54 Rupandhei	071-550181
Thapa Engineering Industries P L	Butwal Industrial Estate 12, Rupendhei, Nepal	071-551560; 071-543658
AG Power Company P L	Aadarshanagar, Syuchatar 01, Kathmandu Nepal GPO Box No :5794 Kathmandu	01-4032687
Dhaulagiri Civil Electrical Mechanical Engineering P L	Shreenagar tole 02, Baglung,Nepal	068-520221; 068-520836
Himalayan Power Industry	Naghal 17, Kathmandu,Nepal GPO Box No :4889 Kathmandu	01-4259069
Housing Services Company P L	Natole, Pulchowk,Lalitpur,Nepal GPO Box No : 176,Lalitpur	01-5547485; 01-5541864
Lumbini Enginering and HP Company	Swyambhu 16, Kathmandu,Nepal GPO Box No :11430,Kathmandu	01-2180144; 014287818
Hydro Energy Concern P L	Samakoshi-Kathmandu,Nepal GPO Box No :8975,EPC5042 Kathmandu	01-4355416
Power Tech Nepal PL	Patan Industrial Estate 05,Patan,Nepal GPO Box No : 03418	01-5522263; 01-5543076
Rural & Alternative Energy P L	Main Road 11, Tanuhn, Nepal	065-560573 ; 065-560873
Universal Consultancy Services Pvt. Ltd	Balaju Chowk 16, Kathmandu,Nepal GPO Box No :20506 Kathmandu	01-4350580 ; 01-4385585
Motherland Engineering Group P L	Balaju Chowk 16, Kathmandu,Nepal	01-4385585 ; 01-4350580
Multi Power Construction Company P L	Minbhawan 34, Kathmandu Nepal GPO Box No. 20997 Kathmandu	01-2043686 ; 01-4462931
Multi Service Link Nepal PL	Kalanki 14,Kathmandu Nepal	01-6208789
Great Nepal P L	Jwagal, Kupandole, Lalitpur,Nepal GPO Box No : 9957, Kathmandu	01-5546859 ; 01-5011213
Radha Structure & Engineering Works PL	Baneshwor 34, Kathmandu, Nepal GPO Box No :20989,Kathmandu,Nepal	01-4472111
Center for Resource Conservation Nepal P L	Amritnagar,Kirtipur,01,Kathmandu, Nepal	01-4333312
Nepal Energy Development Company P L	Ekantakuna 08, Lalitpur,Nepal	01-5525332
Energy Prabardhan Company P L	Gongabu 07.Kathmandu Nepal GPO Box No :24144 Kathmandu	01-4353697
Gautam Energy Engineering PL	Butwal Industrial Estate 12, Butwal, Rupendehi,Nepal	071-550140
Kathmandu Metal Industries & Hydropower P L	Naghal 17,Kathmandu,Nepal GPO Box No :4889, Kathmandu	01-4259069
Nepal Yantrashala Energy	Lagankhel12, Lalitpur,Nepal GPO Box No : 8975EPC2041	01-5522167
Appropriate Engineering Butwal	Kalikanagar 11,Butwal, Rupendhei,Nepal	071-437748
Seimens Hydro Engineering & Energy Production	Baglung Municpality 02, Baglung	068-520822
Universal Equipment Industries	Butwal Industrial Estate 12.Rupendhei Nepal.	071-5400074
Remote Area Development Engineering Consultancy P L	Sitapaila 04, Kathmandu,Nepal	01-4276507
Manaslu Engineering Pvt. Ltd	Balaju 16, Kathmandu,Nepal	01-6203012

Technical Engineering Design Consultancy & Construction PL	Santoshi Tole, Kalanki 14, Kathmandu,Nepal GPO Box No : 26096 Kathmandu	01-4671657
H A Hydro Power P L	Chhorepatan17, Pokhara,Nepal GPO Box No :302,Pokhara	061-460118 ; 061-463330
K P Byawasayi Sewa JV Synergy Company P L	Buddha Pathline, Birendranagar, Surkhet,Nepal	083-521428
Techno Village Consultancy PL	Kupondole 10, Lalitpur,Nepal GPO Box No : 8975EPC 1522	
CADS Consultancy & HydroResearch P L	Jwagal 10, Lalitpur,Nepal	01-5542051
Sitara Consult JV Cosmic Electrical Engineering Associates P L	Kupondol 11, Lalitpur,Nepal GPO Box No :8973,NPC-763	01-6914281; 01-5520630
D L Energy Concern P L	Mitranagar 29, Kathmandu,Nepal	01-4354398
Himali Power Development P L	New Road, Bharatpur 04, Narayangadh, Chitwan,Nepal	056-692893
Joint Ventures - Epsom Engineering Consultancy P L, Dhulikhel Nirman Sewa P L & Engineering Consultancy for Constructive Development Efforts in Nepal P L	Kupondole , Lalitpur,Nepal Baneshwor-10, Kathmandu,Nepal GPO Box No : 8973 NPC-585, Kathmandu	01-5546792
Green Tech Nepal PL, Axiom Engineering Industries &Sewa's Consortium P L	Kupondole 10,Lalitpur,Nepal GPO Box No :4505,Kathmandu	01-6210330; 01-5011158
Energy Development Services P L	Sitapila 02, Kathmandu,Nepal GPO Box No :5565,Kathmandu	01-4033016; 01-41209736
Cream Hydel PL	Shankarnagar 02,Butwal Rupendhei,Nepal GPO Box No :88,Butwal	071-437416;071 -438670
Tej Energy Solution Nepal P L	Kathmandu Metropolitan Ward No. 35, Old Sinamangal, Pepsi Cola Town Planning Area	01-4992942
Eligible to carry out Installation/Construction of Micro Hydropower Projects up to 5 kW capacity		
Himchuli Consultancy P L	Banepa 05, Kavre,Nepal	011-680435
Ujyalo Consultancy P L	Chautara-8, Sindupalchowk,Nepal	011-620326
Technology Upliftment Engineering Centre	Thanavarang 11, Hetuda, Makwanpur,Nepal	057-522880
Renewable Nepal Alternative Energy PL	Balaju 16, Kathmandu,Nepal GPO Box No : 5691, Kathmandu	01-4381445; 01-6207110
Nepal Power Solution P L	Palpasa Road Siddhartha path-24, Hetuda, Makwanpur, Nepal.	057-691955;057-210833
Design Point P L	Jwagal 10, Lalitpur,Nepal	01-5011104
Nuwakot Prabidhi Tatha Pariyojana Sewa Kendra PL	Bidur 03.Nuwakot,Nepal	10-681062
Maa Shakti Engineering & Hydropower P L	Gatthaghar 15, Bhaktapur,Nepal	01-6635391
Singhabahini Engineering Works	Mayanglung 02, Tehrathum, Nepal	026-460685
Khanal Engineering and Industries	Butwal Industrial Estate, Butwal, Rupandhei,Nepal	071-544492
Dhaulagiri Hydro Consult Butwal P L	Butwal Industrial Estate 12. Rupendhei,Nepal	Tel :071-540496;071-546422
Siddhartha Engineering Works	Nepalgunj Industrial Estate, Building No. 22, Nepalgunj, Banke, Nepal	081-523017
Institute of Rural Technology Development P L	Butwal Industrial Estate, Rupendhei,Nepal	071-540074

6. List of Biogas Companies in Makwanpur

Company Name	Address	Contact Number
All Nepal Biogas Company	Hetauda-3, Makawanpur	057- 5221910
Biogas Tatha Urja Bikas Company		
Baikalpik Urja Bikas Company		
Gobar Gas Tatha Krishi Yantra Bikas		
Hetauda Gobar gas		
National Iron and Alternative Power Development Company		
Nil Kamal Gobar Gas	Hetauda-8, Makawanpur	057-524388
Ratna Jyoti Gobargas Tatha Urja Bikas Company		
Rapti Renewable Energy Service	Hetauda -4, Huprachour, Makawanpur	057-521825
Rastriya Gobar Gas Nirman Tatha Sewa	Hetauda, Makwanpur	057- 523414
Shova Biogas Company		

Annex 12: LEAP fact sheet by Stockholm Environment Institute's

Software name:	Long-range Energy Alternatives Planning System (LEAP)
Application:	Energy policy analysis and climate change mitigation assessment
Current users:	Government agencies, academics, NGOs, energy utility companies, consulting companies
Distribution:	Distributed free of charge to academic, governmental and not-for-profit organisations based in the developing world. Materials are available for download at the COMMEND website (www.energycommunity.org)

Introduction

The Long-range Energy Alternatives Planning System (LEAP), developed by the Stockholm Environment Institute, is a widely-used software tool for energy policy analysis and climate change mitigation assessment.

Hundreds of organisations in more than 150 countries worldwide have adopted LEAP. Its users include government agencies, academics, non-governmental organisations, consulting companies, and energy utilities. It has been used at many different scales ranging from cities and states to national, regional and global applications, especially in the developing world.

The United Nations recently announced that more than 85 countries have chosen to use LEAP as part of their commitment to report to the U.N. Framework Convention on Climate Change (UNFCCC).

Integrated planning

LEAP is an integrated modelling tool that is used to track energy consumption, production and resource extraction in all sectors of an economy. It can be used to account for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks. In addition to tracking GHGs, LEAP can also be used to analyse emissions of local and regional air pollutants, making it well-suited to studies of the climate co-benefits of local air pollution reduction.

Flexibility and ease-of use

LEAP presents complex energy analysis concepts in a transparent and intuitive way. It is flexible enough for use by users with a wide range of expertise: from leading global experts who wish to design policies and demonstrate their benefits to decision makers to trainers who want to build capacity among young analysts who are learning to understand the complexity of energy systems.

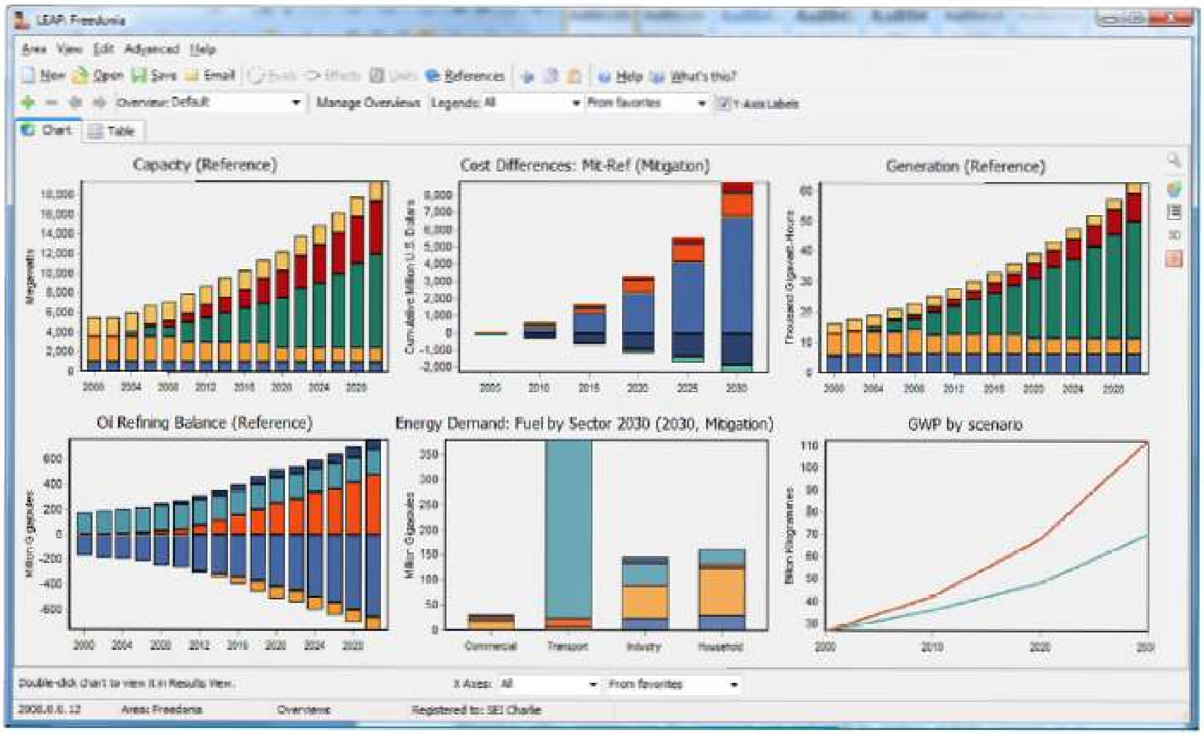


Photo: Richard Clay

Modelling methodologies

LEAP is a tool that can be used to create models of different energy systems. It supports methodologies on both the demand side (for example, stock-turnover) and the supply side (for example, capacity expansion planning). LEAP's modelling capabilities operate at two basic conceptual levels. At the first level, LEAP's built-in calculations handle 'non-controversial' energy, emissions and cost-benefit accounting. At the second level, users can enter specific time-varying data or create a wide variety of sophisticated multi-variable models.

Timeframe

LEAP is intended as a medium to long-term modelling tool. Most of its calculations occur at yearly intervals, but can be extended for an unlimited number of years. Most studies use a forecast period of between 20 and 50 years. It is also possible to split a year into different user-defined "time slices" to represent seasons, types of days or even representative times of the day. Studies typically include both a historical period, in which the model is run to test its ability to replicate known statistical data, as well as multiple forward looking scenarios.

Scenario analysis

Using LEAP, policy analysts can create and then evaluate alternative scenarios by comparing their energy requirements, their social costs and benefits, and their environmental impacts. Policy makers can use LEAP to assess the marginal impact of an individual policy as well as the interactions that occur when multiple policies and measures are combined.

Low initial data requirements

As LEAP relies on simple accounting principles, and because many aspects of LEAP are optional, its initial data requirements are relatively low. This means that users can rapidly create a simple initial analysis, before adding complexity when data is available and where the added detail provides further useful insights into the issue. In this way energy and environmental forecasts can be prepared before any cost data have been entered.

Policy impacts

LEAP has had a significant impact in shaping energy and environmental polices worldwide. For example:

In China, the Chinese Energy Research Institute (ERI) has used LEAP to explore how China could achieve its development goals while also reducing carbon intensity. These studies have helped to influence national energy policies and plans.

In the US, the Natural Resources Defense Council (NRDC) uses LEAP to analyse national fuel economy standards and advocate for policies that encourage clean vehicles and fuels.

In Rhode Island, LEAP has been the main tool for analysing and monitoring the State's award-winning GHG mitigation process, in which multiple stakeholders are guiding the State's efforts to meet its GHG emission reduction goals.

In the Philippines, LEAP is used by the Department of Energy to help develop its National Energy Plans.

Decision support system

LEAP is more than just a model: it is a full decision support system providing extensive data management and reporting capabilities. It can serve as both a historical database showing the evolution of an energy system and a forward-looking scenario-based tool. LEAP provides powerful data management tools including full importing and exporting to Microsoft Excel, Word and PowerPoint, and a rich graphical environment for visualising data and results.

Training and capacity building

For over twenty years LEAP has been an important tool in training and capacity building programmes. SEI has created a range of training materials designed to support national and international institutions across the globe. These are available in 6 languages, including Spanish, Portuguese and French, and have been used by SEI and its partners in seminars and training workshops worldwide. The training materials are designed to draw out typical energy-environment policy dilemmas, and to encourage trainees to think about the trade-offs inherent in different policy options.

LEAP

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